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ABSTRACTS
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SYMPOSIA AND ORAL SESSIONS

Triennial Reproduction Symposium: Symposium I — The Follicle and Oocyte

1 The dominant ovarian follicle. M. C. Lucy*, *University of Missouri, Columbia.*

The dominant ovarian follicle (DF) occupies a central role in reproductive biology. Essential functions of the DF are to nurture and ultimately release the oocyte and to synthesize hormones that control reproduction. The very fact that the DF does not undergo atresia makes it unique among ovarian follicles. Considerable effort has been placed on the study of DF recruitment (the development of a follicular cohort from which the DF is selected) and selection (continued growth of the DF and regression of the remaining members of the cohort). Recruitment and selection may yield a single DF (e.g., cattle and horses), a small number of co-dominant follicles (sheep) or a large number of follicles that could be viewed as non-dominant (swine). The mechanisms through which dominance is established or not established (co-dominant and non-dominant scenarios) are of interest from a purely scientific perspective but also are important to applied reproduction. For example, overcoming dominance is the basis for superovulation and failed dominance is the basis for multiple ovulations in otherwise mono-ovulatory species (often viewed as undesirable). In most animals, the DF is short-lived; existing long enough to allow for the final maturation of the oocyte. An exception to this rule is found for cattle that develop at least one non-ovulatory DF during the estrous cycle. The end of dominance is triggered by the LH surge; an event initiated by the mature DF. The LH surge redirects the DF toward its ultimate demise (luteinization, ovulation, and differentiation into the corpus luteum). Maturation of the DF and initiation of the LH surge, which are eloquently timed in the natural setting, have proved cumbersome to manage pharmacologically. Treatments that are designed to extend the period of dominance, induce luteal regression and (or) cause ovulation may fail because the DF does not intrinsically control its developmental program. The metabolic status of an animal impinges on the DF as well and this relationship links nutrition and reproduction together. Future work on the DF will clarify the mechanisms that control DF growth and development in farm animals.

Key Words: Ovary, Dominant follicle

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2 Oocyte cytoplasmic maturation: A key mediator of both oocyte and embryo developmental competence. A. Watson*^{1,2}, ¹*The University of Western Ontario, London, Ontario, Canada,* ²*Children's Health Research Institute, London, Ontario, Canada.*

Efforts have intensified to successfully mature, and inseminate oocytes in vitro and then culture ensuing embryos to transferable stages from a large number of mammalian species. Success varies but generally even for the most successful species it is only possible to obtain a maximum of a 40-50% development of zygotes to the blastocyst stage. Reduced oocyte developmental competence is suggested as a primary reason for the reduced potential of in vitro produced embryos. The vast majority of in vitro matured oocytes are meiotically competent however many do not attain an optimal oocyte diameter before insemination. Variations in oocyte in vitro maturation media can influence embryo development, blastocyst cell number and apoptosis. In addition studies have indicated that cytoplasmic donation from so-called competent to incompetent oocytes can improve developmental outcomes. Oocyte cytoplasmic maturation includes those events that instill upon the oocyte a capacity to complete nuclear maturation, insemination, early embryogenesis and thus provide a foundation for implantation, initiation of pregnancy and normal fetal development. Although we can define oocyte cytoplasmic maturation we are only now beginning to understand the molecular steps that underlie this process. In general terms oocyte cytoplasmic maturation involves the accumulation of mRNAs, proteins, substrates and nutrients that are required to achieve the oocyte developmental competence that fosters embryonic developmental competence. Both immediate and longer term effects of oocyte cytoplasmic maturation will be discussed including influences on cumulus cell-oocyte communication, cumulus cell expansion, insemination and oogenetic control of zygote development to the blastocyst stage. Collectively we are beginning to specify oocyte cytoplasmic maturation and eventually a coherent understanding of this critical event in oocyte biology will emerge.

Key Words: Oocyte, Embryo, In vitro maturation

3 Regulation of oocyte meiotic maturation. F. J. Richard*, *Université Laval, Québec, QC, Canada.*

Mammalian oocytes are arrested at prophase of the first meiotic division before induction of maturation by the preovulatory luteinizing hormone surge. In vitro, oocyte maturation occurs spontaneously. The first meiotic arrest is characterized by a large nucleus called the germinal vesicle. One important signalling molecule for resumption of meiosis is cAMP. High levels of cAMP block spontaneous meiotic resumption. Research investigating the regulation of oocyte cAMP has led to the discovery of new receptors, G proteins, cyclases and phosphodiesterases. Leydig insulin-like 3 (INSL3), a polypeptide growth factor of the insulin family, is expressed in theca cells. INSL3 activates LGR-8 (leucine-rich repeat-containing G protein-coupled receptor 8) which is expressed in the oocyte. LGR-8 is coupled to the inhibitory G protein, thus leading to a decrease in cAMP production. Treatment with INSL3 initiates meiotic progression of oocytes in preovulatory follicles, demonstrating the importance of cAMP management for meiotic resumption. Furthermore, micro-

injection of an anti-Gs protein into mouse oocytes resulted in meiotic resumption, suggesting that meiotic arrest of the oocyte was dependent on Gs activity. The orphan Gs-linked receptor GPR3 is expressed in the oocyte. The oocytes of null-GPR3 mice resume meiosis when still in their follicles, suggesting that GPR3 is involved in the control of cAMP production, and thus meiotic maturation. Cyclic nucleotides are synthesized by cyclases and degraded by phosphodiesterases. Mouse and rat oocytes express isoform 3 of adenylyl cyclase. In the mouse, the null mutation results in approximately 50% of the oocytes resuming meiosis, demonstrating the importance of the synthesis of cAMP in controlling nuclear maturation. The null mutation of the major PDE expressed in mouse oocytes (PDE3A) results in female sterility due to ovulation of GV-arrested oocytes that cannot be fertilized. Maintenance of meiotic arrest is explained by constitutive cAMP signalling associated with undetectable cAMP-PDE activity. Collectively, these results are starting to illuminate the key players involved in the control of oocyte cAMP and thus, nuclear maturation.

Key Words: Oocyte, Maturation, cAMP

Triennial Reproduction Symposium: The USDA-NRI in Reproduction — Relevance to Production Agriculture

4 The National Research Initiative (NRI) competitive grants program in animal reproduction: Changes in priorities and scope relevant to U.S. animal agriculture. M. A. Mirando*, *Cooperative State Research, Education, and Extension Service, United States Department of Agriculture, Washington, DC.*

The NRI is the USDA's major competitive grants program and is administered by the Cooperative State Research, Education, and Extension Service (CSREES). The NRI was authorized by the U.S. Congress in the 1990 Farm Bill at a funding level of \$500 million; however, the maximal NRI appropriation was \$181.17 million in fiscal year (FY) 2006. Across all programs, the NRI is mandated to use 30% of its funding to support mission-linked research. Since its inception in 1991, the NRI has funded competitive grants in the discipline of animal reproduction. Before 2004, the Animal Reproduction Program funded a broad range of projects encompassing almost every sub-discipline in reproductive biology of farm animals, including aquatic species important to the aquaculture industry and laboratory animals. During FY 2004, the NRI Animal Reproduction Program narrowed the focus of its funding priorities to five issue-based topics in an effort to make greater measurable improvements in a few high impact areas over the next 10 years. Funding priorities were narrowed further in FY 2006 to three sub-disciplines based, in part, on recommendations that emerged from a stakeholder workshop conducted by CSREES in August, 2004. In FY 2003, Congress authorized expenditure of up to 20% of funds appropriated to the NRI to support projects that integrate at least two of the three functions of research, education, and extension-outreach. In FY 2004, the Animal Reproduction Program included a funding priority for integrated projects focused primarily on infertility in dairy cattle. The program funded its first integrated project in FY 2005. During FY 2002, increased emphasis on justification for use of model systems (e.g., laboratory animals and in vitro systems) was included in the NRI Request for Applications (RFA). In FY 2006, applications proposing to primarily utilize nonagricultural animal models were excluded from the program. Currently, all proposed studies must be thoroughly justified in terms of relevance to U.S. animal agriculture and relevance to program priorities identified within the RFA.

Key Words: Reproduction, Grants, Funding

5 A researcher's perceptions of USDA funding in reproduction. J. J. Reeves*, *Washington State University, Pullman.*

Through the 1970's, NIH was the only source of federal competitive research funding for Animal Scientists in reproduction. This required couching domestic animals as models for basic research on human reproduction. The first USDA Competitive Research Grants Program was initiated in 1978 under the auspices of the Competitive Research Grants Office. Again, Animal Scientists could only get funds for research in reproduction through the Animal Health Special Grants Program, which began in 1980. Dedicated funding for animal reproduction did not start until 1985 and was available primarily in the reproductive efficiency and physiology areas of the Animal Science Program. Funding for individual grants and duration of funding were similar between NIH and USDA, typically in the range of 3 years with total direct costs of \$150,000. USDA funding in reproduction permitted directing research more toward the animal industry and less toward human reproductive problems or animal health problems. The names of these programs have changed over time, the National Research Initiative (NRI) Competitive Grants Program started in 1991 with a program in Animal Reproduction. Successful funding of individual grants has been based on an industry problem with a sound hypothesis and basic technology. The USDA review system has been based on external (ad hoc) reviewers as well as a primary and a secondary panelist reviewer. This review system may drop the external reviewers. USDA did not change the award size for individual grants until 2001 when it gradually increased through 2003. It then markedly increased individual grants in 2004 to a funding level of \$300,000-\$500,000 over 3 to 4 years. This is good in some respects but results in funding many fewer grants. Policies based on funding the best designed and presented proposals in priority areas should continue. The number of grants funded per year is approaching a low critical number, with an average of only 10 new grants funded per year. At the present funding level it will be difficult for even the best scientist to sustain a research career based only on USDA funding.

Key Words: USDA, Grants, Reproduction

6 National Research Initiative (NRI) in reproduction: Challenges for success. W. W. Thatcher*, *University of Florida, Gainesville.*

Program managers developed a dynamic system for the NRI to receive scientific inputs on priorities for research to reduce infertility and improve reproductive management (e.g., <http://www.biolreprod.org/cgi/rapidpdf/biolreprod.105.048686v1>) including strengthening programs and training. The reduction in funded grants at an increased rate per grant reflects the need for congressional infusion of funds to the NRI. Presently, panels are still able to identify excellent and very good proposals. Should this NRI funding strategy continue, or should award level be fixed with the RFA, precluding panel mandated budget cuts? Should there be bi-annual submission deadlines and possible two tier funding levels? The increased percent of applied research grants reflects the importance of transition research to shareholders. Does the single panel review process accommodate both basic and applied proposals? Partnerships between NRI and commercial enterprises should be developed for developmental application of research results.

Does the EPSCoR strengthening program really meet the USDA mandate to implement a competitive grants program of priority mission areas? An alternative would be joint regional grants of excellence that have both synergistic and strengthening effects. Should panel service be limited so re-submitted proposals are considered by an independent set of agricultural oriented reviewers or should panelist turnover be reduced to sustain evaluation criteria? Innovative joint funding with the NIH/NRI, to incorporate large animal models for human biomedical relevance, should be applied to a multiplicity of areas (i.e., Table 1 in <http://www.adsbm.msu.edu/whitepaper.html>) without compromising support to the NRI agricultural enterprise. Basic research needs a visionary focus on areas of need. Investigator teams should strive towards shortening the interval from a "biological observation" to implementation in "food production systems". Such successes become the focus for an aggressive joint education effort of Congress by universities, commercial entities, scientific societies, stakeholders, and the public for congressional support of the NRI.

Key Words: NRI, Grants, Congress

Triennial Reproduction Symposium: Concurrent Techniques Sections — Molecular Techniques and Statistics

7 RNA interference: a new approach to *in vivo* study of gene function. R. V. Anthony* and J. D. Cantlon, *Colorado State University, Fort Collins.*

Definition of hormone function was classically accomplished by ablation-replacement studies. However, as our knowledge of the complexity of hormones and growth factors has grown, it has become increasingly difficult to clearly define the necessity and function of many of the hormones, growth factors and regulatory proteins under investigation. The use of homologous recombination within mouse embryonic stem cell lines allows functional gene ablation, and has been used extensively during the past 15 years to define specific gene function. The use of similar methodologies in livestock species has yet to yield an efficient approach. In contrast, the parallel development of our understanding of naturally occurring RNA interference with the development of efficient virus-based vectors for gene transfer holds great potential for effectively "knocking down" specific gene function. Short-hairpin (sh) RNA-encoding cassettes, typically consisting of inverted repeats separated by a loop sequence, followed by a short poly(T) string to signal transcription termination, are inserted downstream of a RNA polymerase III promoter within the viral-vector of choice. Several virus vectors are useful for delivery of shRNA expression cassettes, each with particular attributes. Both adenovirus and lentivirus-derived vectors provide a high rate of infectivity in most mammalian cell types, with lentiviral vectors allowing stable integration into the host genome if the study of long-term effects is needed. Upon transcription a shRNA is generated and the loop is recognized by the processing enzyme Dicer, generating "guide" sequences. Guide sequences are incorporated into the RNA-induced silencing complex (RISC), which targets mRNA for degradation if recognized by the guide sequence. For each mRNA of interest, design and testing of a number of shRNA, along with adequate controls, are required to identify the most efficient construct before proceeding to *in vivo* use. This technology, which has been used effectively in rodents, may become the method of choice for defining gene function in livestock.

Key Words: RNA interference, shRNA, Viral-mediated infection

8 Interpretation of microarray data: Trudging out of the abyss towards elucidation of biological significance. G. W. Smith*¹, G. J. M. Rosa¹, P. M. Coussens¹, R. Halgren¹, A. C. O. Evans², M. Mihm³, P. Lonergan², and J. J. Ireland¹, ¹*Michigan State University, East Lansing*, ²*University College Dublin, Dublin, Ireland*, ³*University of Glasgow, Glasgow, UK.*

The recent development of tools for expression profiling in livestock has availed reproductive biologists new opportunities to examine global changes in gene expression during key developmental timepoints, in response to hormonal treatments, and as a tool for phenotyping or predicting developmental potential. Such experiments often yield lists of tens to hundreds to thousands of regulated genes/transcripts of interest. Some argue such technological advances signal a move from hypothesis driven research to descriptive discovery research and information overload at the expense of biological significance. One can easily spend hours and hours staring into the abyss, wondering if results are real and what they mean. Microarrays can be more than a high throughput and expensive screening tool. Many factors contribute to success of expression profiling experiments and yield of interpretable data including nature of the hypothesis/objective of study, platform, complexity of tissue of interest, experimental design and incorporation of best available strategies for data processing, analysis, and interpretation. Beyond mere assessment of significant differences in transcript abundance between tissue A and B, current experimental and statistical approaches for microarray data provide opportunities for studying variation in transcriptional activity across multiple experimental groups and time points, for building classification models for use in diagnosis and outcome prediction, and for clustering genes and subjects to study gene pathways and networks and to unravel/search for hidden patterns, respectively. Although challenging due to limited annotation/ontology classification for a large proportion of genes in livestock species, functional categories of co-regulated genes and gene pathways can be mined, and hypotheses about common regulatory elements/functional significance formulated. We have applied cDNA microarray technology to studies of follicular growth, oocyte quality and the periovulatory period in cattle. Strategies to facilitate analysis and interpretation of microarray data will be discussed, using select examples from our data sets and other sources.

9 Statistical power calculations. R. Lenth*, *University of Iowa, Iowa City.*

The talk will focus on how to do meaningful power calculations and sample-size determination for common study designs. There are important guiding principles: (1) Certain types of retrospective power calculations should be avoided, as they add no new information to an analysis. (2) Effect size should be specified on the actual scale of measurement, not on a standardized scale. (3)

Rarely can a definitive study be done without first doing a pilot study. Sample-size guidelines for pilot studies will also be briefly discussed. Finally, I will present some examples, using Java applets that I have developed and that are available on the web at <http://www.stat.uiowa.edu/~rlenth/Power/>.

Key Words: Statistical power, Sample size

10 Procedures for statistical treatment of binomial and categorical data. R. Quaas*, *Cornell University, Ithaca, NY.*

The analysis of discrete observations has always presented problems with a variety of methods of varying complexity but typically none simple. Unless, that is, one ignores the categorical nature of the data and does a usual analysis of variance. Surprisingly this often does quite well yielding "p values" quite similar to more appropriate methods, e.g. logistic regression for binomial data. If one is interested in estimates, however, these may be more interpretable using an appropriate non-linear method. Currently there is readily available software for the analyses. A series of case studies will be presented.

Key Words: Categorical data, Binomial data

Triennial Reproduction Symposium: Symposium II — Reproductive Immunology

11 Regulation of immune cells in the uterus during pregnancy in ruminants. P. J. Hansen*, *University of Florida, Gainesville.*

Pregnancy results in a change in number and function of immune cells in utero that potentially affect fetal survival and uterine defense mechanisms postpartum. These changes are driven by local signals from the conceptus as well as from hormonal changes mediated by the placenta or maternal system. In sheep, for example, macrophages accumulate in the uterine endometrium during pregnancy. Use of a unilaterally-pregnant model, in which pregnancy is surgically confined to one uterine horn, has revealed that accumulation is due to both systemic signals (numbers of cells in the non-pregnant uterine horn of non-pregnant ewes) and locally-produced signals (number of cells in the uterus of unilaterally-ligated ewes higher in the pregnant horn than in the non-pregnant horn). Gamma-delta T cells also accumulate in uterine epithelium during pregnancy as a result of unidentified systemic signals. These cells may participate in growth of the conceptus, immunosuppression, or placental detachment at parturition. One of the key regulators of uterine immune function is progesterone. In sheep, progesterone can block tissue graft rejection in utero when injected to achieve concentrations too low to directly inhibit lymphocyte proliferation. Progesterone probably inhibits uterine immune responses in sheep indirectly by inducing secretion of a member of the serine proteinase inhibitor family called uterine serpin from the endometrial epithelium. Uterine serpin can block lymphocyte proliferation in vitro in sheep and natural killer cell mediated abortion in vivo in mice. Uterine serpin is also present in cattle, goats and pigs but its role in immune function in these species has not been documented. The relevance of changes in uterine immune function to the reproductive and immune status of ruminants has not been established. There is little evidence for immunological causes of pregnancy loss (except for cloned fetuses) but the downregulation of uterine immune function during pregnancy is likely to lead to a postpartum uterus with compromised capacity for preventing establishment of infectious disease.

Key Words: Pregnancy, Ruminants, Immunology

12 Why is the fetal allograft not rejected? C. J. Davies*, *Washington State University, Pullman.*

In viviparous species the fetus must be protected from a potentially hostile maternal immune system. The major histocompatibility complex (MHC) is a genetic region that encodes MHC class I (MHC-I) and class II (MHC-II) proteins, which present peptide antigens to T lymphocytes and induce graft rejection. MHC-II proteins are only expressed on professional antigen presenting cells. However, classical MHC-I proteins are expressed on all nucleated somatic cells. Protection of the fetus from immune-mediated rejection involves down-regulation of classical MHC-I antigen expression on trophoblast cells, which form the external epithelial layer of the placenta, and maintenance of an immunologically favorable, immunosuppressive, environment in the uterus. Normally, bovine trophoblast cells do not express MHC-I antigens prior to day 120 of pregnancy. However, third trimester trophoblast cells in the interplacental and arcade regions of the placenta express both classical MHC-I proteins, that could potentially induce fetal rejection, and non-classical MHC-I proteins. A human non-classical MHC-I antigen, HLA-G, is an important immunoregulatory factor required for maintenance of pregnancy. In cattle, third trimester MHC-I expression has no adverse effects and probably contributes to placental separation at parturition. However, somatic cell nuclear transfer (SCNT) fetuses, the majority of which are aborted between days 30 and 90 of pregnancy, had trophoblast cell expression of MHC-I antigens prior to day 34 of pregnancy. In conjunction with increased trophoblast MHC-I expression, SCNT pregnancies exhibited a marked increase in the number of stromal lymphocytes in the uteri of surrogate dams. A retrospective study found that SCNT pregnancies established using MHC-I homozygous cell lines, where the immunological barrier is greatly reduced, had significantly improved fetal survival from day 28 to term (51% survival for MHC-I homozygous and 5% for MHC-I heterozygous SCNT fetuses). Consequently, it appears that the high rate of fetal mortality in SCNT pregnancies is due, at least in part, to inappropriate expression of trophoblast MHC-I antigens and immune-mediated placental rejection.

Key Words: Abortion, Immunology, Bovine

13 Seminal plasma signalling in the female reproductive tract. S. A. Robertson*, *The University of Adelaide, Adelaide SA, Australia.*

Providing sperm for conception is generally thought to be the sole male contribution to pregnancy. But this view is now outdated – as well as sperm, semen contains potent signalling molecules that influence female reproductive physiology to improve the chances of pregnancy success. Cytokines and prostaglandins secreted by seminal vesicle and prostate glands bind to receptors on target cells in the female reproductive tract, activating changes in gene expression leading to modifications in the cellular composition, structure and function of the cervix and uterus. The consequences are increased sperm survival, ‘conditioning’ of the female immune response to tolerate the conceptus, and molecular and cellular changes in the endometrium that facilitate embryo development and implantation. Male-female tract signalling occurs in rodents, livestock animals and all other mammals so far studied including humans. The key active factors in seminal plasma are identified as members of the transforming growth factor- β family.

Experiments in rodents show that disruption of seminal plasma priming causes fetal growth retardation and changes in placental structure, with long-term consequences for growth of the neonate. Recent studies indicate a similar function for seminal plasma in the pig. In gilts, seminal plasma elicits an endometrial response with recruitment of inflammatory leukocytes and induction of pro-inflammatory cytokines and cyclo-oxygenase-2. The consequences persist through the pre-implantation period with altered leukocyte populations and cytokine parameters seen for at least 9 days. Exposure to semen also alters the dynamics in pre-implantation embryo development with an increase in the number of embryos and in their viability. Furthermore seminal plasma influences the timing of ovulation, corpus luteum development and progesterone synthesis. A better understanding of seminal plasma signalling may lead to new treatment products and management protocols to ensure maximal fertility and reduce embryo mortality in livestock animals.

Key Words: Seminal plasma, Cytokines, Pregnancy

Dairy Foods: Advances in Cultured Foods

14 Historical overview of lactic cultures. R. Sellars*, *R. L. Sellars and Associates, Waukesha, WI.*

A historic overview of the culture problems in the cheese industry that initiated the need for lactic culture research will be briefly presented. This led to the first commercialization of lactic acid producing starter-cultures used by the European and North American cheese industries. Interactions between the commercial starter houses, academia, and the cheese industry that led to the development of the current service oriented industry will be highlighted. The search for suitable cultures, protective media, plant sanitation procedures and starter rooms that reduce bacteriophage infections will also be discussed. The most important commercial milestones of starter-culture developments by commercial companies from 1878 to present and the strategies to produce flavorful, consistent hard cheeses will also be presented.

Key Words: Lactic culture, Cheese, Starter

15 Non-starter lactic acid bacteria. T. M. Cogan* and T. P. Beresford, *Moorepark Food Research Centre Teagasc, Fermoy, Ireland.*

In cultured dairy products, non-starter lactic acid bacteria (NSLAB) are only important in ripening and ripened cheeses. They mainly comprise facultatively homofermentative lactobacilli, e.g., *Lactobacillus casei*, *Lb. paracasei*, *Lb. curvatus* and *Lb. plantarum*, although pediococci and enterococci are found in lower numbers in some cheeses. Some obligate heterofermentative species, e.g., *Lb. brevis* are occasionally found. During ripening the NSLAB grow from low numbers of c. 10^2 to 10^8 cfu/g over several weeks or months depending on the cheese and its ripening temperature. NSLAB require an energy source for growth but lactose has been metabolised completely to lactate by the time exponential growth of NSLAB occurs. Citrate, arginine, sugars in lysed starter cells and in the milk fat globule membrane have been suggested as energy sources in cheese. The chromosome of at least one strain has been completely sequenced. Generally it is believed that their source is post pasteurisation contamination from equipment and air. However, many strains resist pasteurisation implying that raw milk is also a major source. The effect of NSLAB on cheese flavour has

been studied for over 120 years with variable results. More recent studies have generally shown a positive effect of selected strains on cheese flavour formation. During ripening, they are responsible for converting L lactate to D lactate and cause development of white spots on aged Cheddar cheese due to calcium-D-lactate formation. Many NSLAB metabolise citrate to formate and acetoin; they also metabolise amino acids, especially methionine to potent S containing flavour compounds like methanethiol and its degradation compounds, as well as various S containing esters. These and other aspects of NSLAB will be discussed in the presentation.

Key Words: NSLAB, Cheese, Lactobacilli

16 Insights from genomic studies on dairy lactic acid bacteria. J. L. Steele*, *University of Wisconsin, Madison.*

The genome of lactic acid bacteria (LAB) contains both plasmid and chromosomal DNA. The characterization of plasmids in lactic acid bacteria has been an ongoing area of study for the past thirty years. Characterization of LAB chromosomes begun in the early 1970s, however the most exciting developments in LAB genomics are now being fueled by nucleotide sequence information for complete chromosomes. Currently, the genome sequence is known or is being determined for more than twenty LAB. The value of genome sequence information for dairy-related LAB cannot be overstated. The availability of genomic sequences allows researchers to rapidly ascertain the genetic potential of an organism. For example, investigations into the proteolytic enzyme system of *Lactobacillus helveticus* CNRZ32 over a twelve year period had resulted in the identification of twelve genes encoding components of this system. However, within three months of obtaining a draft genome sequence of this organism, an additional thirteen genes encoding proteolytic enzymes were identified. Additionally, the availability of multiple genome sequences within a species allows for the study of strain specific traits. For example, a comparison of the complete genome sequence of two strains of *Lactobacillus delbrueckii* subsp. *bulgaricus* identified regions involved in bacteriophage resistance, a trait known to vary from strain to strain. The availability of genome sequences also allows studies to follow

global gene regulation via DNA microarrays. A major strength of this technology is that it provides a non-biased global view of an organism's transcriptional response to an environment of interest. This unbiased holistic view consistently yields unexpected observations that ultimately lead to the identification of genes with critical functions in the physiological system of interest. An example of this outcome was the identification of expression of a pathway for the utilization of serine-phosphate during growth of *Lb. helveticus* CNRZ32 in milk. Access to genomic information has provided researchers with unprecedented power to elucidate mechanisms by which LAB have adapted to milk and cheese environments.

Key Words: Genomics, Lactic acid bacteria, Sequence

17 Engineering culture attributes. J. Broadbent*, *Utah State University, Logan.*

Metabolic engineering of cells is founded upon the power to establish cellular and molecular functions via DNA manipulation. Today, the ability to genetically manipulate or 'engineer' animals, plants, and microorganisms to manufacture, modify, or improve products or processes has blossomed into a multibillion dollar enterprise that has revolutionized the pharmaceutical, chemical, and agricultural industries. Many of the most exciting and successful applications involve microbial products. While use of recombinant DNA (rDNA)-derived microbial products in agricultural and food systems is commonplace, a similar situation does not apply to the use of live, rDNA-containing microbial cells. When we consider potential applications for genetically modified dairy cultures, it is important to recognize a few basic principles: 1) dairy starter technology can be traced to the late 19th century, and their long history of safe application in human food provides dairy starter bacteria with GRAS status; 2) existing knowledge of starter genetics and physiology has already identified clear strategies to improve the industrial performance of these cells; and 3) in some cases, these improvements can be effected by means other than rDNA technology. Examples of genetic improvements that satisfy these criteria and have already been implemented by industry involve introduction of phage-resistance plasmids and the selection for enhanced diacetyl production in lactococci. Moreover, rDNA experiments with starter bacteria in research laboratories has fueled important advancements in culture technology. This is because rDNA methods permit construction of isogenic cells that differ from their wild-type strain only by the action of a single polypeptide. By comparing the wild-type culture to its isogenic derivative, the role of that polypeptide in a particular process can often be unequivocally established. From this knowledge, dairy technologists can utilize strain selection or screening methods to identify starter bacteria that already possess the trait of interest.

Key Words: Lactic acid bacteria, Starter culture

18 Use of bacteriophage peptides as vectors or blockers to receptors on lactic cell membranes. C. Hicks*, *University of Kentucky, Lexington.*

Bacteriophage (phage) peptides hydrolyzed (.01% ficin at 31°C) from *Lactococcus lactis* ssp *lactis* c2 phage were tested to determine their effectiveness in blocking c2 phage from attacking *L. lactis* C2 host. Initial results showed that c2 peptides had only a minor inhibitory affect on culture growth. Heat treatments =111°C were effective in

killing any contaminating c2 phage that were present in the purified peptides without affecting peptide activity. Extended cell growth times were observed when c2 phage peptides (2.5%) were added to growth medium (M17) where the culture was infected with c2 phage (10^2 , 10^4 and 10^8 pfu/ml). When phage infections were at 10^2 pfu/ml, *L. lactis* C2 culture could grow to the stationary phase when 2.5% c2 phage peptide was present. When *L. lactis*C2 culture was grown in 2% c2 phage peptide and used to inoculate milk which was infected with 10^3 pfu/ml of c2 phage, acid developed faster than when the culture was added to milk containing 2% c2 peptide. Although some protection was observed when c2 peptide was added directly to the cheese milk, c2 peptide was most effective when added to the culture medium. In other experiments peptides were prepared from *L. plantarum* yit0068 phage and *L. Lactis* ssp *lactis* ml3 phage. These peptides were tested with *L. plantarum* and *L. lactis* C2 hosts that were infected with their specific phage. Growth times of *L. plantarum* were extended up to 25% as peptide (yit0068) concentration increased in the growth medium. When *L. plantarum* was grown in medium containing 4% yit0068 peptide and infected with 10^2 pfu/ml (yit0068 phage), the culture reached the stationary phase without lysing. Peptides derived from ml3 and yit0068 phage inhibited *L. lactis* C2 culture growth and did not inhibit phage proliferation equal to the c2 phage peptides.

Key Words: Bacteriophage, Culture, Cheese

19 Media development for selective enumeration of lactic acid bacteria. N. P. Shah*, *Victoria University, Melbourne, Victoria, Australia.*

Because of the potential health benefits, probiotic organisms such as *Lactobacillus acidophilus*, *Bifidobacterium* spp., and *L. casei* are increasingly incorporated into dairy foods. Viability of probiotic bacteria is important in order to provide health benefits. In order to assess viability and survival of probiotic bacteria, it is important to have a working method for selective enumeration of these probiotic organisms. Several media for selective enumeration of *L. acidophilus*, *Bifidobacterium* spp., and *L. casei* have previously been proposed. However, most of these methods are based on pure cultures of these organisms and may not be suitable for selective enumeration of probiotic organisms in the presence of other probiotic organisms and yogurt culture organisms (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*). Further, differences exist among the strains of the same species with respect to sugar fermentation characteristics and tolerance of low pH, and bile. A selective medium *L. casei* (LC) agar has been developed by Ravula and Shah for enumeration of *L. casei* populations from commercial yogurts and fermented milk drinks. MRS-salicin or MRS-sorbitol agar can be used for selective enumeration of *L. acidophilus* provided *L. casei* is not added into the product. However, if *L. casei* is added to the product, then MRS-sorbitol agar or MRS-salicin agar can be used to obtain counts of *L. acidophilus* and *L. casei*, and LC agar can be used to obtain a total count of *L. casei*. The counts of *L. casei* can be subtracted from the total population of *L. acidophilus* and *L. casei* enumerated using MRS-salicin or MRS-sorbitol agar. *Bifidobacterium* can be enumerated on MRS-NNLP agar.

Key Words: Probiotic, Media development

20 Probiotics and health: Their potential role in modulation of immune function. Z. Ustunol*, *Michigan State University, East Lansing.*

About a century ago, Metchnikoff wrote in his book 'The Prologation of Life' that consumption of fermented dairy products by lactic acid bacteria provided in improved health and longer life. Today, an increasing number of health foods, functional foods as well as pharmaceutical preparations are promoted with health claims based on the probiotic characteristic of some of these bacteria. It is widely accepted that the gastrointestinal (GI) microflora play an important role in the health of the host and possess immunomodulating capacity. Probiotic ingestion is thought to alter the GI microflora by providing bacterial cells to this ecosystem and have been suggested as potential candidates for immune modulation. Various studies have been conducted on the effect of probiotic bacteria on immune function. However, most often interpretation of the findings has been inconclusive or conflicting in the absence of clear mechanistic data. It is thought that the mechanism by which probiotics influence the immune system

may relate to their ability to differentially modulate expression of cytokines and co-stimulatory molecules. More recently, probiotics have been reported to modulate innate and acquired immune control and contribute to a more finely tuned T helper 1 (Th1) and Th2 immune responses. Activation of surface receptors designated as Toll-like receptors (TLRs) by bacterial components, are believed to be key for regulation of immune response and to mediate a link between innate and adaptive immunity. Role of probiotics in the linking of innate and adaptive immune function and their capacity to favor Th1 or Th2 immune responses may have significant implications for inflammatory diseases. This presentation will focus on the most current information on immune modulation by probiotic bacteria. Elucidation of the mechanisms by which intestinal microorganisms, and ingested probiotics modulate immune function may facilitate implementation of therapeutic probiotic dairy products that are individually tailored for immunoregulatory properties.

Key Words: Probiotics, Immune modulation, Th1, Th2, TLR

Monday, July 10, 2006
POSTER PRESENTATIONS

Animal Health I

M1 Parturient steroids and labor duration associate with dystocia and stillbirth. J. L. Burton*¹, P. S. D. Weber¹, A. A. Bush¹, L. Neuder¹, W. Raphael¹, R. J. Erskine¹, J. Carrier², and S. Godden², ¹*Michigan State University, East Lansing*, ²*University of Minnesota, St. Paul*.

Dystocia and stillbirth are important sources of economic loss for the dairy industry. The goal of this study was to assess parturient steroids and labor duration as potential risk factors for them. Close-up cows from a Transition Management Facility in Western Wisconsin (n = 78) and from a large dairy in Central Michigan (n = 50) were monitored hourly to identify animals in labor (e.g. mucoid vaginal discharge, calf limbs visible), which were moved into individual maternity pens for videotaping of parturition and recording of calf birth weight (BW) and status (alive, dead) and cow body condition score (BCS). In the Wisconsin cows, calving ease score (CES; 1 = easy to 5 = very difficult) was recorded and a venous blood sample collected within 1 h of delivery for enzyme immunoassay of serum cortisol and progesterone. In both herds, BCS and BW did not associate with calving difficulty. In the Wisconsin cows, progesterone was lower ($P \leq 0.05$) in CES 5 cows (378.8 ± 167.2) than in cows with CES 1-4 (mean 1085.6 ± 18.0 pg/ml) with little difference in cortisol, driving the cortisol:progesterone ratio higher ($P \leq 0.05$) in the CES 5 cows. All calves from CES 4-5 cows (n = 18) were born dead. In CES 1-3 cows, mean cortisol was higher ($P = 0.03$) in animals delivering live ($22,315 \pm 3,921$ pg/ml; n = 31) versus dead calves ($14,347 \pm 2,488$ pg/ml; n = 29). The same trend was observed for progesterone ($P = 0.11$). In the Michigan cows presenting with mucoid vaginal discharge, time to live assisted delivery was 212.2 ± 24.5 min and to dead assisted delivery was 293.1 ± 24.1 min ($P \leq 0.05$) but times to live assisted and unassisted deliveries did not differ. Collectively, these preliminary results suggested that parturient concentrations of cortisol and progesterone and labor duration are potential risk factors for dystocia and stillbirth. Future studies will determine if variations in serum steroids are linked to cervical dilation and labor duration, which may underlie dystocia and (or) stillbirth.

Key Words: Calving ease, Parturition, Calf health

M2 The association between hoof lesions and milk production in Ontario dairy cows. G. Cramer*¹, K. Lissemore¹, D. Kelton¹, C. Guard², and K. Leslie¹, ¹*University of Guelph, Guelph, ON, Canada*, ²*Cornell University, Ithaca, NY*.

Lameness in dairy cattle is one of the most important issues facing the dairy industry in terms of both production costs and consumer perception of animal welfare. The objective of this project was to determine the association between infectious and non-infectious hoof lesions and 305-day milk production in dairy cows. A convenience

sample of 5 hoof trimmers were trained and asked to record lesions on a standardized form for all cows they trimmed in a herd. Individual cow lesion data from 7300 cows in 173 herds were merged with dairy herd improvement (DHI) production data. To determine the association between individual lesions and milk production, the cow's projected and actual 305-day milk production were used as outcome variables in a linear mixed model. All models included breed, lactation, days in milk and hoof trimmer as fixed effects and herd as a random effect. From all recorded individual hoof lesions, only deep sepsis had a negative association with projected 305-day milk production (-1571 kg). The presence of white line separation (+302 kg), any non-infectious lesion (+109 kg), and any hoof lesion (+73 kg) all had a significant positive association with projected 305-day milk production. Similarly, the presence of a sole ulcer (+204 kg), any non-infectious lesion (+120 kg) and any lesion (+101 kg) all had a significant positive association with actual 305-day milk production. The positive association between hoof lesions and small increases in cumulative milk yields shows that cows with non-infectious lesions are genetically higher producing cows. It is likely that the hypothesized negative effect of these lesions on 305-day milk production is being masked by the higher production potential of the affected cows. To quantify this negative effect a more complex model using multiple individual test day measurements is required.

Key Words: Lameness, Milk production, Hoof lesions

M3 The association between hoof lesions and culling risk in Ontario dairy cows. G. Cramer*¹, K. Lissemore¹, D. Kelton¹, C. Guard², and K. Leslie¹, ¹*University of Guelph, Guelph, ON, Canada*, ²*Cornell University, Ithaca, NY*.

There is widespread concern within the dairy industry about the longevity of today's dairy cow. Considering the high prevalence of lameness it is surprising that the association between hoof lesions and culling has not been widely evaluated. The objective of this project was to determine the association between infectious and non-infectious hoof lesions and culling risk in dairy cows. A convenience sample of 5 hoof trimmers was trained and asked to record lesions on a standardized form for all cows they trimmed in a herd. Individual cow lesion data from 7610 cows in 173 herds were merged with dairy herd improvement (DHI) culling data. Using a Cox proportional hazard model, the association between individual lesions and culling risk was determined. All models included 305-day milk, breed, lactation, days in milk, linear score and hoof trimmer as fixed effects. Since cows are clustered within herd, herd was accounted for using robust standard errors. Additional disease information was unavailable for analysis.

2888(38%) of cows were culled over a 20-month period. Median time to culling from hoof trimming was 245 days. Cows identified as lame by the hoof trimmer had a 30% increased culling risk. The presence of any lesion significantly increased culling risk by 22%. However, this was mainly due to the effect of non-infectious lesions such as white line abscess, solar hemorrhage, white line separation and sole ulcers as they increased culling risk 46%, 32%, 69% and 34% respectively. None of the infectious lesions had a significant association with culling risk. The addition of a housing variable to the model did not change culling risks significantly. These results highlight the importance the dairy industry should place on lameness and hoof lesion prevention. Dairy producers cannot afford to ignore a problem that increases the culling risk of high producing cows by 30-70%. Since the majority of these lesions were found at a routine hoof trimming, there appears to be a need for earlier detection and more effective therapy in addition to ensuring proper housing and feeding.

Key Words: Lameness, Culling risk, Hoof lesions

M4 Effect of intrauterine infusion of ceftiofur on uterine health and conception rate in dairy cows. K. N. Galvao*, L. F. Greco, J. M. Vilela, and J. E. P. Santos, *University of California, Tulare.*

Objectives were to determine the effects of intrauterine infusion of ceftiofur hydrochloride on uterine health and conception rate in lactating cows. Holstein cows, 830, at 44 d in milk (DIM), were blocked by parity, treatment of any illness in the first 44 DIM, and treatment of acute puerperal metritis (PM) by intrauterine infusion of 2.5 g of oxytetracycline and, within each block, randomly assigned to one of two treatments: IUIC, intrauterine infusion of 125 mg of ceftiofur hydrochloride at 44 DIM; Control, no intrauterine infusion. All cows received two injections of 25 mg of PGF2a 14 days apart, at 37 and 51 DIM, and cows not detected in estrus and inseminated 14 days after the second PGF2a were enrolled in a timed AI protocol (d 65, 100 µg of GnRH; d 72, 25 mg of PGF2a; d 73, 1 mg of ECP; d 75, timed AI). Body condition was scored in all cows at 44 DIM. A subset of 206 cows had their vaginal mucus scored (0 = clear, 1 = mucopurulent or purulent) on d 44, and had uterine fluid harvested on d 51 for cytology and bacteriology. Pregnancy was diagnosed on d 38 after AI. Pregnancy data is available for 486 cows. The conception rate was similar ($P = 0.29$) for the IUIC and Control groups (42.9 vs 47.2 %). Conception was greater ($P = 0.05$) for primiparous than multiparous (49.7 vs 35.8%) and for cows that did not have PM (45.6 vs 43.8 %). When only cows that had PM were evaluated (n=146), those infused with oxytetracycline early postpartum tended ($P = 0.09$) to have greater conception rate than cows not infused (47.1 vs 28.0 %). The proportion of cows with positive uterine culture at 51 DIM was similar ($P = 0.26$) between IUIC and controls (25.3 vs 32.4 %), but IUIC decreased ($P = 0.04$) the proportion of cultures positive for *Archaeobacterium pyogenes* (1.0 vs 7.4 %). Cows with mucus score 1 had greater ($P < 0.05$) proportion of *A. pyogenes*, *Escherichia coli* and overall positive cultures. Intrauterine infusion of ceftiofur hydrochloride reduced prevalence of infection by *A. pyogenes*, but did not improve conception rate of dairy cows.

Key Words: Metritis, Uterine infusion, Dairy cow

M5 Evaluation of high concentrations of non-esterified fatty acids in plasma around parturition as a risk factor for occurrence of subclinical ketosis. S. O. Juchem*, J. E. P. Santos, R. L. A. Cerri, E. J. DePeters, and M. Villaseñor, *University of California, Davis.*

Data from two studies conducted in different dairy farms in the Central Valley of California were compiled in order to investigate the relationships between high plasma NEFA concentrations and the incidence of subclinical ketosis. Cows that had at least one plasma sample with concentration of B-hydroxybutyrate (BHBA) above 1.4mMol/L during the first 4 wk of lactation were considered positive. Data from 85 primiparous cows were obtained from study 1, while study 2 provided information from 175 primiparous (P) and 290 multiparous (M) cows. Concentrations of plasma NEFA were categorized for P (<0.50, 0.50 to 0.65, and >0.65 mMol of NEFA/L) and M cows (<0.46, 0.46 to 0.90 and >0.90 mMol of NEFA/L) according to concentrations at the first week postpartum. The mean (0.834 and 0.819 mMol/L) and median (0.749 and 0.754 mMol/L) concentrations of NEFA in plasma at one week postpartum were similar for P cows across study 1 and 2, respectively. Mean and median for M cows in study 2 were 0.865 and 0.787 mMol/L of NEFA, respectively. A logistic regression model that included the effects of NEFA category and study was utilized, while the two parity groups were analyzed separately. Concentration of NEFA in the first week of lactation had a major impact ($P < 0.01$) on the incidence of subclinical ketosis. Primiparous cows that had concentrations of NEFA in plasma greater than 0.65 mMol/L (n=154) at week 1 postpartum were 7.6 (OR) times more likely to experience high plasma concentrations of BHBA during the first 28 d in milk than herdmates in the < 0.50 mMol category group (n=47). Similar result was observed for M (OR=5.0; $P < 0.01$) cows. Incidence of subclinical ketosis in the lower category group was 25.5 and 40.7%, for P and M, respectively. Management and nutritional practices that can alleviate the peak of NEFA could be a useful management tool to decrease the incidence of subclinical ketosis in early lactation.

Key Words: Transition, Subclinical ketosis, Dairy cow

M6 Evaluation of clinical mastitis therapy used on commercial dairy farms. K. J. Hohmann*, D. A. Rhoda, and P. L. Ruegg, *University of Wisconsin, Madison.*

The objective of this study was to evaluate cow level clinical outcomes of commercial intramammary treatments for clinical mastitis. Treatment records from two commercial dairy farms (n = 2900 cows) were assessed. Outcomes of the first case per cow per lactation (n = 1009) were evaluated. Results of on farm cultures were used to assign intramammary (IMM) treatments (50 mg pirlimycin, 125 mg ceftiofur, 62.5 mg ampicillin or no treatment). The 4 IMM treatments were used in 8 separate protocols that varied by duration of treatment. Cases classified as Gram positive (n = 557), no growth or Gram negative (combined n = 391) were included in the analysis. Outcomes included recurrence of mastitis in the cow within 14 days or 15 days after treatment or no second case of mastitis. Somatic cell count response was defined as test-day SCC <250,000 cells/mL during at least 1 of the 3 test dates subsequent to the mastitis case. Chi-square analysis using Statistix vers. 8 was used to assess the association between intramammary treatment and clinical outcomes. The choice of intramammary treatment was associated with recurrence ($P < 0.001$) of mastitis caused by both Gram positive and negative pathogens. Of Gram positive infections, no recurrence occurred in 44%, 34% and 50% of cases treated with ampicillin, pirlimycin or ceftiofur, respectively. Of Gram negative and no growth infections, no recurrence occurred in 48%, 50%, 58% and 37% of cases treated with ampicillin, pirlimycin, ceftiofur or no treatment, respectively. SCC response was associated with treatment for Gram negative and no growth ($P = 0.02$) but not Gram positive infections ($P = 0.24$). Of Gram negative infections, SCC responses were not identified for 34%, 30%, 47%

and 33% of cases treated with ampicillin, pirlimycin, ceftiofur or no treatment, respectively. This data suggests there are differences between common therapies used to treat clinical mastitis in dairy cows.

Key Words: Mastitis, Dairy cow, Treatment

M7 Use of producer-recorded health data in determining incidence risks and relationships between health events and culling.

J. B. Cole¹, A. H. Sanders*¹, and J. S. Clay², ¹*Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD*, ²*Dairy Records Management Systems, Raleigh, NC*.

Studies of disease incidence among dairy cows have typically relied on data collected in a research setting, or by veterinarians. Little use has been made of producer-recorded data. The spread of computerized on-farm recordkeeping has increased the opportunity to collect and analyze these data. Dairy Records Management Systems (Raleigh, NC) provided producer-recorded health data for 1834 herds from 1997 through 2003. Of 3.7 million event records, 34% were categorized as health disorders (36 categories) and 59% as health maintenance or management events. Disorder records were matched with records from the national dairy database (DB) for lactations which began before July 2002. Data from lactations 1 to 7 were used, and herd-years were required to have at least 20 cows and 80% of records passing edits for the DB. The resulting 43,489 lactations from 440 herds (1244 herd-years) were combined with 135,659 lactation records of herdmates. Milk fever during the first 7 DIM (MF), retained placenta during the first 7 DIM (RP), metritis (MET), displaced abomasums (DA), and ketosis (KET) were reported in 8, 5, 54, 41, and 23 percent of herd-years, respectively. Cystic ovaries (CO), mastitis (MAST), and foot/locomotion problems (LOCO) were reported in 65, 59, and 43 percent of herd-years. Lactational incidence risk (LIR) or incidence density (ID) was calculated for herds reporting each disorder. Overall, LIR was 2.9% for MF, 3.7% for RP, 9.8% for MET, 4.2% for DA, and 6.6% for KET; ID was 12.0% for CO, 13.4% for MAST, and 20.9% for LOCO. In general, LIR and ID increased with increasing parity. Risk of culling for mastitis was 2.76 times greater in lactations with at least one reported MAST event. Culling for reproduction was 2.05 times greater in lactations with at least one RP, MET, or CO event. These results suggest that producer-recorded health data can be used to investigate disease incidence and relationships, and warrant further research.

Key Words: Culling, Field data, Health

M8 Effects of nutrition, weaning age and incidence of subclinical mastitis on colostrum and milk quality of santa inês breed.

S. Fernandes, E. R. Siqueira, P. F. Domingues, E. V. Z. Stasienuik, L. S. Serrão, and R. M. S. Emediato*, *São Paulo State University, Botucatu, São Paulo, Brazil*.

Twenty nine multiparous Santa Inês ewes, all of them at the same reproductive age, were submitted to four treatments in the last gestation month and during lactation. A factorial delineation (two nutrition levels and two weaning ages), was used as follows: treatment 1: corn silage diet and weaning at the age of 45 days; treatment 2: corn silage plus concentrate diet and weaning at the age of 45 days; treatment 3: corn silage diet and weaning at the age of 70 days; treatment 4: corn silage plus concentrate diet and weaning at the age of 70 days. Colostrum samples were collected after parturition, 24 and 48 hours later, to determine immunoglobulin concentration by Faey & Mc Kelvey (1965) method. Milk samples were collected weekly, starting in the second

week after parturition to somatic cell count. It were analyzed both in colostrum and milk, the contents of protein, fat, lactose and total solids. There was diet effect ($P < .05$) for colostrum protein, fat and total solids. The ewe group fed with corn silage plus concentrate presented the lowest values of colostrum contents. For milk fat percentage the higher result ($P < .05$) was obtained only for weaning at 70 versus 45 days of age (5.51 and 4.32 respectively). The milk chemical composition was similar to the values obtained by other authors for milk production breeds. Somatic cell count (1,535,138 cell/ml) did not affect milk quality (5.26 % for lactose, 4.83 % for fat, 4.78 % for protein and 16.03 % for total solids).

Key Words: Milk chemical composition, Immunoglobulin, Sheep

M9 Mastitis treatment practices on organic dairy herds. M. Pol and P. L. Ruegg*, *University of Wisconsin, Madison*.

The objective of this project was to determine mastitis treatment practices on organic dairy herds. Organic (ORG) dairy herds ($n = 20$) were required to be certified organic for at least 3 yr. Data on treatment practices were obtained during a farm visit using an 84-question survey instrument. Half of ORG farmers reported using non-antimicrobial products to improve udder health at dry-off. Three farms used three different products, 4 farms used 2 products, and 2 farms used one product to treat cows at dry-off. Ultrafiltered bovine whey products were administered orally and parenterally on 5 farms. Other products used by ORG farmers were vitamin supplements (oral, 2 farms), microbial supplements (intramammary; 2 farms), vitamin C (intramammary; 2 farms), and aloe vera (oral; 2 farms). About 80% of the farmers were satisfied or very satisfied and 20% were somewhat satisfied with the products used at dry-off. Only one ORG farm reported the use of antimicrobials to treat a few (1%) quarters at dry-off. No ORG farmer reported using antimicrobials to treat clinical mastitis. Most organic farms ($n = 19$) reported using organic products to treat clinical mastitis. Bovine whey products were administered orally or parenterally on 9 farms. Other products commonly used were garlic tincture (oral, *in vulva*; 7 farms), aloe vera (oral, intramammary, parenteral, *in vulva*; 6 farms) and vitamin C (intramammary, parenteral; 5 farms). Compounds used on 4 farms included aspirin (oral), homeopathy (oral, *in vulva*), vitamins (oral), and vegetable oils (topical). Almost 74% of ORG farmers using compounds to treat clinical mastitis were satisfied or very satisfied with the product used while the rest was somewhat dissatisfied. A variety of compounds are used for treatments of cows at dry off or after a case of clinical mastitis. Numerous routes are used to administer these compounds. Organic farmers should be made aware that the use of intramammary aloe vera is prohibited by FDA regulations.

Key Words: Organic farm, Mastitis, Treatment

M10 Age-specific prevalence of *Mycoplasma* spp. in the nares of calves in the San Joaquin Valley, California.

D. A. C. Bacon*¹, J. Reynolds¹, R. R. Sakai¹, and C. Collar², ¹*University of California - Veterinary Teaching and Research Center, Tulare*, ²*University of California Cooperative Extension, Hanford*.

The objective of this study was to determine the weekly prevalence of *Mycoplasma* in the nares of calves from the first to the eighth week of life. Two dairy farms (A, B) and two calf ranches (C, D) with different feeding practices were selected to participate in this study between June and August 2005. Milk fed to the calves was available in the form of milk replacer (calf ranch C), waste milk (pasteurized: farm

A, not pasteurized: farm B) and a combination of milk replacer and pasteurized waste milk (calf ranch D). All dairy operations were located in the southern San Joaquin Valley and ranged in size from 500 to 4000 calves. Calves were housed in outdoor individual hutches. Physical contact with neighbor calves was not allowed only in farm B. Fifteen healthy Holstein calves less than five days old were randomly selected on each farm/calf ranch for enrollment (farm B had only fourteen calves). Only eight calves (13.6%) were male (from calf ranch C). Three calves (5.1%) died during the study period. Alternate nostrils were sampled with sterile cotton tipped swabs weekly for eight weeks. Samples were immediately cooled after collection and processed at the VMTRC - Milk Quality Laboratory (UC Davis - Tulare) in the same day. The laboratory procedures to isolate *Mycoplasma* followed National Mastitis Council recommendations. The bacterial colonies from positive cultures were checked against seven strains of *Mycoplasma* by fluorescent antibody. The weekly prevalence of *Mycoplasma* spp. in the nares of the calves from week 1 to 8 was, respectively: 1.7%, 10.3%, 35.1%, 60.7%, 73.2%, 83.9%, 89.3% and 92.9%. Only three species of *Mycoplasma* were identified: *M. bovirhinis* (77.7% of samples), *M. bovis* (12.4%) and *M. alkalescens* (9.9%). *M. bovirhinis* was isolated in all operations while *M. bovis* was isolated from calves on both dairies but not from either calf ranch. *M. alkalescens* was only found in farm B. The results indicate *Mycoplasma* spp. are prevalent in the nares of replacement calves on these farms and that there may be farm-associated differences in the distribution of the types of *Mycoplasma* between farms.

Key Words: *Mycoplasma*, Calves, Milk feeding management

M11 Effect of sampling protocol on plasma NEFA concentration. A. E. Kulick*, R. R. Rastani, and R. R. Grummer, *University of Wisconsin, Madison*.

The objective was to determine effect of sampling protocol on plasma non-esterified fatty acid (NEFA) concentration. Plasma NEFA concentration is often used as a tool to assess metabolic status of dairy cows during the periparturient period. In experiment 1, 8 non-lactating, non-gestating dairy cows were blood sampled (basal), moved to an exercise lot for 15 min, returned to stanchions, and sampled immediately and at 5, 15, 30, 60 and 120 min following return. Following 15 min of exercise, cows displayed an increase in plasma NEFA concentration, peaking at 5 min (225 μ Eq/L) and returning to basal (84 μ Eq/L) by 30 min (110 μ Eq/L; $P < 0.001$). Cows were moved to box stalls overnight and 24 h after basal sample, they were locked up and sampled again. Housing cows in a box stall overnight and locking them in headlocks increased plasma NEFA concentration (184 μ Eq/L; $P < 0.01$). In a second experiment at a large freestall commercial dairy, 11 late gestation dairy cows were locked in headlocks at feeding, blood was sampled (0 min), and cows were released and allowed to finish eating and return to stalls. Cows were then herded into headlocks and sampled immediately (120 min), and at 135, 150, and 180 min. Plasma NEFA concentration was highest at initial lockup (284 μ Eq/L), lowest at 180 min (178 μ Eq/L) and intermediate at time points in between ($P < 0.05$). A second group of 10 late gestation dairy cows were locked in headlocks at feeding and blood sampled immediately, and at 5, 15, 30 and 60 min. Plasma NEFA concentration was highest 15 min after being placed in headlocks and lowest at 60 min (221 and 113 μ Eq/L, respectively; $P < 0.05$). At each time point, a behavior score was given (1 to 10; 1=calm; 10=extremely excited). There was a significant correlation between plasma NEFA concentration and behavior score ($r=0.55$ for experiment 1, $r=0.31$ for

experiment 2; $P < 0.05$). In conclusion, plasma NEFA concentration was altered with different sampling protocols.

Key Words: Non-esterified fatty acid, Sampling protocol, Behavior

M12 Bacteremia not detected during experimental coliform mastitis infection. J. Goff*¹, H. Springer², D. Bannerman³, and M. Paape³, ¹NADC, USDA-ARS, Ames, IA, ²Iowa State University, Ames, ³BARC, USDA-ARS, Beltsville, MD.

A bacteremia, caused by diverse species, was associated with about one third of acute coliform mastitis cases occurring in a field study report. However, blood is typically a very hostile environment for bacteria. Using blood from normal cows we demonstrate that when 2000 CFU of *Escherichia coli* or *Staphylococcus aureus* were added to 1 ml blood, more than 97% of bacteria were killed within 3 h, suggesting normal blood cells are efficient at killing bacteria entering the blood. However this may not be the case during acute mastitis if blood immune cells are compromised. We tried to recreate the field conditions by inoculating one quarter of the udder of 20 cows with 220 CFU *E. coli*, which caused an acute mastitis with bacteria and somatic cell counts in the milk each exceeding 1 million/ml milk. Rectal temperatures were elevated by 18 h in all cows ($P < 0.05$) and remained elevated for another 18 h. *E. coli* infection caused an acute decline in blood neutrophil and lymphocyte numbers and neutrophil function by 24 h of infection ($P < 0.05$), which could be indicative of generalized immune suppression. All cows cleared *E. coli* from milk without treatment in 5 -10 d. Blood (1 ml) obtained aseptically at 0, 6, 12, 18, 24, 30, 36, 48 and 60 h of infection from each cow was added to 10 ml Brain Heart Infusion Broth and incubated for 48 h. With the exception of 2 cultures suspected of *Bacillus* sp. contamination, all other cultures were negative for aerobic growth, despite evidence of systemic effects of challenge on the immune system. Bacteremia observed in field cases of mastitis could not be recreated in this experimental coliform mastitis model using the culture technique described. Field case cows may also have more severe compromise of the immune system than cows in this experimental model.

Key Words: Mastitis, Bacteremia, Coliform

M13 Changes in feeding behavior but not dry matter intake identify dairy cows as risk for metritis. J. M. Huzzey*¹, D. M. Veira², D. M. Weary¹, and M. A. G. von Keyserlingk¹, ¹*Animal Welfare Program, University of British Columbia, Vancouver, BC, Canada*, ²*Pacific Agri-Food Research Centre, Agassiz, BC, Canada*.

Dairy cows experience a high incidence of disease during the transition period. Early identification of cows most at risk for disease could help reduce this incidence. Previous work by our group has shown that cows most at risk of metritis after calving are those with reduced feeding times in the days before calving, but it is not clear if this association was due to reduced DMI. The objective of the current study was to determine if changes in DMI could also be used to identify cows at risk for metritis. We followed behavior and intakes of 52 Holstein dairy cows beginning 3 weeks before and ending 3 weeks after calving. Every 3 days after calving the severity of metritis was rated on a five-point scale that incorporated rectal body temperature and condition of the vaginal discharge. Data were analyzed using a mixed model in SAS where period (pre- and post-calving) and health (healthy and sick) were treated as fixed effects and cow was treated as a random effect. During the experiment 21% of the cows were diagnosed with metritis. After calving, DMI were lower in metritic cows (14.4 ± 0.79 kg/d)

compared to healthy animals (18.8 ± 0.41 ; $P < 0.001$), and the metritic cows also spent less time feeding (164.2 ± 11.04 min/d compared to 204.9 ± 5.72 min/d for healthy animals; $P = 0.002$). As in our previous work, metritic animals spent less time feeding during the pre-calving period (185.3 ± 11.04 min/d) compared to cows that remained healthy (214.8 ± 5.72 min/d; $P = 0.002$). However, there was no difference in DMI between these two groups before calving. These results indicate that reduced time at the feeder pre-calving is a better indicator for identifying dairy cows at risk for metritis than reduced DMI.

Key Words: Feeding, Transition, Metritis

M14 The impact of colostrum supplement processing on serum IgG levels in Holstein neonates. K. J. Whitman^{*1}, J. R. Wenz¹, F. B. Garry¹, A. N. Merritt², A. N. Putnam², and J. H. Crabb², ¹Colorado State University, Fort Collins, ²Immucell Corp, Portland, ME.

Efforts to change current processing methods of colostrum supplements to increase absorbable immunoglobulin levels are being evaluated. Commercially available spray-dried (SD) product may provide less available immunoglobulin G (IgG) for absorption than freeze-dried (FD) product, due to a loss of heat labile IgG during the spray drying

process. The objective of this study was to evaluate the impact of pasteurized colostrum supplement processing (SD vs FD), and blood gas effects on serum IgG levels of newborn calves. Thirty singleton Holstein bull calves (43 ± 3.6 kg) born without assistance were used. Whole blood was collected via jugular venipuncture at birth (0h) and 48h, and radial immunodiffusion was used to determine serum levels of IgG. At 0h, arterial blood was collected from the brachial artery for immediate blood gas analysis. At approximately 1h after birth and at approximately 12h after birth, calves were fed either a FD or SD powdered colostrum supplement in 1.4L of warm water via a bottle or esophageal feeder. At 0h, 53% of calves were hypoxic ($pO_2 < 58$ mmHg), and 30% were acidemic ($pH < 7.3$), however, when compared to normal calves, these blood gas parameters had no impact on passive transfer ($P = 0.70$). There was no difference in mean IgG of SD (1110 mg/dl) vs. FD (981 mg/dl) fed calves or % calves with failure of passive transfer at 48hr. Results of this study indicate that serum IgG was similar, regardless of processing method, and hypoxemia or processing method had no impact on passive transfer. The impact of pasteurization in colostrum supplement processing on absorbable IgG should be investigated in the future.

Key Words: Colostrum supplement, IgG, Processing

Beef Species

M15 Impact of feedlot morbidity on performance, carcass characteristics and profitability of New Mexico ranch to rail steers. J. W. Waggoner^{*1}, C. P. Mathis¹, C. A. Loest¹, J. E. Sawyer², and F. T. McCollum, III³, ¹New Mexico State University, Las Cruces, ²Texas A&M University, College Station, ³Texas A&M University, Amarillo.

Records from steers enrolled in the New Mexico Ranch to Rail program (n = 813) from 2001 to 2004 were utilized to evaluate feedlot morbidity effects on performance, carcass characteristics and profitability. Steers were classified based on number of medical treatments during the finishing period. Classifications were: zero medical treatment (HEALTHY), one medical treatment (ONE), and two or more medical treatments (TWO(+)). Data were analyzed by analysis of variance and contrasts evaluated differences between HEALTHY and sick (ONE and TWO(+)) steers and between ONE and TWO(+). Initial calf market value, carcass grid value structure, and unit feed cost were standardized to remove market variation. Steers were assigned to marketing groups based on ultrasonographic prediction of individual optimum marketing dates. Twenty-two percent (177 hd) of 813 steers received medical treatment. Net income (Table 1) was greatest among HEALTHY steers and declined among steers for ONE and TWO(+) (HEALTHY vs. sick, $P < 0.01$; ONE vs. TWO(+), $P < 0.01$). Sick steers (ONE and TWO(+)) exhibited lower ADG, spent more days on feed, and had lower carcass values than HEALTHY steers (HEALTHY vs. sick, $P < 0.01$). Total cost of gain increased as the number of medical treatments increased (HEALTHY vs. sick, $P < 0.01$; ONE vs. TWO(+), $P < 0.01$). Analysis of records from steers in the New Mexico Ranch to Rail program confirms and quantifies the effects of morbidity on feedlot performance, carcass value and profitability.

Table 1. Effects of morbidity on performance and profitability of steers

Item	HEALTHY	ONE	TWO(+)	SEM	H vs S	1 vs 2+
Days on feed	192	197	209	7.0	<0.01	0.11
ADG, kg	1.45	1.39	1.26	0.77	<0.01	0.12
Cost of gain, \$/kg	1.26	1.43	1.76	0.06	<0.01	<0.01
Carcass value, \$/kg	2.51	2.39	2.18	0.10	<0.01	0.06
Net income, \$/hd	14.01	-69.63	-253.70	25.93	<0.01	<0.01

Zero (HEALTHY), one (ONE), or two or more (TWO(+)) medical treatments. Contrasts: H vs S = HEALTHY vs. sick (ONE and TWO(+)); 1 vs 2+ = ONE vs. TWO(+).

Key Words: Morbidity, Feedlot, Steers

M16 Management factors affecting selling prices of Arkansas beef calves. T. R. Troxel^{*}, B. L. Barham, S. Cline, J. Foley, D. Hardgrave, R. Wiedower, and W. Wiedower, *University of Arkansas Cooperative Extension Service, Little Rock.*

The objective of this study was to determine how management factors affected the selling price of beef calves. Data were collected from January 1 to December 31, 2005 at fifteen Arkansas livestock auctions. The database consisted of 52,401 lots consisting of 105,542 head of cattle representing 18.2% of the total calves sold. Information was collected by experienced livestock market news reporters and included body condition, castration, horn status, fill, health, and individual or group selling. Each factor was analyzed using GLM procedures using weight as a covariate, and least-squared means were generated and separated using the pdiff option. All prices are based on dollars per 45.45 kg of live weight. Body condition affected selling price ($P < 0.0001$) with very thin, thin, average, and fleshy and fat calves selling for \$119.55, \$116.80, \$118.14, \$112.28 and \$101.98, respectively. The

selling prices of steers, bulls and heifers were different from each other ($P < 0.001$) and were \$124.20, \$117.93 and \$112.81, respectively. Polled calves sold for \$3.70 more ($P < 0.001$) than horned calves. Fill affected selling price ($P < 0.0001$) with gaunt, shrunk, average, full and tanked calves selling for \$119.63, \$120.22, \$116.77, \$110.05 and \$92.80, respectively. Healthy calves sold for \$118.21, which was higher ($P < 0.001$) than dead hair (\$105.55), stale (\$100.01), sick (\$80.22), bad eye(s) (\$104.39) or lame (\$84.74) calves. Calves that were announced as preconditioned sold for a higher price (\$122.36; $P < 0.001$) than healthy calves. The selling prices of calves sold as singles, groups of 2 to 5 head or groups of six or greater were \$117.26, \$120.12 and \$122.61, respectively ($P < 0.001$). Cattle classified as calves sold for \$118.73, which was higher than cattle classified as yearlings (\$116.89; $P < 0.001$). 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

M17 Impact of the phenotypic expression of calf genetics on the selling price of Arkansas beef calves. T. R. Troxel, B. L. Barham*, S. Cline, J. Foley, D. Hardgrave, R. Wiedower, and W. Wiedower, *University of Arkansas Cooperative Extension Service, Little Rock.*

A study was conducted to evaluate the impact of the phenotypic expression of calf genetics on the selling price of beef calves marketed through Arkansas auction barns. Data was collected on 52,401 lots consisting of 105,542 head marketed through fifteen auction barns in 2005. 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 using the GLM procedure in SAS with calf weight and month of sale as covariates, and least-square means were generated using the PDIF option when a significant F test was noted. All prices are based on dollars per 45.45 kg of live weight. Breed, color (independent of breed), frame and muscle impacted ($P < 0.001$) feeder calf price. Twenty-three breed or breed groupings were evaluated. Angus by Hereford (\$121.74), Angus (\$121.43), Charolais by Limousin (\$121.33), Angus by Limousin (\$120.83), Angus by Charolais (\$120.59), and Hereford by Angus by Brahman (\$120.01) calves brought a higher selling price ($P < 0.01$) than all other breeds. Brahman (\$108.24), Hereford (\$107.25), $\frac{1}{4}$ Brahman (\$106.25) and Longhorn/Longhorn cross calves (\$89.38) were lower in price ($P < 0.001$) compared to other breeds. Yellow-white faced (\$120.44), yellow (\$120.29), and black-white faced (\$120.03) calves were similar in selling price but brought a higher selling price ($P < 0.001$) compared to all other calf colors. Spotted calves (\$107.37) received the lowest selling price ($P < 0.001$). The selling prices for large- (\$118.27) and medium- (\$118.15) framed calves were similar ($P > 0.10$) but were higher ($P < 0.001$) than small-framed calves (\$95.43). Price also differed ($P < 0.001$) for muscle scores 1, 2, 3 and 4 (\$120.54, \$111.31, \$96.28 and \$82.21, respectively). Breed, color, frame score and muscling score are all important factors that can influence buyers decisions at Arkansas auction barns.

Key Words: Feeder calves, Market price, Genetic factors

M18 A meta-analysis study on the effect of maturity and implant status on carcass characteristics. M. J. McPhee*, J. W. Oltjen, T. R. Famula, and R. D. Sainz, *University of California, Davis.*

A meta-analysis was conducted to assess the effects of breed type (early-moderate, **EMM** or late maturity, **LM**) and implant status (estrogenic (**E**) or combination (**C**) or non-implanted (**N**); repeats included) on hot carcass weight (**HCW**, kg), longissimus muscle area (**LMA**, cm²), kidney, pelvic and heart fat (**KPH**, %) and intramuscular fat (**IMF**, %), at harvest. Forty-two publications from 1982 to June 30 2004 with consistent IMF data were evaluated. The Mixed model procedure in SAS was used where the statistical model included the fixed-effect terms maturity and implant status; 12/13th rib fat (BF, cm) as a covariate; all two-way interactions; and intercept-slope and source (the subject in Proc Mixed) as random-effect terms. Source of publication was the experimental unit. A weighted term (w_2) was used for LMA, KPH and IMF where, $w_2 = w_1/\text{mean}$, and $w_1 = \text{inverse of the squared SE}$. The unstructured (UN) covariance structure was used to determine if the intercept-slope covariances were correlated. When the intercept-slope covariances were correlated then a model without the covariance structure was fitted. The estimate for intercept-slope covariance was not statistically different from 0 for LMA ($P = 0.11$), KPH ($P = 0.19$) and IMF ($P = 0.74$), therefore a reduced model without a covariance component was fitted for these carcass characteristics. For HCW ($P = 0.01$) the model had a covariance component fitted. The results for maturity indicate differences between EMM and LM for HCW ($P < 0.01$) and LMA ($P < 0.01$) and no differences for KPH ($P = 0.26$) and IMF ($P = 0.50$); for implant status - single or repeat application of an estrogenic or combination implant increased HCW by 2.9% or 5.7%; increased LMA by 3.7% or 6.4%; decreased IMF 8.1% or 5.2% respectively and decreased KPH by 7.6% for estrogenic implants and increased KPH by 1.1% for combination implants compared to a non-implanted steer.

Key Words: Beef Cattle, Maturity, Implants

M19 Growth performances of Angus Plus calves grazing on pasture in Hawaii subtropical climates. J. Yang*¹, M. DuPont¹, G. Fukumoto¹, and R. Ferreira², ¹University of Hawaii, Honolulu, ²Olumau Angus Plus LLC, Lihue, HI.

Cows and calves are fed by 100% grazing on pastures in Hawaii islands, which are characterized by plentiful sunshine and rainfall with average monthly temperature of 25 to 30°C and average monthly precipitation of 46 mm to 121 mm. To evaluate the suitability of Angus Plus cattle for Hawaii subtropical climates, we collected the data of the growth performances of 149 Angus Plus calves in the past three years (2003-2005). Angus Plus calves were produced by maintaining the purebred lines of Angus or Brangus between 65% and 96% black Angus and a minimum of 4% Brahman. The Angus Plus cattle herd have been selected for preweaning gain, daily gain on pasture grass after weaning, fertility and mothering ability. All the animals were raised on 100% improved pastures of Pangola (*Digitaria decumbens*, *Stent*), Rhodes (*Chloris gayana*) and Guinea (*Panicum maximum Jacq.*) throughout the year. Data for birth weight (BWT), pre-weaning average daily gain adjusted to 205 days (PWADG) were obtained. Average birth weight of calves was 37.1 ± 1.24 , 34.7 ± 0.51 and 34.2 ± 0.51 kg in 2003, 2004 and 2005, respectively, and hip height at birth was 73.4 ± 0.46 cm in 2003, 72.4 ± 0.23 cm in 2004 and 71.9 ± 0.20 cm in 2005. The mean of 205 d-adjusted weight was 252.8 ± 6.63 kg in 2003, 265.4 ± 8.69 kg in 2004, and 247.4 ± 3.41 kg in 2005. Average preweaning daily gain based on the adjusted 205 day is 1.05 ± 0.03 , 1.10 ± 0.13 , and 1.04 ± 0.15 kg/d for year 2003, 2004 and 2005, respectively. Interestingly, the birth weight is significantly correlated with hip height at birth ($r=0.730$, $P < 0.001$), preweaning daily gain ($r = 0.527$, $P < 0.001$) and adjusted 205 d weight ($r = 0.510$, $P < 0.001$)

based on three-year pooled data. However, the hip height at birth is not significantly correlated to the hip height at weaning ($P > 0.05$). These results demonstrated great performances of Angus Plus calves raised on 100% pasture in Hawaii subtropical climates. The combination of Angus with Brangus to produce Angus Plus cattle have the potential to contribute to the growing demand of forage-based production of high-quality natural and organic beef for the local and international markets

Key Words: Angus Plus cattle, Grazing, Growth

M20 Age at first calving and the longevity of beef cows of different breeds. F. Szabo* and I. Dakay, *University of Veszprem Georgikon Faculty of Agriculture, Keszthely, Hungary.*

The age at first calving, lifespan and longevity of cows have great importance in beef cattle husbandry because the cost of raising weaned calves depends largely on age at first calving and how long a cow remains in production. If cows are productive extendedly and raise more progeny, specific costs of raising each calf decrease proportionally. Consideration of lifespan and, specifically, longevity plays an important role in practical breeding. The objective of the present work was to evaluate the impact of breed type on age at first calving (AFC), age at culling (ACU), and longevity (LONG; the period between first calving and culling) in beef cows. A database of 2115 cows belonging to five breeds (Hungarian Grey, Hereford, Aberdeen Angus, Limousin and Charolais) and two crossbred genotypes (Simmental x Hereford F1, Simmental x Limousin F1) born between 1977-1992 was evaluated using multivariate analysis considering breed type, birth year, and birth month. The mean values of AFC, ACU and LONG obtained were 2.71, 9.47 and 6.77 years, respectively. Breed/genotypes and birth year had significant influence ($P < 0.01$) on each evaluated trait, whereas birth month statistically affected only the AFC. The period between first calving and culling (LONG) of the mentioned breed types were 8.95, 9.08, 8.28, 7.81, 7.91, 10.79, and 5.55 years, respectively.

Key Words: Age at first calving, Age at culling, Lifespan

M21 Determining the corn replacement value of wet brewers grains for feedlot cattle. J. W. Homm*, L. L. Berger, and T. G. Nash, *University of Illinois, Urbana.*

Due to increasing energy costs, breweries are marketing brewers grains as wet feeds. The purpose of this trial was to evaluate the corn replacement value of wet brewers grains (WBG) for finishing cattle. Two hundred heifers (287.8 ± 34.5 kg) were randomly assigned to four dietary treatments containing either 0%, 15%, 30%, or 45% WBG on a DMB. The control diet consisted of 15% corn silage, 75% whole high-moisture corn and 10% soybean meal-based supplement on a DMB. The control diet was balanced to contain 13.0% crude protein, 0.4% calcium, 0.3% phosphorus and 0.6% potassium. Two full weights were averaged at the initiation of the trial and carcass adjusted live weight was used to determine the final live weight. Heifers were pen-fed (5 pens per treatment, 10 heifers per pen) for 160 d. Live weight and feed efficiency were not significantly different between dietary treatments. Dry matter intake and average daily gain were quadratic ($P < 0.01$), where 15% and 30% WBG heifers consumed more feed and grew faster than 0% and 45% WBG heifers. Additionally, 15% and 30% heifers consumed more ($P = 0.01$) feed than 45% heifers. Heifers receiving the 15% and 30% WBG diets gained more ($P < 0.01$) than 45% heifers. Ultrasonic marbling was higher ($P < 0.05$) for heifers fed 0% WBG than heifers fed WBG at the start of the trial. Heifers fed 30% WBG had higher ($P = 0.03$) ultrasonic marbling scores than heifers fed 15% at the start of the trial. After 112 d on feed (DOF), heifers fed 30% WBG had higher ($P = 0.03$) ultrasonic marbling scores than heifers fed 15% WBG. At harvest, carcass marbling tended ($P = 0.06$) to be higher for heifers not fed WBG than those fed WBG. Carcass REA was larger ($P = 0.05$) for the 15% and 30% WBG heifers than the 45% WBG heifers. Kidney, pelvic, and heart (KPH) fat increased linearly ($P < 0.05$) as WBG increased in the diet. Additionally, 15% heifers had less ($P = 0.04$) KPH fat than 30% heifers. These data indicate that feeding 15-45% WBG in feedlot diets supports performance and carcass characteristics similar to cattle fed a typical high-moisture corn finishing diet.

Key Words: Wet brewers grains, Beef, Performance

Breeding and Genetics I

M22 Crossbreed dairy cattle production in the tropical area in Mexico. R. Lopez*, C. Vite, J. G. Garcia-Muñiz, and P. A. Martinez, *Universidad Autonoma Chapingo, Chapingo, Mexico.*

The objective was to determine the effect of grade of crossing (G), lactation number (LN), calving season (CS), parity (P) and its interactions on milk yield per lactation (TMY), daily MY (DMY), MY per day of calving interval (CIMY), peak milk yield (PMY), days to peak milk yield (DPMY), lactation length (LL), age at first calving (AFC), days open (DO), and calving interval (CI) of $\frac{3}{4}$ Zebu (Z) x $\frac{1}{4}$ Swiss (S), 3Z1S; $\frac{3}{4}$ Holstein (H) x $\frac{1}{4}$ Z, 3H1Z; $\frac{3}{4}$ S x $\frac{1}{4}$ Z, 3S1Z; $\frac{1}{2}$ H x $\frac{1}{2}$ Z, HZ; and $\frac{1}{2}$ S x $\frac{1}{2}$ Z, SZ cows. Records of 237 lactations of 230 cows collected from 1997 to 2004 in three commercial dual-purpose farms of Veracruz, México, were analyzed. Cows were grazing tropical pastures and were supplemented with 3.0 kg of TMR per cow per d at milking time. Moreover, cows were machine milked twice a day applying 0.25 mL of commercial Oxytocin (Oxytocin-S, Intervet, Tonisvorst, Germany) at each milking to help milk down. Milk yield per lactation, DMY, CIMY, PMY, DPMY, LL, DO and CI were analyzed

with a linear model of fixed effect including G, LN, P, and CS; whereas AFC was analyzed with a linear model of fixed effects including G, LN, and year and season of birth of cows. Results indicated cows genotype had affected ($P < 0.05$) TMY and LL. In contrast, cow genotype did not affect ($P > 0.05$) DMY, PMY, CIMY and DPMY. The range of MY in 270 days of milking was 2719 ± 511 , 4961 ± 416 , 4349 ± 231 , 4070 ± 238 , and 3676 ± 175 kg for 3Z1S, 3H1Z, 3S1Z, HZ and SZ, respectively. Likewise, LN did influence TMY, DMY, PMY, and CIMY, however, did not show any impact on LL. In contrast, P and calving season did not have an influence on all the traits studied. Cows 3H1Z had better AFC than 3S1Z, HZ, and SZ (33.0 vs. 39.6, 33.2 and 34.9 mo, respectively). In addition, F1 animals showed shortest DO and CI than the others genotypes. In conclusion, the crossover of locally adapted breeds with European breeds reduce the age to the sexual maturity especially in the F1 animals and increase MY.

Key Words: Dual-purpose cattle, Supplementation, Tropical forages

M23 Influence of the reproductive system on gestation length and birth weight of Nelore Cattle in the sub-tropical area of Bolivia. J. A. C. Pereira¹, J. H. Landivar¹, A. H. Brown, Jr.*², Z. B. Johnson², and D. W. Kellogg², ¹*Gabriel Rene Moreno University, Bolivia*, ²*University of Arkansas, Fayetteville*.

In Bolivia, the genealogic registration system is based solely on gestation length (GL) from the last reported AI or embryo transfer (ET) to the date of calving. Some ET calves have been rejected for registration because their GL was more or less than the established 305 d. The objective of this study was to determine the influence of reproductive system (RS), ET, or AI on GL and birth weight (BW) of Nelore cattle in Bolivia. A total of 2,062 observations from three herds over two years in the Bolivian Nelore Cattle Association were analyzed with mixed model procedures. Included in the model were the fixed effects of RS, sex of calf (SX), month of birth (BM), and their interactions. Age of dam was a covariate and sire of calf was considered a random effect. The interaction of BM × RS was significant ($P < 0.001$) for mean BW. The combination of ET and November BM of calf resulted in greater mean BW (36.4 ± 0.5 kg). Smaller mean BW resulted from the combination of ET and October BM of calf (31.8 ± 3.2 kg). Mean BW of male calves was 2.0 kg greater ($P < 0.01$) than BW of female calves. Significant effects ($P < 0.01$) for GL were BM, RS, SX, BM × RS, RS × SX. Cows mated by AI with December calf BM had greater ($P < 0.05$) GL and cows mated by ET with September calf BM had the shortest ($P < 0.05$) GL. Of the four RS × SX combinations, cows with male AI calves had the greatest ($P < 0.001$) GL (297.5 ± 0.8 d) and cows with male and female ET calves had the shortest GL (292.0 ± 0.8 d). Sire effects were important ($P < 0.001$) for both BW and GL. Correlation of AI and ET with both BW and GL were low (< 0.25 for both). These data show that variation exists for gestation length between AI and embryo transfer births and suggest that the previously determined gestation lengths should be revisited if both AI and embryo transfer calves are to qualify for inclusion in the genealogic registration of the Bolivian Nelore Cattle Association.

Key Words: Reproductive system, Gestation length, Birth weight

M24 Synchronization effects on parameters for days open. M. T. Kuhn, J. L. Hutchison, and R. H. Miller*, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD*.

The purpose of this research was to determine if synchronization affects parameters related to days open. If synchronization alters genetic or error variances, for example, adjustments could be made to the daughter pregnancy rate evaluations to account for these effects. Synchronization information on individual cows or herds is not currently available. Thus, a chi-square criterion, based on first service only, was used to distinguish between herds that are likely synchronizing and those that are not. Variances were estimated by REML for each synchronization group using a linear model that included the effects of herd-year, year-state-month, parity, permanent environment, animal, and error. The genetic covariance between synchronized and non-synchronized records was also estimated. There were 19,198 synchronized cows and 15,429 non-synchronized cows from 2,903 herds (264 synchronized, 2,697 with non-synchronized records) used for estimation. Herds were randomly selected for inclusion. Calving years spanned 1995 to 2002 and over half the herds had 3 or fewer years of available data. To avoid selection bias, cows were required to have first lactation which further limited the

number of eligible cows for each herd. The genetic correlation between synchronized and non-synchronized records was 1.0. However, there were differences in variances. Genetic and permanent environmental variances were higher for non-synchronized records while error variance was higher for synchronized records. The net effect was slightly higher heritability (0.04 vs 0.03) and higher repeatability (11.6% vs 5.7%) for non-synchronized records. Preliminary results indicated only a slight improvement in sire PTA when days open records were adjusted for these differences in variances. Further research will focus on possible improvements for identifying synchronization herds as well as use of second services to further differentiate herds and perhaps better identify differences in parameters.

Key Words: Estrus synchronization, Days open, Genetic evaluation

M25 THRGIBBS1F90 for estimation of variance components with threshold and linear models. S. Tsuruta* and I. Misztal, *University of Georgia, Athens*.

THRGIBBS1F90 is a FORTRAN program for the analyses of multiple categorical and linear traits. The program is part of a family of programs based on BLUPF90. All programs in this family share common modules and utilize the same common parameter file. Models supported are those with sire, animal, and dominance and maternal effects, random regression, single and multitrait. THRGIBBS1F90 uses Gibbs sampling using by default flat priors. Options allow for restarting the analysis and setting up informative priors. The program creates output files "gibbs_samples" that contains the model information and Gibbs samples, and "solutions". A version of the program exists that stores the log of marginal densities in a file; this is to provide possibility to calculate Bayes Factors and Deviance Information Criteria. POSTGIBBSF90 is a program that analyzes Gibbs samples obtained from THRGIBBS1F90 and other Gibbs sampling programs. It calculates posterior means and standard deviations, highest probability density, effective sample size, and autocorrelations between samples. It also draws graphs of chains and distributions of Gibbs samples. Two kinds of graphs are available for help in determining burn-in period and convergence properties of each parameter. The first graph shows samples for selected parameters, and the second graph shows the distribution of the samples for one parameter. Graphing is by GNPLOT. The source codes and binaries can be downloaded from <http://nce.ads.uga.edu/~ignacy/newprograms.html>. They can be compiled with a variety of FORTRAN compilers in Unix, Linux or Windows environments, including 64 bit.

Key Words: Threshold model, Gibbs sampler, Variance component

M26 Methodology for prediction of bull fertility from field data. M. T. Kuhn* and J. L. Hutchison, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD*.

Simulated data were used to compare alternative models for prediction of bull conception rate (CR) using field data. Two modeling aspects were investigated: an expanded service sire (SSR) effect vs a single term for SSR and linear vs threshold model. In practice, factors such as stud, inbreeding, or age may affect a bull's fertility. Estimating these factors as separate terms in the model (expanded SSR effect), and then adding them back to the bull solution to form the bull's final prediction, may improve accuracy by using more data to estimate the individual components. Simulated data included the effects of herd, SSR, and cow, where the SSR effect had 3 components. Each of 20 replicates had 100,025 cows with a maximum of 7 breedings per cow

and an overall mean CR of 0.35. There were 250 sires per replicate and 595 herds, ranging in size from 35 to 5,000 cows. The expected number of services per bull ranged from 270 to 5,900. Accuracy (correlation of predicted and true SSR effect) and bias were used to compare models. The underlying variable was also analyzed with the true linear model to assess the maximum accuracy for this simulated data. The expanded SSR effect was superior to the single SSR term in all models. However, the additional terms, contributing to the SSR prediction, must be fit as random effects to avoid bias. The linear and threshold models had the same accuracy (86.6%), which was only 4.6% lower than that for the true model for the underlying variable. However, the threshold model showed some bias while the linear model did not. Use of exact variances in the calculation of probabilities from threshold model solutions may improve the threshold model estimates. It is well known that the binomial distribution is approximated by the normal distribution and that this approximation improves as sample size increases. All herds in this simulation had a relatively large number of matings. Thus, further research will determine the effect of subclass sample size on differences between the linear and threshold models.

Key Words: Bull fertility, Threshold model

M27 Comparison of Brown Swiss, Holstein and Brown Swiss x Holstein crosses for production, somatic cell score and days open.

M. I. Phelps*¹, C. D. Dechow¹, A. L. Mosholder¹, J. B. Cooper², and G. W. Rogers², ¹*The Pennsylvania State University, University Park*, ²*The University of Tennessee, Knoxville*.

The objectives of this study were to compare milk, fat, and protein yield, somatic cell score, days open, and age at first calving between Holstein (HO) and Brown Swiss (BS), and among BS and HO crosses and backcrosses. A minimum of five first lactation cows entering a herd in the same year was required and only cows with a first lactation record and a registered HO or BS sire were retained. Data from 16 herds included 5,148 total records from 1,604 HO, 736 BS, 238 BS x Ho (SH), 19 HO x BS, and 60 BS x SH backcrosses (SSH). Data was retrieved through PCDART or Dairy Comp 305 for lactations one through five. Average daily milk, fat, and protein yield, SCS, days open, and age at first calving were analyzed using the MIXED procedure of SAS. The fixed effects were days in milk, age, parity, and breed. Random effects included cow and residual error. Breed effects were significant for all yield traits and age at first calving, approached significance for days open ($P = 0.12$), but were not significant for SCS ($P = 0.48$). Least square means (LSM) for daily milk yield were 32.5 kg for HO, 28.0 kg for BS, 31.4 kg for SH, and 28.8 kg for SSH. Least square means for daily fat yield were 1.17 kg for HO, 1.12 kg for BS, 1.22 kg for SH, and 1.14 kg for SSH. Daily protein yield LSM were 0.98 kg, 0.93 kg, 1.00 and 0.93 kg for HO, BS, SH, and SSH, respectively. Days open LSM were 159.1, 156.2, 148.3, and 149.2 for HO, BS, SH, and SSH respectively. Heterosis in SH crosses for yield traits ranged from 3.83% for daily milk yield to 6.56% for daily fat yield. Heterosis estimates were -5.93% for days open and -2.29% for age at first calving in SH crosses. Milk yield of SH were less than HO, but fat and protein yields were increased slightly. Days open and age at first calving were reduced with SH compared to the BS and HO. Brown Swiss may be effective in crossbreeding systems with HO.

Key Words: Crossbreeding, Holstein, Brown Swiss

M28 Heritability estimates of milk yield and electronically recorded daily body weight. J. K. Toshniwal*¹, C. D. Dechow¹, J. A. D. R. N. Appuhamy², and B. G. Cassell², ¹*The Pennsylvania State University, University Park*, ²*Virginia Polytechnic and State University, Blacksburg*.

The objectives of this study were to estimate the heritability of daily body weight and to estimate the genetic correlation between body weight and daily milk production. The Afiweigh cow body weighing system records the weight of every cow exiting the milking parlor. The Afiweigh system was installed at the Penn State dairy herd in August of 2001 and in July of 2004 at the Virginia Tech dairy herd. Daily body weight and milk yield were available for 542 Penn State Holstein cows and 120 Holstein cows from the Virginia Tech dairy herd. Body weight and milk yield recorded after 365 days in milk were eliminated. Outliers were detected by generating a body weight and milk yield curve for each cow and daily records more than four standard deviations from the predicted curves were removed. A total of 159,388 daily body weights and 235,144 daily milk records from the Penn State herd were analyzed with a two-trait animal model in ASReml. The model included lactation, age, date and days in milk as fixed effects and animal, permanent environment, and error as random effects. Average daily milk yield was 36.5 kg and average body weight was 654 kg. Heritability estimates for body weight and milk yield were 0.62 and 0.21, respectively, and repeatability estimates were 0.86 and 0.66, respectively. The genetic correlation estimate between body weight and milk yield was -0.61 with a standard error of 0.13. The phenotypic correlation estimate was -0.33 with a standard error of 0.04. Body weight can be measured accurately as cows exit the milking parlor and could be used to generate genetic evaluations for body weight. The genetic and phenotypic relationship between body weight and milk yield was negative, indicating that most body weight differences at the Penn State dairy herd may be due to differences in body condition.

Key Words: Daily body weight, Milk yield, Genetic correlation

M29 Genetic differences between Holstein maturity rates in the

Netherlands and United States. H. D. Norman¹, J. R. Wright*¹, R. L. Powell¹, P. M. VanRaden¹, and G. de Jong², ¹*Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD*, ²*NRS, Arnhem, Netherlands*.

Maturity rate of Dutch and US Holstein cows were compared by examining sire predicted transmitting abilities (PTA) for milk yield for each of the first 3 parities. For each bull with US daughters, PTA that included data from parity 1 (PTA₁), parities 1 and 2, and parities 1 through 3 were calculated from US records with first-parity calving dates from 1960 to 1998. Then PTA for contributions from only parity 2 (PTA₂) and parity 3 (PTA₃) were estimated based on numbers of daughters with first, second, and third parities. Parity-specific Dutch estimated breeding values (NLD₁, NLD₂, and NLD₃) were from August 2005 evaluations. To determine whether maturity-rate differences were genetic, comparisons were made across generations. Coefficients for regression of son PTA on sire PTA calculated within sire and son birth years for PTA₁, PTA₂, PTA₃, PTA₂ - PTA₁, PTA₃ - PTA₁, and PTA₃ - PTA₂ were 0.42 to 0.47; most had standard errors of 0.01. Similar regression coefficients for Dutch evaluations were 0.35 to 0.50. Maturity rates of US and Dutch daughters of the same bull were compared. Correlations among parity-specific bull evaluations were calculated within birth year of bulls. Correlations for 2,850 bulls with ≥500 US daughters were 0.88 between PTA₁ and PTA₂, 0.84 between PTA₁ and PTA₃, and 0.96 between PTA₂ and PTA₃; corresponding

correlations for Dutch evaluations of 269 bulls were 0.92, 0.89, and 0.98, which are considerably higher than parity correlations assumed in the Dutch evaluation model. Correlations between $PTA_2 - PTA_1$ and $NLD_2 - NLD_1$ was 0.66 for 539 bulls with ≥ 50 daughters and 0.82 for 93 bulls with ≥ 500 daughters. Corresponding correlations were 0.61 and 0.83 between $PTA_3 - PTA_1$ and $NLD_3 - NLD_1$ but much lower (0.18 and 0.70) between $PTA_3 - PTA_2$ and $NLD_3 - NLD_2$. Differences in maturity rate of bull daughters were quite consistent across countries and transmitted to granddaughters in both countries through bull sons. Accounting for maturity differences should increase evaluation accuracy for bulls that deviate substantially from population mean.

Key Words: Maturity rate, Milk yield, Parity

M30 Estimation of genetic parameters for maturity of lactation in Japanese Holsteins. Y. Masuda* and M. Suzuki, *Obihiro University of Agriculture and Veterinary Medicine, Obihiro, Japan.*

Models used in genetic evaluations of yield traits for dairy cattle usually include age at calving as a fixed effect. The models ignore the contribution of maturity with age to the additive genetic effect. The objective of this study was to estimate genetic parameters of maturity for milk production using a random regression model for Holsteins in Japan. Data consisted of 50,067 305-d milk records for 24,185 cows in the first five lactations calved between 1975 and 2000. Individual lactation yield was calculated with the test interval method using monthly test day records. An animal model with random regressions on age at calving from 20 to 84 mo, was employed. A third order Legendre polynomial was fitted for animal genetic and permanent environmental effects. (Co)variance components were estimated with the AIREMLRES program, and the residual variance was considered in the model as a function of age at calving. Heritability estimates of 305-milk yield at 24, 36, 48, 60, 72 and 84 mo of age were 0.38, 0.34, 0.32, 0.30, 0.27 and 0.21, respectively. Genetic correlations between milk yields at 24 and 36, 48, 60 72 and 84 mo were 0.92, 0.84, 0.78, 0.74 and 0.74, respectively. Additive genetic and permanent environmental variances decreased after 60 mo of age while the residual variance gradually increased until 80 mo of age. The first eigenvalue for the genetic covariance matrix explained 99.6% of the variation; therefore a second order Legendre polynomial may be sufficient to estimate genetic variances. The corresponding eigenfunction was positive and approximately constant over the ages. This approach provides the genetic curve for maturity and more precise genetic evaluations rather than a multiple-trait model based on parities if a cow has repeated records across lactations.

Key Words: Maturity, Milk yield, Random regression

M31 Genetic parameters for birth weight, dystocia, gestation length, and perinatal mortality in Holstein cattle. J. M. Johanson*¹, P. J. Berger¹, S. Tsuruta², and I. Misztal², ¹*Iowa State University, Ames*, ²*University of Georgia, Athens.*

Data from a long-term dairy sire selection experiment at Iowa State University were analyzed to estimate heritability, direct and maternal genetic relationships among four traits expressed at the birth of a calf; dystocia (1=assisted, 0=unassisted), perinatal mortality (1=alive, 0=dead at birth), birth weight [kg], and gestation length [days]. This research implements a multiple trait animal model evaluation for

genetic prediction of animal merit for direct genetic effect of sires and dams on their progeny and maternal genetic effects. This application is unique in its ability to model genetic and environmental factors associated with each measurement and simultaneously account for different distributional properties of discrete data, i.e., dystocia and perinatal mortality, and the symmetric normal distribution of traits with a continuous scale of measurement, i.e., birth weight and gestation length. Perinatal mortality and dystocia have high direct, 0.67, and maternal, 0.45, genetic correlations. These two traits, however, are not controlled by the same genes because the direct-maternal genetic correlation of -0.67 for dystocia and -0.48 for perinatal mortality. Birth weight and gestation length also add information about genetic merit for calving performance because they are moderately correlated with dystocia and perinatal mortality. The sign and magnitude of these genetic correlations suggest a multi-trait genetic evaluation of animals for calving performance. Adequate information exists to begin development of a calving performance index. A calving performance index is expected to enable breeders of dairy cattle to optimize the health and well-being of replacement animals and reduce the incidence of dystocia and perinatal mortality. The antagonism between direct and maternal genetic effects led to the development of a sire-maternal grandsire threshold model for national calving ease genetic evaluations in August, 2002. This research confirms the need to include maternal effects in the evaluation for dystocia and perinatal mortality.

Key Words: Binomial-Gaussian mixed model, Multiple trait, Dystocia

M32 Phenotypic relationships between multivariate measures of lactation curve shape and somatic cell count in Italian Simmental cows. N. P. P. Macciotta*¹, D. Vicario², and A. Cappio-Borlino¹, ¹*Università di Sassari, Sassari, Italy*, ²*ANAPRI, Udine, Italy.*

Multivariate factor Analysis (MFA) and Principal Component Analysis (PCA) are dimension reduction techniques able to extract from the correlation matrix of milk test day records new latent variables related to lactation curve shape. In this paper, MFA and PCA were applied to a data set of 16,364 lactations of Italian Simmental cows, each with seven TD records for milk yield and Somatic Cell Count (SCC). The aim was to study relationships between lactation curve shape and two measures of SCC: lactational geometric mean of SCC (LGSCC) and lactational means of Somatic Cell Score (LSCS). MFA extracted two latent variables, related with level of production in early lactation (PEL) and lactation persistency (PERS) respectively, whereas PCA yields a leading component related to the average level of production (AVY) and a second component positively related with tests of early lactation and negatively with tests of the second part of lactation (SLOPE). Both for MFA and PCA, latent variables were able to explain more than 80% of the original variance. Correlations between indexes of lactation curve shape obtained with MFA and measures of somatic cells are favourable, i.e. near zero or negative as in the case of PERS. Around zero are also correlations of the principal component related with level of production whereas positive and slightly higher (0.18) is the correlation between LSCS and SLOPE, indicating that curves with higher peaks and more pronounced slope in the second part of lactation tend to have higher values of SCC. Results of the present study highlight the ability of both MFA and PCA to extract latent variables related to lactation curve shape that, with the exception of the variable SHAPE, show very low or negative correlations with measures of SCC along the lactation.

Table 1. Correlations among different measures of lactation curve shape and lactational means of somatic cells

	PEL	PERS	AVY	SLOPE	LGSCC	LSCS
PEL	-	0.10	0.75	0.64	0.01	0.03
PERS		-	0.73	-0.66	-0.13	-0.20
AVY			-	0.00	-0.07	-0.11
SLOPE				-	0.11	0.18
LGSCC					-	0.78

Key Words: Lactation curve shape, Somatic cell count

M33 Genetic variation of lactation gross energy efficiency and its association with a number of traits in Holstein dairy cattle. P. Zamani*¹, S. R. Miraei-Ashtiani², A.-A. Naserian³, and A. Nik-Khah², ¹BuAli University, Hamedan, Iran, ²University of Tehran, Tehran, Iran, ³Ferdowsi University, Mashhad, Iran.

Improving a cow's biological efficiency for converting feed to milk is an important goal for dairy industry. This study was conducted to estimation of genetic variation in gross energy efficiency of lactation (GEE) and its association with some of other traits in Holstein dairy cattle. 3503 monthly records of individual feed intake and composition and milk yield and composition were collected from 906 Holstein lactating cows in 3 herds. Energy content of milk (out put energy) was estimated according to National Research Council's model. GEE calculated as energy content of milk yield over net energy intake. Genetic parameters were estimated using Derivative Free approach of Restricted Maximum Likelihood procedure based on multi-trait animal models, with fixed effects of herd-year-season, parity number, lactation stage (months after parturition) and random effects of animal additive genetic and permanent environment. GEE was weakly heritable (0.09). Dry matter intake (DMI) and milk fat yield (FY) had low heritabilities (0.12 and 0.15, respectively) and milk yield (MY) fat corrected milk (FCM) and milk protein yield (PY) were moderately heritable (0.26, 0.29 and 0.34, respectively). GEE had high positive correlations with FY (0.80) and PY (0.57), high negative correlation with DMI (-0.32) and moderate positive correlations with MY and FCM (0.13 and 0.15, respectively). The results of this study showed that GEE is not a worthwhile criterion for direct selection in breeding programs, but can be improved by indirect selection through correlated response to protein yield, FCM or milk yield selection.

Key Words: Gross energy efficiency, Genetic parameters

M34 Bayesian heritability estimates of monthly test day milk yields for Iranian Holsteins. H. Farhangfar*¹ and H. Mehraban², ¹Birjand University, Birjand, Iran, ²Zabol University, Zabol, Iran.

A total of 18360 monthly test day milk yields collected from 2104 Iranian first lactation Holsteins (progeny of 279 sires) calving between 1993 and 2004 was used to estimate heritability of milk yield at each month of lactation using Bayesian statistical method in a random regression test day animal model. The records analysed were obtained from a large-size dairy farm (Astan-e-Quds) consisting of two herds in Khorasan province of Iran. In the random regression model, fixed environmental effects of herd test date (HTD with 273 levels) and covariables (linear and quadratic) of cow age at recording time as well as random effects of direct additive genetic and permanent environment

were included. Orthogonal legendre polynomials of order 4 (cubic) were also included in the model to take account of milk yield variation over the course of the lactation at two genetic and environmental levels. Random regression analysis was undertaken using RRGIBBS software in which Bayesian heritability estimates of test day milk yields were obtained through 100000 rounds Gibbs sampling. The results showed that months 1 and 9 of the lactation had the lowest (0.164) and greatest (0.339) heritabilities respectively. The average heritability of monthly test day milk yields at the second part of the lactation curve was generally higher than the first part of the lactation curve (0.202 vs. 0.310) suggesting that accuracy of predicting breeding value for candidate animals could increase as milk yield at the second part of the lactation curve is used in genetic evaluation programme.

Key Words: Bayesian estimate, Test day milk, Iranian Holstein

M35 Estimation of phenotypic and genetic trends for milk and fat yield traits in Khorasan province Holsteins of Iran by using a univariate model. H. Naeemipour*¹, H. Farhangfar¹, H. Moravej², and M. Rokoei³, ¹Birjand University, Birjand, Iran, ²Tehran University, Tehran, Iran, ³Zabol University, Zabol, Iran.

A total of 17971 first lactation milk records from Holstein heifers, calving from 1990 to 2003 in 133 herds, was used to estimate phenotypic and genetic trends by implementing an animal model. In the model, fixed effects of herd-year-season of calving, age at first calving as well as random effect of additive genetic effect were included. Heritability of first lactation milk yield was found to be 0.28 and statistically significant. Genetic and phenotypic trends were 9.824 and 139.162 Kg/year respectively for milk yield and -0.0616 and 4.349 kg/yr indicating that environmental improvement contributed a major part of annual milk and fat yield traits increase in Holstein cows of Khorasan province.

Key Words: Genetic and phenotypic trends, Holstein, Khorasan

M36 Comparison of lactation and test day models for genetic evaluation of 305-day milk trait in Iranian Holstein heifers. H. Farhangfar* and H. Rezaee, *Birjand University, Birjand, Iran.*

A total of 179,460 monthly test day milk records obtained from 17,946 Iranian Holstein heifers (trice a day milking) distributed in 287 herd and calved from 1986 to 2001 was used to predict breeding value of animals. Monthly test day milk production was analyzed by applying a covariance function in which the effects of herd, year of calving, season of production, age at test day, genetic merit and permanent environmental effects were included. Orthogonal legendre polynomials up to order 5 was also implemented in the covariance model to take account of genetic and environmental aspects of milk production variation over the course of lactation. In the present research, predicting of breeding value of animals based upon using 305-day and monthly test day milk yields was compared. The results indicated that ranking of ten top sires, dams as well as progenies changed as the genetic evaluation of animals switched from the traditional (based on 305-day milk yield) to the new method that was based on the covariance function. Regression analysis of average breeding value of progenies on first year of their calving showed that the amount of genetic trend obtained from the covariance function for 305-day milk yield was greater than that of the lactation model (11.607 vs 3.860 Kg/year) over the period of 16 years of calving. The phenotypic trend for lactation milk yield was 92.97 Kg per year that it was significant statistically. This indicates that a large proportion of annual increase of milk

production of Holstein heifers in Iran has been due to environmental rather than genetic improvement.

Key Words: Genetic evaluation, Covariance function, Iranian Holsteins

M37 Phenotypic study of lactation curve in Iranian Holsteins. H. Farhangfar* and H. Naemipour, *Birjand University, Birjand, Iran.*

A total of 136250 monthly test day milk records collected from 13625 Iranian Holstein heifers (3x milking) calved between 1991 and 2001 and distributed in 264 herds, was used to study the effects of some environmental factors influencing lactation curve parameters as well as production characteristics. Wilmink function ($Y_t = W_0 + W_1t + W_2e^{-0.05t}$) was fitted to individual lactations. The results of least squares analysis of variance indicated that herd, year and month of calving had a very high significant effect on all traits under consideration. Correlation analysis showed that parameter W_0 had a negative and significant relationship with parameters W_1 and W_2 while it was positively significantly correlated with milk at peak time and 305-day milk yield. Simple linear regression analysis of adjusted means of 305-day milk yield, days to reach peak yield as well as peak milk yield on year of first calving also revealed that there was a phenotypic increase of 137.152 Kg, 0.535 day and 0.434 Kg per year respectively.

Key Words: Lactation curve, Wilmink function, Iranian Holsteins

M38 Estimation of genetic trends for milk production traits in Iranian Holsteins. H. Farhangfar*, H. Naemipour, and M. R. Asghari, *Birjand University, Birjand, Iran.*

In order to estimate genetic trends for milk production traits in Iranian Holsteins a total of 18989 adjusted 305d-2X-ME first lactation records collected from 18989 heifers calved between 1995 and 2001 and distributed in 202 herds over the country were used. The traits were milk, fat and protein yields as well as fat and protein percentages. A multiple trait animal model was utilized. The effects included in the animal model were fixed contemporary group of province-herd-year-season of calving, linear covariate of Holstein genes and random additive genetic effect. Restricted maximum likelihood estimates of variance and covariance components and best linear unbiased prediction of breeding value of individual cows for each trait were obtained by using MTC and MTJAAM softwares respectively. Genetic trends for the traits under consideration were estimated based upon simple linear regression analysis of BLUP solutions on year of first calving. The results obtained in this study revealed that the average breeding value of cows had a significant increase of +33.178 Kg per year ($P < 0.01$) for milk yield. At the same time, fat and protein yields had positive genetic trends of +245 g ($P > 0.05$) and +789 g per year ($P < 0.05$) respectively. In contrast to yield traits, the genetic trends calculated for fat and protein percentage showed an annual decrease of -0.011 % ($P < 0.001$) and -0.003 % ($P < 0.05$) respectively which were significant statistically.

Key Words: Genetic trend, Milk production traits, Iranian Holsteins

Forages and Pastures: Forage Quality

M39 Direct or sequential determination of ADF in legume forages. M. J. Marichal*, M. Carriquiry, and A. I. Trujillo, *Facultad de Agronomía, Montevideo Uruguay.*

Objectives of this study were to compare ADF values of legume forages obtained from samples treated directly with acid detergent solution (direct, DP) or after extraction with NDF solution (sequential, SP) and the effect of the ADF extraction method on lignin quantification. Pastures (n=26) corresponding to nine harvest dates (HD) of alfalfa (AA), ten HD of birdsfoot trefoil (BT), and seven HD of red clover (RC) were evaluated. For each specie and HD, ADF and Lignin concentrations were determined in triplicate. The ADF was determined by filter bag technique (ANKOM Technology), corrected for ash. In SP, Na_2SO_3 was not included in NDF solution. Lignin was determined by extraction with 72% H_2SO_4 (Ligsa). Data were analyzed in a completely randomized design and the model included specie, extraction procedure, and their interaction. There was an interaction ($P < 0.02$) of specie with extraction procedure for ADF concentration as ADF concentration determined by DP tended ($P = 0.10$) to be greater than SP for AA (27.9 vs 26.4 ± 1.5) and lower ($P < 0.01$) for BT (29.7 vs 32.1 ± 1.5) whereas ADF for RC (28.7 vs 29.4 ± 1.5) did not differ ($P = 0.55$) between extraction procedures. There was an effect of ADF extraction method on Ligsa quantification as Ligsa was greater ($P < 0.01$) for SP than DP for all legume species (8.57 vs 6.75 ± 0.44). It would be advisable to always specify the procedure followed in ADF quantification. Additional studies are required to establish equivalency between ADF determined by DP and SP, and the affects on nutritional fractions such as Ligsa and ADIN.

Table 1. Number of determinations resulting on equal or different concentrations for ADF or Lignin

Specie	Number	ADF		Lignin	
		Equal	Different	Equal	Different
Alfalfa	9	4	5	7	2
Birdsfoot trefoil	10	3	7	5	5
Red clover	7	6	1	3	4

Key Words: ADF, Lignin, Extraction procedure

M40 Direct verses sequential analysis of acid-detergent insoluble nitrogen in forage legume hays. J. H. Grabber* and D. R. Mertens, *USDA-Agricultural Research Service, US Dairy Forage Research Center, Madison, WI.*

Acid-detergent insoluble nitrogen (ADIN) is thought to represent nitrogen that is not degraded during ruminal and post-ruminal digestion of forages by cattle. Forage ADIN can be determined following direct acid detergent extraction or following sequential extraction with neutral and acid detergents. In this study, we evaluated how direct verses sequential detergent extraction influenced the ADIN content of legume hays differing in polyphenol composition and degree of conditioning at harvest. In 2002 and 2003, first and second cuttings of polyphenol-free alfalfa, low to high tannin birdsfoot trefoil, and red clover with

o-diphenols and polyphenol oxidase were conditioned by rolls or by maceration and then dried as hay. ADIN, as a proportion of total N, was determined by combustion after direct or sequential detergent extraction by the ANKOM filter bag system, without the addition of sulfite or amylase to neutral detergent solution. The forage X conditioning method X ADIN method interaction was highly significant ($P < 0.0001$, SEM 3.7 g/kg). In hays conditioned with rolls, ADIN concentrations by direct and sequential methods averaged 41 and 34 g/kg for alfalfa, 55 and 32 g/kg for low tannin trefoil, 50 and 38 g/kg for moderate tannin trefoil, 57 and 41 g/kg for high tannin trefoil, and 48 and 33 g/kg for red clover. In hays conditioned by maceration, ADIN concentrations by direct and sequential methods averaged 41 and 34 g/kg for alfalfa, 41 and 36 g/kg for low tannin trefoil, 33 and 40 g/kg for moderate tannin trefoil, 40 and 55 g/kg for high tannin trefoil, and 52 and 40 g/kg for red clover. Thus, analysis method, forage type, and severity of conditioning differentially influenced ADIN concentrations. The potential impact of shifts in ADIN and other nitrogen fractions on milk production and nitrogen utilization by dairy cattle will be evaluated using nutrition models.

Key Words: Acid detergent insoluble nitrogen, Forage conditioning, Polyphenols

M41 Ruminal dry matter, crude protein, neutral detergent fiber and acid detergent fiber degradation parameter kinetics of *Agropyron tauri*, *Agropyron trichophorum*, and *Bromus tomentellus*. P. Shawrang¹, A. Nikkhah^{*1}, and A. A. Sadeghi², ¹Tehran University, Karaj, Iran, ²Science and Research Campus, Islamic Azad University, Tehran, Iran.

This study was carried out to determine rate and extent of DM, CP, NDF and ADF degradation parameter kinetics of *Agropyron tauri* (ATA), *Agropyron trichophorum* (ATR), and *Bromus tomentellus* (BT). Forage samples were collected at the preflowering stage in spring by hand. Dried forage samples were incubated for 0, 6, 12, 24, 48, 72 and 96 h in the rumen of four Varamini wethers. Immediately after submersion of the 0 h bags of substrate into the ruminal fluid, all bags were removed and rinsed with an automatic washing machine. Bags were then freeze dried, weighed and analysed for chemical composition. Data were fitted to non-linear degradation model to calculate effective rumen degradation (ERD), and analysed (DM, CP, NDF and ADF degradability parameters of forages) using GLM proc of SAS (1996) as CRD design. Crude protein contents of ATA, ATR and BT were 123, 72, and 143 g/kg, NDF contents were 604, 638, and 451 g/kg and ADF contents were 348, 378 and 273 g/kg DM, respectively. There were differences ($P < 0.05$) between effective DM, CP, NDF and ADF degradability of these pasture species. The ERD of DM, CP, NDF and ADF for ATA at rumen outflow rate of 0.05/h were 473, 630, 239 and 395 g/kg, for ATR were 393, 498, 331 and 337 g/kg, and for BT were 548, 760, 298 and 237 g/kg, respectively. Constant degradation rate of DM, CP, NDF and ADF for ATA were 6.0, 11.8, 2.7 and 5.7%/h, for ATR were 3.8, 8.6, 5.8 and 3.5 %/h and for BT were 4.2, 10.0, 1.8 and 3.7%/h, respectively. The differences between pasture species in the rate and extent of DM, CP and fiber degradation are likely to lead to major differences in forage intake, therefore these characteristics must be considered as main parameters in developing models and ration formulation of grazing ruminants.

Key Words: Pasture species, Chemical composition, Ruminal degradation

M42 Voluntary feed intake, rumen fermentation characteristics and nitrogen retention in Iranian Balouchi sheep fed halophyte forages. A. Riasi^{*1}, M. Danesh Mesgaran², H. Nassiri Moghaddam², and A. Heravi Moussavi², ¹University of Birjand, Birjand, Khorasan, Iran, ²Ferdowsi University of Mashad, Mashad, Khorasan, Iran.

Halophyte forages (*Kochia scoparia* and *Atriplex dimorphostegia*) were harvested from different regions of central Iran desert (with average annual rainfall of 170 mm). These forages are halophytic plants typically grown on salty land that are a significant part of the local flora in central Iran. During unfavorable environmental conditions, these forages can provide supplemental or emergency feed for ruminants. Each sample ($n=20$) was immediately chopped and composited before air-drying. Dried forages were analyzed for total N, NDF, ash, Na, Cl and K. Nine cannulated Balouchi ewes (48 ± 2 kg) were transferred to metabolism cages and randomly allocated to three dietary treatments [T 1: kochia + alfalfa (1:1), T 2: atriplex + alfalfa (1:1), T 3: alfalfa] in a Latin Square design with three periods of 21 d each. Animals had ad libitum access to feed and water during each period. The results showed that the voluntary dry matter intake of T 1 and T 2 were lower ($P < 0.05$) compared with T 3 (468 and 486 g/d, respectively v 628 g/d). Mean ruminal pH (T 1 = 7.53, T 2 = 7.52, T 3 = 7.46) and ammonia-N concentrations (T 1 = 10.25, T 2 = 9.89, T 3 = 9.71 mg/100ml) were similar for all treatments at different times after feeding (0, 0.5, 1, 2, 3, 4, 6, 8 hours) ($P > 0.05$). The N retention was higher ($P < 0.001$) in ewes fed T 3 (2.03 g/d) compared with T 1 (1.07 g/d) and T 2 (0.93 g/d). Urine volume for T 2 was higher ($P < 0.01$) than for the other two treatments. Sheep fed an Atriplex-based diet excreted more Na in the urine daily ($P < 0.01$) whereas sheep fed kochia excreted more urea-N in the urine daily ($P < 0.001$). Results showed that the diets containing kochia or atriplex have good potential as ruminants' feeds.

Key Words: Feed intake, Rumen fermentation, Halophyte forages

M43 Effective neutral detergent fiber supply to dairy grazing cows by alfalfa pasture. R. Gregoret^{*1}, M. Gallardo¹, P. Ludueña², and M. Cagnolo², ¹INTA Rafaela Experimental Station, Rafaela, Santa Fe, Argentina, ²Villa Maria National University, Villa Maria, Cordoba, Argentina.

The objective of this trial was to evaluate the effectiveness of the neutral detergent fiber (NDF) supply by an autumn alfalfa pasture and their effect on milk composition. Six lactating Holstein cows (100 DIM) were used in a cross-over design with two 28 days periods. The treatments were: Alfalfa hay coarsely chopped (LH), and Alfalfa pasture grazed (AG). In LH, penned cows were fed ad-libitum coarsely chopped alfalfa hay. In AG, cows daily grazed alfalfa in strips that provided approximately 40 kg DM/d. Pasture available herbage was 1655 ± 182 kg/ha. All cows received 2.7 kg DM/d of ground corn grain, half at each milking. Pasture DMI was estimated by difference between pre- and postgrazing pasture mass. Chewing activities of the six cows were monitored visually every 5 min for a 24-h period in each experimental period. Alfalfa hay particle size was 44% > 13 mm and 49% > 2 mm. Cows receiving alfalfa hay had significantly higher DMI than AG cows (22.8 vs. 18.1 kg DM/d, $P = 0.023$). The NDF intake was also higher for the LH cows (10.6 vs. 5.4 kg DM/d, $P < 0.001$). The time used for rumination was 447 and 318 min/d for LH and AG respectively ($P = 0.051$). Total chewing activity per kilogram of NDF was significantly higher for grazing cows (83.95 vs. 135.17 min/kg NDF, $P = 0.026$). No significant differences were detected in milk production (16.5 vs. 17.8 kg/d, $P = 0.445$). Milk fat content was lower for the grazing (3.42%) than for the hay feed cows (3.99%), ($P =$

0.018). Concentration of short and middle chain fatty acids (C4 – C17) was lower in milk from grazing cows ($P < 0.05$). On the other hand C18 chain fatty acids concentration was significantly higher for grazing cows ($P < 0.05$). Concentration of C18:1 trans and CLA were four times as high in AG milk, as compared to LH treatment ($P < 0.01$). Under the condition of the present work the NDF of the grazed alfalfa was not effective enough to support the milk fat of grazing dairy cows. Grazing could enhance the production of milk fat synthesis inhibitors.

Key Words: Alfalfa grazing dairy cows, Milk fat depression, eNDF

M44 Forage conservation effects on conjugated linoleic acid and trans-C18:1 production by rumen microbes when incubated with soybean oil and fish oil in continuous culture. R. Buckles, A. AbuGhazaleh*, and G. Apgar, *Southern Illinois University, Carbondale*.

The objective of this study was to evaluate the effect of forage conservation method (freeze-dried vs. oven-dried) on ruminal production of trans-C18:1 and cis-9, trans-11 conjugated linoleic acid (CLA) when incubated with soybean oil (SBO) and fish oil (FO) in continuous culture. Forages (70% Pasja, 30% oat) were grown in paddocks, and a 30 kg sample was collected. One portion was rapidly frozen -5°C and then freeze-dried (T1) while the other portion was oven-dried (T2) at 45°C for 48 h. Four dual flow continuous culture apparatus, designed to simulate ruminal digestion and solid and liquid outflow, were used in this experiment in two 10 d periods using a cross over design. Treatment diet (50% forage, 50% concentrate) was fed (120 g/d DM basis) in three equal portions during the day. The concentrate mix contained 1% FO and 2% SBO (DM basis). Concentration of trans-C18:1 was not affected ($P < 0.15$) by conservation method, but was numerically higher with T2 (22.0 mg/g of overflow) than T1 (20.4 mg/g of overflow). The concentration of cis-9, trans-11 CLA tended ($P < 0.08$) to increase with T2 (0.32 mg/g of overflow) compared with T1 (0.18 mg/g of overflow). Concentration of linolenic acid was higher ($P < 0.05$) with T2 (2.12 mg/g of overflow) than T1 (1.72 mg/g of overflow). Based on these results, forage conservation method has limited effect on ruminal production of trans-C18:1 and cis-9, trans-11 CLA in continuous culture.

Key Words: Forage, Trans FA, Continuous culture

M45 The effect of fatty acid source and forage source on trans-C18:1 and conjugated linoleic acid production by ruminal microbes in batch culture. R. Buckles, A. AbuGhazaleh*, and G. Apgar, *Southern Illinois University, Carbondale*.

Previously, docosahexaenoic acid (DHA) was identified as the active component in fish oil that enhances trans-C18:1 production. The objective of this study was to evaluate the effect of combining DHA with linoleic acid (C18:2) and linolenic acid (C18:3), using three different dried forages (oats, pasja, or alfalfa) on production of trans-C18:1 and conjugated linoleic acid (CLA) in batch culture. Treatments were as follows: 1) Forage (T1), 2) Forage + 100mg C18:2 (T2), 3) Forage + 80mg C18:2 + 20mg DHA (T3), 4) Forage + 100mg C18:3 (T4), and 5) Forage + 80mg C18:3 + 20mg DHA (T5). Treatments (15 in total) were incubated in triplicate in 500 ml flasks containing 2g finely ground forage, 40 ml strained ruminal fluid, 160 ml

media, and 8 ml reducing solution. A 5-ml sample of culture contents was taken at 24 h for fatty acid analysis by gas liquid chromatography. After 24 h of incubation, the concentration of trans-C18:1 was higher ($P < 0.01$) in cultures incubated with C18:2 than C18:3. Addition of DHA further increased the concentration of trans-C18:1 and the increase was greatest ($P < 0.01$) with T3. Forage type had no effect ($P > 0.05$) on trans-C18:1 concentration. Cis-9, trans-11 CLA was detected only in cultures incubated with C18:2 (T2 and T3) and concentration was higher ($P < 0.05$) with T3 than T2. The concentration of cis-9, trans-11 CLA was higher ($P < 0.05$) when pasja and alfalfa were used as forage sources compared with oats. In conclusion, production of trans-C18:1 and cis-9, trans-11 CLA in rumen cultures were greatest when DHA was incubated with linoleic acid. In addition, forage type used in this study had a minimal effect on trans fatty acids formation.

Key Words: Forage source, FA source, Trans fatty acids

M46 Using the Synchrotron (SRFTIRM) to Reveal Molecular Structural-Chemical Differences between Two Types of Forages Seeds –Winterfat (*Krascheninnikovia lanata*). P. Yu*, R. Wang, and Y. Bai, *University of Saskatchewan, Saskatoon, Canada*.

Winterfat (*Krascheninnikovia lanata*) (forage seed) is a long-lived native shrub with superior forage quality for livestock and wildlife. The objectives of this study were to use the advanced synchrotron technology (SRFTIRM) as a novel approach to reveal protein molecular structural-chemical differences between the two types of winterfat (forage) seeds which showing physiological differences in low temperature tolerances. This experiment was performed at beamline U10B at Brookhaven National Laboratory. Statistical analyses were performed using SAS with the model: $Y = m + \text{seeds (S)} + \text{fitting methods (F)} + \text{S} \times \text{F} + \text{error}$ (where, S= Large, Small; F= Gauss, Lorentz). The results showed that with the synchrotron SRFTIRM, the molecular structural-chemical makeup and characteristics of the winterfat seed tissues could be imaged and revealed. The protein secondary structures differed between the large and small seed tissues. The large type of seeds contained no significant differences ($P > 0.05$) in percentage of β -sheet (average 37.0%) and α -helix (average 24.1%). However, the large type of seeds contained lower ($P < 0.05$) percentage of β -turn (18.1 vs. 20.1%) and lower ($P < 0.05$) ratio of β -turn to α -helix (0.8 vs. 0.9) and β -turn to β -sheet (0.5 vs. 0.6). The results indicated that: 1) the large and small type winterfat seeds have subtle differences in protein secondary structure profile, which implicating differences in structural chemical make-up and features of the two types of winterfat seeds. These subtle differences may affect winterfat seed quality, germination behaviors and growth characteristics. Keeping in mind current research on 'Prion Diseases', perhaps only subtle changes in secondary structure are needed to provide big consequences. Our results demonstrate the potential of highly spatially resolved synchrotron-based FTIR microspectroscopy to reveal differences of structural molecular chemistry and protein secondary structures, which are associated with seed size variation and may affect germination behaviors.

Key Words: Synchrotron FTIR microspectroscopy, Forage seed, Molecular chemistry

M47 Assessment of forage production and nutritional value of subtropical grasses in north-western Argentina. M. V. Cornacchione¹ and J. I. Arroquy*^{1,2}, ¹*Instituto Nacional de Tecnología Agropecuaria, Santiago del Estero, Argentina*, ²*Consejo Nacional de Investigaciones Científicas y Técnicas, Santiago del Estero, Argentina*, ³*Universidad Nacional de Santiago del Estero, Santiago del Estero, Argentina*.

The aim of this trial was to evaluate forage yield and quality of subtropical grasses in the Semiarid Chaco of Argentina. In 2002, ten cultivars were planted in a completely randomized block design; *Brachiaria brizantha* (cv. Marandú; BBM), three cultivars of *Chloris gayana* (cv. Callide [CGC], cv. Katambora [CGK], and cv. Finecut [CGF]), two cultivars of *Cenchrus ciliaris* (cv. Biloela [CCB] and cv. Molopo [CCM]), *Panicum maximum* (cv. Gatton panic [PMG]), *Panicum maximum* var. *Trichoglume* (cv. Green panic [PMTG]) and two *Panicum coloratum* (cv. Klein [PCK], and cv. Bambatsi [PCB]). During 4 seasons, three experimental plots (10 × 20 m) per cultivar were clipped once a year at the end of the growing season (May; mature forage). Cultivar × year interaction was significant for forage production ($P < 0.01$). In a group of cultivars (CGC, CGK, CGF, BBM, and CCM) forage production linearly decreased ($P < 0.01$) in response to sward maturity. But other species (PMG, PMTG, PCB, PCK, CCB) had a quadratic response ($P < 0.01$; initially peaked, and then decreased in DM production) to maturity. BBM had more forage accumulation ($P < 0.01$; 7445 kg DM /ha) than *Chloris* cultivars (5698 kg DM /ha) and *Panicum* spp. (4310 kg DM /ha), but did not differ from *Cenchrus* cultivars (6306 kg DM /ha). Cultivars of *Cenchrus* accumulated more forage than *Panicum* spp. ($P < 0.01$), and they had similar DM production than *Chloris* cultivars. *Chloris* cultivars were superior to *Panicum coloratum* ($P < 0.01$; 2980 kg DM /ha) but they were similar to *Panicum maximum* (4975 kg DM /ha). *Panicum maximum* had more forage production than *Panicum coloratum* ($P < 0.01$). Crude protein and NDF content did not differ among cultivars ($P < 0.10$; average CP = 4.75 ± 0.46 , NDF = 77.5 ± 6.3). The content of CP in the forage linearly decreased ($P < 0.01$) because of advancing maturity of the sward, while NDF increased ($P < 0.01$) in response to sward maturity. In conclusion, *Brachiaria* and *Cenchrus* cultivars had higher forage productivity in the Semiarid Chaco than the other species, whereas forage quality was similar among cultivars.

Key Words: Subtropical pastures, Forage production, Forage quality

M48 In vitro ruminal degradation of anthocyanidin-containing alfalfa transformed with the maize *Lc* regulatory gene. Y. Wang*¹, T. A. McAllister¹, and M. Y. Gruber², ¹*Agriculture and Agri-Food Canada Research Centre, Lethbridge, Alberta, Canada*, ²*Agriculture and Agri-Food Canada Research Centre, Saskatoon, Saskatchewan, Canada*.

To reduce the propensity of alfalfa to cause pasture bloat in grazing animals, researchers sought to transform this popular forage with a *bHLH* anthocyanin regulatory gene (*Lc*) from maize. Expression of the *Lc* (leaf color) gene causes accumulation of anthocyanidin and proanthocyanidins in alfalfa tissues, giving rise to novel 'purple-green' forage. In this study, the effects of *Lc* expression on ruminal degradation of the forage were studied in vitro. Field-grown parental and three transgenic forages were harvested at the pre-bud stage, freeze-dried and ground (1.0 mm) for use as substrate. Anthocyanidin content in the transgenic genotypes ranged from 130 to 136 µg/g DM. The ground forages (500 mg in F57 bags) were incubated anaerobically for 0, 2, 4,

8, 12, 16, 24, and 48 h in a DAISY^{II} Incubator (ANKOM Technology, Macedon, NY) for determination of DM and N degradabilities ($n = 9$). A second incubation was conducted (sampling at 0, 4, 8 and 12 h) with ¹⁵N included as a marker for microbial protein. Compared to the non-transgenic parental alfalfa (NT), the *Lc*-transgenic genotypes contained less ($P = 0.034$) rapidly soluble DM, but their slowly degradable DM fractions, rates of degradation and lag times for digestion were similar ($P \geq 0.122$) to NT. At 0 h, the true disappearances of N and DM were lower ($P < 0.001$ and $P = 0.027$, respectively) from the *Lc* genotypes than from NT alfalfa, but they did not differ ($P \geq 0.137$) at 4, 8, or 12 h. Solubility of DM and N were both negatively correlated ($r^2 \geq 0.563$) with the concentration of anthocyanidins measured in the forage. *Lc*-transformation reduced the initial rate, but not the extent of DM and N digestion of alfalfa in the rumen. These properties could improve the utilization of protein and possibly reduce the risk of bloat in ruminants consuming fresh alfalfa.

Key Words: *Lc*-transformation, Forage quality, Ruminal degradation

M49 Antitherbivory compounds on the leaf surface of intact and resprouted tarbush. R. Estell*¹, E. Fredrickson¹, and M. Remmenga², ¹*USDA-ARS Jornada Experimental Range, Las Cruces, NM*, ²*New Mexico State University, Las Cruces*.

Shrub encroachment into desert grasslands of the southwestern United States is a serious problem resulting in loss of forage and rangeland productivity. *Flourensia cernua* (tarbush) is one such shrub contributing to the decline of Chihuahuan Desert grasslands. Our previous research has shown tarbush consumption by sheep and goats to be negatively related to leaf surface concentration of individual terpenes and epicuticular wax. Concentrations of antitherbivory compounds such as terpenes change with plant age and phenology. Our objective was to alter the vegetative state and potential palatability of tarbush by clipping intact plants and generating resprouts. We hypothesized resprouts would invest fewer resources into antitherbivory compounds and therefore have lower concentrations of volatile chemicals such as terpenes than intact plants. Ninety tarbush plants were randomly selected and all biomass within 10 cm of the soil surface was removed from 45 plants during winter dormancy. Leaves were collected the following summer during active growth from the canopy of intact controls and resprouts. Leaf surface volatiles were extracted in ethanol and analyzed by gas chromatography-mass spectroscopy. Data were transformed to natural logarithms and subjected to univariate analysis of variance and stepwise discriminate analysis. Of the 87 compounds present on tarbush leaves, 35 were greater in canopy samples and 16 were greater in regrowth samples based on univariate analysis ($P < 0.05$). Mean concentration of total volatiles on canopy leaves tended to be less ($P = 0.0622$) than that of regrowth (3642 vs 4684 µg/g DM). Nine compounds in the discriminate analysis (α -muurolene, iso-borneol, unknown#6, *p*-cymen-8-ol, unknown#7, sabinene, β -caryophyllene, δ -cadinene, and α -copaene) explained 95% of the variation between canopy and regrowth samples. In contrast to our hypothesis, lower cumulative concentration of volatile compounds in canopy than regrowth samples suggests resprouts may be less vulnerable to herbivory than old growth tarbush. However, animal studies are needed and effects on other classes of secondary compounds must be examined.

Key Words: Regrowth, Shrub, Terpene

M50 Chemical composition, intake and *in vitro* gas production of the forage selected by cattle in a grassland of Northern Mexico.

M. Murillo-Ortíz, O. Reyes-Estrada, E. Herrera-Torres, M. Guerrero-Cervantes, G. Nevárez-Carrasco, R. Montoya-Escalante, A. S. Juárez-Reyes, and M. A. Cerrillo-Soto*, *Universidad Juárez del Estado de Durango, Durango, Dgo. México.*

The study was performed to determine the voluntary intake, nutritional value and *in vitro* gas production of the diet of grazing cattle during two periods of the year: wet (Jul-Dec), and dry (Jan-Jun). Four esophageal cannulated steers (320 ± 5.0 kg BW) were utilized to obtain extrusa samples. The collection was carried out at 700 during 45 min for a period of 4 days during Jul, Sept, Oct, Dec, Jan, Mar, Apr and Jun. The OM voluntary feed intake was determined from total fecal collection and the indigestible fraction of the forage after 48h incubation in the rumen. Chromium sesquioxide (8g/anim/14d) was dosed to the four steers to estimate total fecal production. The sampling was performed morning (700) and evening (1600) for 4 days during the months mentioned above. Estimations of CP, NDF, ADF and lignin were performed. *In vitro* gas production determinations were carried out by incubating 500 mg DM samples in calibrated 100 ml glass syringes using rumen fluid from two steers fed alfalfa hay *ad lib*. Gas production was recorded at 0, 3, 6, 15, 24, 36, 48, 72 and 96h. Data were fitted to the exponential equation: $Y = a + b(1 - e^{-ct})$. The variables were then analyzed using PROC GLM according to a completely randomized design. Nutritional level was increased ($P < 0.05$) during the wet season compared with that observed during the dry season. Dry matter intake was increased 82%, CP by 128%, and the gas production rate constant c by 35% during the wet vs. dry season. Potential degradability ($a + b$) was not affected ($P > 0.05$). Based on these data a supplementation schedule is warranted during the dry season to improve the body condition score of cattle.

Table 1. Voluntary intake, Nutritional value and parameters from *in vitro* gas production

Item	Sampling period		Mean	SEM
	Dry	Wet		
Intake				
kg OM/d	5.0 ^b	9.1 ^a	7.0	0.270
Percentage BW	1.5 ^b	2.8 ^a	2.1	0.048
g/kg BW ^{0.75} (g OM)	66.8 ^b	123.3 ^a	95.0	0.127
Nutritional value (% DM)				
CP	6.6 ^b	15.1 ^a	10.8	0.61
NDF	74.7 ^a	60.6 ^b	67.6	0.73
ADF	48.6 ^a	40.5 ^b	44.5	0.32
Lignin	6.7 ^a	3.5 ^b	5.1	0.27
<i>in vitro</i> gas production				
$a + b$ (ml/500 mg DM)	106.8 ^a	100.1 ^a	103.5	7.69
Digestion rate constant (%/h)	3.4 ^b	4.6 ^a	4.0	0.60

Means between rows with different superscripts differ ($P < 0.05$)

Key Words: Range cattle, Nutritional value, Gas production

M51 Effect of nitrogen-fertilizer application on chemical compositions and *in vitro* rumen digestibility of corn stovers. Q. Meng^{*1,2} and G. Yan^{1,2}, ¹State Key Laboratory of Animal Nutrition, Beijing, China, ²Beef Cattle Research Center and College of Animal Science & Technology, China Agricultural University, Beijing, China.

Corn stovers supply a major source of roughage feeds of ruminant animals in China. Chemical compositions and ruminal fermentation of

stover generally determines the animal performance and the product quality. Because emphasis has been placed on improvement of corn grains rather than nutritive values of stover, this experiment was conducted to ascertain the effect of nitrogen-fertilizer application on chemical composition and *in vitro* digestibility of corn stovers. Traditional corn (*Zea mays* L.) plants were fertilized under five levels of urea (0, 75, 150, 300, 450 kg/ha) during middle growth stage. After ear harvest, stover samples were collected and measured for chemical components, *in vitro* digestibility and gas production characteristics. Increasing N-fertilizer application levels linearly increased ($P < 0.001$) the contents of crude protein (CP), total amino acids and Ca, but linearly decreased ($P < 0.01$) the total water soluble saccharides. Fertilizer rate had little or no influence ($P > 0.08$) on the contents of ether extract, ash, P, NDF, ADF and lignin. Increasing N-fertilizer application levels resulted in quadratic ($P < 0.05$) changes in digestibilities of dry matter, CP, NDF and ADF with the highest digestibilities achieved at the urea application level of 300 kg/ha. As urea application levels increased, potential degradability ($a + b$) of stovers linearly decreased ($P < 0.001$), but gas production rates linearly increased ($P < 0.001$). Results indicated that application rate of N-fertilizer during middle growth stage of corn plants can influence the chemical composition and rumen fermentation of corn stover.

Key Words: Nitrogen fertilizer, Corn stover, Chemical composition and rumen fermentation *in vitro*

M52 *In vitro* evaluation of various energy supplements for tropical and temperate forages. R. D. L. Pacheco^{*1}, D. D. Millen¹, N. DiLorenzo², and A. DiCostanzo², ¹FMVZ/UNESP, Botucatu, Sao Paulo, Brazil, ²University of Minnesota, St. Paul.

The objective of this study was to evaluate the effects of various energy supplements (Corn Grain, CG; Citrus Pulp, CIP; or Soy Hulls, SH) on IVDMD in two types of forages: *Brachiaria decumbens* (BD), a tropical forage, or *Poa pratensis*, (PP) a temperate grass, hay. Energy supplementation level was based on providing 0.2 % corn per kg BW for a 450-kg cow expected to consume a total of 8.1 kg DMI daily. Energy-supplemented diets were isoenergetic and formulated based on the following TDN values: CG = 92%, CIP = 81% and SH = 74%. Forage only (FOR) or forage mixed with respective supplement (DIET) in Ankom fiber bags were incubated in jars in a Daisy^{II} Incubator (Ankom Technology Corp.). Jars containing FOR bags only were added respective supplement in the media. A set of control bags (CTL) contained forage only. Supplementation had no effect on IVDMD of the forage ($P > 0.05$) regardless of source. Temperate grass hay had greater ($P < 0.01$) IVDMD values than BD. A supplement type X forage source interaction was observed ($P = 0.04$) for total diet IVDMD. No differences ($P > 0.05$) in total diet IVDMD were observed for BD supplementation (CTL = 41.58%, CG = 40.19%, CIP = 42.38%, SH = 42.67%; SEM = 2.42), but greater ($P < 0.05$) total diet IVDMD values were observed for CTL and CG when compared to SH (CTL = 55.20%, CG = 55.02%, CIP = 53.00%, SH = 51.21%; SEM = 2.42). In conclusion energy supplementation effects on total diet and forage fraction IVDMD were dependent on forage type and supplemental source. At the supplementation level tested, no effect on IVDMD was observed in the forage fraction of the diet for either PP or BD. No effects were observed in IVDMD when supplementing tropical forage (BD) based diets. A reduction in total diet IVDMD was observed when supplementing a PP with soy hulls, when compared to no energy supplementation or supplemented with corn grain.

Key Words: Forages, IVDMD, Energy supplementation

M53 Neutral detergent fiber digestibility of cool-season grasses. P. D. French*, T. W. Downing, B. D. Frisch, J. L. Chamberlain, and J. L. Wartjes, *Oregon State University, Corvallis.*

Forage grass production is an important component of profitable dairying along the Pacific Northwest coast. Neutral detergent fiber digestibility (NDFD) is increasingly being used in ration formulation and forage benchmarking. However, data on differences in NDFD between and within cool-season grass species is limited. Therefore, the objective of this study was to determine if NDFD differs between and within species. In experiment 1, 15 cool-season grass varieties were replicated 3 times each in 6 m² randomized field plots. Included were 5 varieties each of perennial ryegrass (*Lolium perenne*), orchardgrass (*Dactylis glomerata*), and tall fescue (*Lolium arundinaceum*). In experiment 2, three diploid and three tetraploid cool-season ryegrass varieties (*Lolium perenne*) were replicated 3 times each in 6 m² randomized field plots. Plots were mechanically harvested six times at approximately 28 d intervals beginning in March. Forty eight-hour in vitro neutral detergent fiber (NDF) digestibility was determined using 0.3 g of sample in F57 bags in a Daisy^{II} Incubator (Ankom Technology, Fairport, NY). In experiment 1, yield (2124±79 kg DM/ha/cutting) was similar across species. Neutral detergent fiber was less for ryegrass compared to orchardgrass (47.1 vs 48.5±0.4%; $P < 0.01$), but similar to both of these grasses was tall fescue (48.0%). Neutral detergent fiber digestibility was greater for ryegrass compared to orchardgrass and tall fescue (80.4 vs 77.5±0.6% of NDF; $P < 0.01$). Digestible NDF did not differ and was 37.4±0.3% of DM or 799±32 kg/ha/cutting. Neutral detergent fiber increased (linear; $P < 0.01$) and NDFD decreased (quadratic, cubic; $P < 0.05$) as the growing season progressed. In experiment 2, yield (2220±110 kg DM/ha/cutting), NDF (47.2±0.5%), NDFD (80.7±0.5%), and digestible NDF (38±0.4% of DM and 851±47 kg DM/ha/cutting) were similar for diploid and tetraploid ryegrasses. These results indicate species, when managed intensively, has little effect on yield and digestibility.

Key Words: Neutral detergent fiber digestibility, Cool-season grass, In vitro digestibility

M54 Effect of *Lactobacillus buchneri* applied to alfalfa hay treated at high moisture. G. E. Higginbotham*¹, S. Mueller¹, and R. Kuber², ¹*University of California Cooperative Extension, Fresno,* ²*Conner Marketing, Clovis, CA.*

The effectiveness of a microbial inoculant containing *L. buchneri* in high moisture alfalfa hay was evaluated. Third cutting alfalfa from alternate windrows was baled into six 900 kg bales at 75% DM (high moisture) without (HM-C) or with (HM-T) inoculant and at 85% DM (normal moisture) without inoculant (NM). Application rate was 1.2 million colony forming units (CFU) per gram of forage. Each bale (six per treatment) had three core samples collected per end at 0 and at 28 d of storage to determine chemical composition. Internal bale temperatures were measured throughout the 28-d storage period. Treatment effects on all quality attributes were analyzed using the NCSS statistics software. At baling, differences between high moisture treatments were not significant for percentages of CP, soluble protein, bound protein, ADF, NDF or 30-h NDF digestibility. After 28 d of

storage, no differences were detected between high moisture treatments for CP, soluble protein, ADF, NDF and NDF 30h digestibility. Bound protein was greater ($P < 0.05$) for HM-T compared to HM-C and NM (1.48%, 1.09%, 0.98%, respectively). Both HM hays heated to between 37.8°C and 48.9°C. Temperatures of NM varied between 27.8°C and 32.2°C. After storage, differences in mold values for both HM groups were not different with yeast counts similar for HM hays but significantly lower than NM hay. Bales from each treatment were broken open and evaluated by an independent nutrition consultant for timber, color, leaf quality, aroma, mold, dustiness and overall quality using a scale from 1 to 5 where 5 is a high rating. No differences were detected for timber rating but both HM treatments had significantly lower ratings than NM treatment in color, leaf quality aroma, dustiness and overall quality. No differences were noted between the HM treatments. Based on this trial, the addition of *L. buchneri* to the high moisture alfalfa hay did not appreciably improve chemical or visual characteristics over non-treated controls or hay baled at normal moisture levels.

Key Words: Inoculant, Alfalfa, Hay

M55 Effect of fibrolytic enzymes or ammonia treatment on the nutritive value of 6-wk and 8-wk regrowths of guineagrass hay. D. B. Dean*^{1,2}, A. T. Adesogan¹, E. Valencia³, and N. Krueger¹, ¹*University of Florida, Gainesville,* ²*Universidad del Zulia, Maracaibo, ZU, Venezuela,* ³*Universidad de Puerto Rico, Mayaguez, PR.*

This study evaluated the effect of applying four fibrolytic enzymes or NH₃ on the nutritive value of 6- (6-wk) and 8-week (8-wk) regrowths of guineagrass (*Panicum maximum*) hay. The NH₃ was applied at 4% DM and enzymes Promote (Pr) Biocellulase X-20 (X-20), Fibrozyme (Fib) and Biocellulase A-20 (A-20) were dissolved in water and applied in a fine spray at 0, 0.5x, 1x and 2x manufacturer-recommended rates to 2 kg of hay in triplicate. Hays were stored for 3 weeks before determination of chemical composition and 6-h and 48-h in vitro digestibility of DM (IVDMD), NDF (IVNDFD), and ADF (IVADFD) using a completely randomized design. Crude protein concentration, 6-h and 48-h IVDMD, and 48-h IVNDFD and IVADFD values were greater ($P < 0.01$), while ADF and NDF concentrations were lower ($P < 0.01$) in 6-wk hays compared to 8-wk hays. Additive treatment did not affect ADF or NDF concentration of 6-wk hays, but in 8-wk hays, X-20 and Fib treatment slightly (<4%) reduced NDF and ADF concentrations (additive x maturity interaction, $P < 0.1$). Ammoniation increased ($P < 0.01$) CP concentration of 6-wk and 8-wk hays by 42 and 91%, respectively (additive x maturity interaction, $P < 0.01$). Ammoniation increased 6-h IVDMD by 35% and increased 48-h IVDMD and IVNDFD by 10%, and there were no maturity x additive interactions for these measures. Additive treatment did not increase 48-h IVADFD. This study shows that guineagrass quality decreases as the duration between harvests increases. Certain enzymes produced small (<4%) decreases in the fiber concentration of 8-wk hays, but enzymes had no other effects on nutritive value. Ammoniation increased CP concentration and in vitro DM and NDF digestibility, therefore ammoniation was the only treatment that increased the nutritive value of guineagrass hays

Key Words: Guineagrass hay, Enzymes, Nutritive value

Goat Species: Feeding Management of Goats

M56 Characterization of pubertal development in nanny-fed and synthetic milk-fed crossbred meat goat does. K. Collard*¹, M. S. Torres¹, E. Gonzales¹, C. W. O’Gorman¹, R. L. Stanko^{1,2}, and M. R. Garcia¹, ¹Texas A&M University, Kingsville, ²Texas A&M University Agriculture Research Station, Beeville.

Kid goats raised on synthetic goat milk (SM) reportedly have a substantially lower growth rate than nursing doe-reared kids, which may affect age at puberty. Therefore, the effect of SM on pubertal development was determined in January-born crossbred (Boer x Spanish) meat goat does. Newborn doe kids remained with their respective nursing doe during the first 24h. After 24h doe kids were randomly selected to continue nourishment from the nursing doe (N; n=10) or begin a SM regimen (n=7). All doe kids had ad libitum access to pelleted goat feed and sorghum hay throughout the study. At 45 d of age doe kids were weaned. Body weight and ADG were recorded weekly throughout the study. Blood samples were collected twice weekly beginning at 5 mo of age and analyzed for concentrations of serum progesterone (P4), circulating metabolites, and metabolic hormones. To determine serum LH characteristics during development, does were bled every 12 min for 8 h beginning at 6 mo of age and every 30 d thereafter until confirmation of puberty, i.e., 2 consecutive concentrations of P4 (1 ng/ml). Effect of milk source on age at puberty was determined using the MIXED procedure of SAS. Effect on serum hormones and circulating metabolites from 20 weeks prior to puberty until the week of pubertal ovulation were analyzed using the MIXED procedure of SAS for repeated measures. Age at puberty tended ($P=0.1$) to occur earlier in N does compared to SM does ($278.3 \text{ d} \pm 7.7$ vs. $299.4 \text{ d} \pm 9.2$, respectively). Despite an increase ($P < 0.05$) in BW as puberty approached, neither BW nor ADG differed between the two groups. LH pulses were detected at 6 mo of age in all does at a frequency of 1.7 pulses/8 h, increasing ($P < 0.01$) to 3.4 pulses/8 h within 30 d of pubertal onset. LH pulse amplitude decreased ($P = 0.03$) from 3.0 ng/ml at 6 mo of age to 2.2 ng/ml within 30 d of pubertal onset. The baseline of LH did not differ throughout the sampling period. Serum concentrations of total cholesterol and glucose decreased ($P < 0.01$) in all does as puberty approached. Results suggest that SM may not adversely affect the age at puberty in crossbred meat goat does.

Key Words: Goats, Milk, Puberty

M57 Water balance in goats under feed restriction. K. T. Resende*^{1,4}, I. A. M. A. Teixeira¹, J. M. Pereira Filho², and P. J. Murray³, ¹Universidade Estadual Paulista/FCAV, Jaboticabal, SP, Brazil, ²Universidade Federal de Campina Grande, Patos, PB, Brazil, ³School of Animal Studies, University of Queensland, Gatton, Qld, Australia, ⁴FAPESP, São Paulo, SP, Brazil.

The effect of feed restriction on water balance and nutrient utilization was investigated in individually penned Boer x Saanen kids. Twenty-two male Boer x Saanen kids with an initial average BW of 15 kg were used. Seven kids were slaughtered at the beginning of the experiment (reference animals) and the remainders were allocated to one of 3 treatments (0, 30 and 60% water restriction). The feed intake for the 0% restriction treatment animals determined the intake for the animals in the 30% and 60% restriction treatment. When the animals in the 0% restriction treatment group reached 25 kg BW, the animals in the 30% and 60% restriction treatment groups were also slaughtered. There was a negative relationship between DMI and water intake, whereas

the greater intake of water was found in goats in the 60% restriction treatment group ($P < 0.05$). The digestibility coefficients for DM, OM, carbohydrates, ash, ether extract, energy, NDF, ADF and lignin did not differ between treatments ($P > 0.05$), whereas the digestibility coefficient for CP was different between treatment groups ($P < 0.05$). The highest metabolic water production was in animals in the 0% restriction treatment group ($P < 0.05$). No significant differences were observed in the composition of gastro-intestinal tract contents of the goats in the different treatments ($P > 0.05$). Lower water retention was found in the animals in the 60% restriction treatment group ($P < 0.05$). The study showed that feed restriction affected water intake, CP digestibility and water retention in the body of the goat kids. This experiment demonstrated that DM:water intake ratio changed when severe feed restriction was applied (60% restriction) and water was freely available. Our findings suggested that penned goats might have different pattern of drinking, particularly if feed intake is restricted, and caution is needed to extrapolate results from nutritional and physiological trials in pens to goats on pasture.

Key Words: Goat kids, Metabolic water production, Penned goats

M58 Energy and protein requirements for maintenance and growth of Boer crossbred kids*. M. H. M. R. Fernandes*¹, K. T. Resende¹, L. O. Tedeschi², J. S. Fernandes Jr.¹, H. M. Silva¹, G. E. Carstens², and I. A. M. A. Teixeira¹, ¹Universidade Estadual Paulista/FCAV, Jaboticabal, Sao Paulo, Brazil, ²Texas A&M University, College Station.

Meat production by goats has become an important livestock enterprise in several parts of the world. However, energy and protein requirements of meat goats have not been well defined. The objective of this study was to determine energy and protein requirements for maintenance and growth of 34 intact male crossbred ($\frac{3}{4}$ Boer $\frac{1}{4}$ Saanen) from 20 to 35 kg BW. The baseline group (BL) was comprised of seven randomly selected kids, averaging 20 kg BW. An intermediate group was fed ad libitum and consisted of six randomly selected kids that were slaughtered when they reached 27.5 kg BW. The remaining kids (n = 21) were randomly allocated to three levels of DMI (treatments: ad libitum and restricted to 30 and 60% of the ad libitum) within seven groups. A group was slaughtered when the ad libitum treatment kid reached 35 kg BW. Body components were weighed, ground, mixed, and subsampled for chemical analysis. Initial body composition was determined using equations developed from the composition of the BL kids. The diet DM consisted of 47% corn hay and 53% concentrate (21.4% CP). A digestion trial was conducted in parallel to determine dietary DE and ME. The NE_m calculated was $77.3 \pm 1.05 \text{ kcal/kg}^{0.75}$ EBW ($67.4 \pm 1.04 \text{ kcal/kg}^{0.75}$ BW). The ME for maintenance (ME_m ; $118.1 \text{ kcal/kg}^{0.75}$ EBW) was calculated by iteration assuming heat produced is equal to ME intake at maintenance. Therefore, the partial efficiency of use of ME to NE for maintenance was 0.65. A value of $391 \pm 59 \text{ mg N/d/kg}^{0.75}$ EBW for N losses (or $2.44 \pm 0.4 \text{ g}$ of $NP_m/\text{d/kg}^{0.75}$ EBW) was determined. Net energy (NE_g) and protein (NP_g) requirements for growth ranged from 2.55 to 3.0 Mcal/kg empty weight gain (EWG) and 178.8 to 185.2 g/kg EWG for 20 and 35 kg BW; respectively. These findings suggested that net energy and protein requirements for growth of Boer crossbreds, a meat type breed, might be higher than published requirements for dairy goats. * Sponsored by FAPESP and CAPES, Brazil.

Key Words: Gain, Goat, Net requirement

M59 Effects of feeding method, diet nutritive value and physical form, and genotype on feed intake, feeding behavior, and growth performance by meat goats. T. Gipson*, A. Goetsch, G. Detweiler, and T. Sahl, *American Institute for Goat Research, Langston University, Langston, OK.*

Thirty-two F₁ Boer x Spanish (28.7 kg, SE = 0.49) and 40 3/4 Boer-1/4 Spanish (31.9 kg, SE = 0.47) wethers, 5 mo of age, were used to compare feeding systems with different dietary treatments. Feeding systems were Calan gates and automated feeding units allowing one animal to consume feed at a time. Two diets included concentrate (C) and two were dehydrated alfalfa (A), fed pelletized (P) or loose (L). Main effects of feeding method were not significant. There was an interaction in DMI involving feeding method, diet, and genotype, which indicated that with a concentrate diet, regardless of physical form, DMI was not influenced by feeding method. Main effect dietary treatment means (1.78, 1.67, 2.04, and 1.70 kg for C-P, C-L, A-P, and A-L, respectively; SE = 0.030) indicated that pelletizing had a slightly greater effect on DMI with A vs C. ADG was lowest ($P < 0.05$) among treatments for A-L (212, 205, 190, and 157 g for C-P, C-L, A-P, and A-L, respectively; SE = 8.9), and ADG:DMI was greater for C vs A (127, 120, 94, and 94 g/kg for C-P, C-L, A-P, and A-L, respectively; SE = 7.8). ADG and ADG:DMI were similar ($P > 0.05$) between genotypes. For wethers subjected to automated feeding units, the number of feeder visits was lowest among diets ($P < 0.05$) for C-P (23.1, 31.2, 35.7, and 35.7 per day); total feeder occupancy time per animal ranked ($P < 0.05$) C-P < A-P < C-L and A-L (74, 130, 105, and 122 min/d), and rate of DMI was greater ($P < 0.05$) for P than for L diets (24.6, 12.9, 22.0, and 13.7 g/min for C-P, C-L, A-P, and A-L, respectively). In summary, there appear limits to change by meat goats in feeding behaviors in response to diet types and forms, as exemplified by lowest ADG for A-L. Calan gates and automated feeding systems appear similar in the ability to compare growth performance with treatments such as the concentrate-containing diets and genotypes of this experiment. Pelletizing does not seem to affect growth performance with diets consisting of appreciable concentrate and effects with forage diets may be attributable to change in level of feed intake.

Key Words: Feed intake, Goats, Growth

M60 Methane emission by goats consuming diets with different levels of condensed tannin-containing lespedeza and sorghum-sudangrass. G. Animum^{*1}, R. Puchala¹, A. Goetsch¹, T. Sahl¹, G. Detweiler¹, A. Patra¹, V. Varela², and J. Wells², ¹*American Institute for Goat Research, Langston University, Langston, OK*, ²*US Meat Animal Research Center, Clay Center, NE.*

Boer (7/8) x Spanish wethers (24; BW = 34.1 kg, SE = 1.02) were used to determine effects of dietary levels of a condensed tannin (CT)-containing forage Kobe lespedeza (*Lespedeza striata*; K) and sorghum-sudangrass (*Sorghum bicolor*; G) on methane emission. Treatments were K levels (DM basis) of 100, 67, 33, and 0% (100K, 67K, 33K, and 0K, respectively). Forages harvested daily were fed at 1.3 times the maintenance energy requirement. The experiment lasted 21 d, with measures on the last 8 d. N was 1.7 and 2.2%, in vitro true DM digestibility was 85.5 and 68.0%, and CT was 0 and 15.1% for G and K, respectively. DMI was similar among treatments (677, 664, 633, and 626 g/d; SE = 30.8) and gross energy (GE) digestibility increased linearly ($P < 0.05$) with decreasing K (47.1, 51.4, 58.9, and 65.6% for 100K, 67K, 33K, and 0K, respectively). ME intake increased linearly ($P < 0.05$; 398, 431, 485, and 513 kJ/kg BW^{0.75}),

whereas energy expenditure (356, 350, 399, and 504 kJ/kg BW^{0.75}) and methane emission changed linearly and quadratically ($P < 0.05$) with decreasing K (10.9, 13.8, 17.6, and 26.2 L/d; 3.3, 4.0, 5.4, and 8.2% GE; 7.0, 7.7, 8.8, and 11.9% DE for 100K, 67K, 33K, and 0K, respectively). In vitro methane production by incubation of ruminal fluid for 3 wk with a medium for methanogenic bacteria and other conditions promoting activity by methanogens also was affected linearly and quadratically ($P < 0.05$) by K (7.0, 8.1, 9.2, and 16.1 mL for 100K, 67K, 33K, and 0K, respectively). The total bacterial count was similar among K levels, but the number of total protozoa increased linearly ($P < 0.05$) as K declined (8.3, 11.8, 15.6, and 27.1 x 10⁵/mL for 100K, 67K, 33K, and 0K, respectively). In conclusion, the CT-containing forage K decreased methane emission by goats regardless of nonzero level. The impact of K CT on methane emission appears attributable to changes in methanogenic bacterial activity, although alterations of protozoal actions might be involved as well. This project was supported by USDA Project No. 2004-38814-15045.

Key Words: Condensed tannins, Goats, Methane

M61 Efficiency of energy use for pregnancy by crossbred Boer x Spanish does with different litter size. I. Tovar-Luna¹, A. L. Goetsch¹, R. Puchala^{*1}, T. Sahl¹, G. E. Carstens², H. C. Freetly³, and Z. B. Johnson⁴, ¹*Kika de la Garza American Institute for Goat Research, Langston, OK*, ²*Texas A&M University, College Station*, ³*USDA/ARS Meat Animal Research Center, Clay Center, NE*, ⁴*University of Arkansas, Fayetteville.*

Twenty-four Boer x Spanish does (3 yr of age, having kidded once previously and with an initial BW of 42.7 ± 1.2 kg) were used to determine the efficiency of ME utilization for pregnancy (k_{preg}). Six does were nonpregnant and, based on ultrasound determination on day 45 of gestation, six had a litter size (LS) of 1, 2, and 3. However, only 10 of the pregnant does delivered the expected number of kids (three, four, and three with LS of 1, 2, and 3, respectively). Does were fed a diet of approximately 50% concentrate in accordance with assumed maintenance plus pregnancy energy requirements based on estimated nonpregnancy tissue BW and LS. Recovered energy (RE) was determined by subtraction of energy expenditure (EE; respiration calorimetry) near day 80, 100, 120, and 140 of gestation from ME intake (MEI). RE was assumed attributable to pregnancy tissues (fetus, fetal fluids and membranes, uterus, and mammary gland), and ME used for pregnancy (ME_{preg}) was estimated by subtracting ME_m determined with nonpregnant goats from MEI by those pregnant. For does with actual LS equal to that expected, the no-intercept equation for the regression of RE against ME_{preg} was: RE = ME_{preg} x 0.252 (SE = 0.030; R² = 0.64), indicating a k_{preg} of 25%. Although, a regression including LS (1 vs. 2 or 3) suggested greater k_{preg} for LS of 1 (40.2% ± 5.6) vs. 2 or 3 (20.5% ± 3.2). Regressions for goats with LS different from expected suggested positive effects of use of energy mobilized from nonpregnancy tissues on k_{preg} and of use of dietary ME for energy accretion in nonpregnancy tissues on the efficiency of whole body ME utilization. In conclusion, the average efficiency of ME use for pregnancy regardless of LS in goats was near 25%, which when considering the expected proportion of all pregnancy tissues attributable to fetal or conceptus tissues implies an energy requirement for pregnancy of goats similar to common recommendations for sheep and cattle.

Key Words: Energy, Goats, Pregnancy

M62 Relationship between energy expenditure and heart rate in pregnant Boer x Spanish does with different litter size. R. Puchala*, I. Tovar-Luna, A. L. Goetsch, and T. Sahlul, *E (Kika) de la Garza American Institute for Goat Research, Langston, OK.*

Twenty-four Boer x Spanish does (3 yr of age, having kidded once previously and initial BW of 42.7 ± 1.19 kg) were used to determine effects of litter size (LS) and stage of gestation (near day 80, 100, 120 and 140) on the relationship between energy expenditure (EE) and heart rate (HR). Six does were nonpregnant (0) and, based on ultrasound determination on day 45 of gestation, six had LS of 1, 2 and 3. However, only 10 of the pregnant does had the expected number of kids (three, four, and three with LS of 1, 2 and 3, respectively). Does were fed a diet of approximately 50% concentrate in accordance with assumed maintenance plus pregnancy energy requirements based on LS. EE determined by respiration calorimetry on d 80, 100, 120 and 140 of gestation with head-boxes was expressed relative to average BW within the 2-d measurement periods and HR was determined at the same time using Polar S610 HR monitors. There was an effect of animal within LS ($P < 0.05$), CV of 10.2, 11.2, 3.8, and 8.6% and maximum differences of 41.7, 16.6, 5.2, and 12.0 of means for LS 0, 1, 2, and 3, respectively). Time of the day affected ($P < 0.05$) EE, HR, and EE:HR; highest values 0900 and 1600 and lowest values between 0200 and 0700). CV for hourly values were 3.9, 2.1, and 2.4%, and maximum differences relative to means were 9.0, 4.1, and 4.8% for EE, HR and EE:HR, respectively. There was an interaction in EE:HR between LS and stage of gestation ($P < 0.05$). EE:HR decreased as gestation progressed (LS 1:7.29, 6.79, 6.14, and 5.53; LS 2:6.73, 6.42, 6.07, and 5.02; LS 3: 6.53, 6.07, 5.71, and 5.07 (kJ/kg BW^{0.75})/(beats/min) on d 80, 100, 120, and 140, respectively, whereas nonpregnant goats had stable EE:HR (8.04, 7.78, 7.78, and 7.74 (kJ/kg BW^{0.75})/(beats/min)). In conclusion, changing EE:HR in pregnant animals may preclude use of HR to predict EE. Magnitudes of difference in EE:HR among animals and time of the day suggest benefit from determinations for individual animals and over extended periods of time.

Key Words: Energy expenditure, Goat heart rate, Pregnancy

M63 Tethering meat goats grazing forage of high nutritive value and moderate to high mass. A. Patra*¹, R. Puchala¹, G. Detweiler¹, L. Dawson², G. Animut¹, T. Sahlul¹, and A. Goetsch¹, ¹*American Institute for Goat Research, Langston University, Langston, OK,* ²*Oklahoma State University, Stillwater.*

Yearling Boer x Spanish goats (n=24) were used in a crossover design to determine effects of tethering with forage of high nutritive value and moderate to high mass. Four 0.72-ha pastures of wheat (*Triticum aestivum*) and berseem clover (*Trifolium alexandrinum*) were grazed in April to May. Each pasture hosted six animals, three with free movement (Free) and three attached to a 3 m tether (Tethered) for access to a circular area of 28.3 m². One animal of each treatment and pasture was used to determine forage selection, fecal output, or grazing behavior and energy expenditure (EE). Measures were in the second week of 2-wk periods. Mass of forage DM before grazing in Tethered areas averaged 2,649 and 2,981 kg/ha in periods 1 and 2, respectively. The CP concentration in ingesta was greater ($P < 0.05$) 23.1 and 20.3%; SE = 0.82) for Free vs Tethered animals. The level of NDF (54.0 and 55.9%; SE = 1.66) and in vitro true DM digestion (75.7 and 76.5%; SE = 1.20) were similar between treatments. Metabolizable

energy intake was greater ($P < 0.05$) for Free vs Tethered animals (12.7 and 10.4 MJ/d; SE = 0.89). There were small treatment differences ($P < 0.05$) in in vivo apparent digestibility of OM (71.7 and 72.3.4%; SE = 0.24) and NDF (63.3 and 65.2% for Free and Tethered, respectively; SE = 0.92). There were no treatment effects on time spent ruminating, idle, or eating (405 and 366 min/d for Free and Tethered, respectively; SE = 42.5). Energy expenditure was considerably greater ($P < 0.05$) for Free vs Tethered animals (633 and 512 kJ/kg BW^{0.75}, respectively; SE = 27.4). In conclusion, differences in EE between goats freely grazing and tethered may not be solely attributable to ME intake, distance traveled, and/or grazing time. Tethering as a model for free movement may offer a reasonable means of studying some aspects of grazing such as ingesta composition but appears inappropriate for others, including EE and efficiency of energy metabolism. This project was supported by National Research Initiative Competitive Grant no. 2004-35206-14166 from the USDA Cooperative State Research, Education, and Extension Service.

Key Words: Energy, Goats, Tether

M64 Tethering meat goats grazing forage of high nutritive value and low to moderate mass. A. Patra*¹, R. Puchala¹, G. Detweiler¹, L. Dawson², G. Animut¹, T. Sahlul¹, and A. Goetsch¹, ¹*American Institute for Goat Research, Langston University, Langston, OK,* ²*Oklahoma State University, Stillwater.*

Yearling Boer x Spanish goats (n=24) were used to determine effects of tethering with forage of high quality and low/moderate mass. Four 0.72-ha pastures of wheat (*Triticum aestivum*) and berseem clover (*Trifolium alexandrinum*) were grazed in December and January. Each pasture hosted six animals, three with free movement (F) and three attached to a 4.11 m tether (T) for access to a circular area of 53.1 m². One animal of each treatment and pasture was used to determine forage selection, fecal output, or grazing behavior and energy expenditure (EE). Measures were in the second week of 2-wk periods. Mass of forage DM before grazing in T areas averaged 1,280 and 1,130 kg/ha in periods 1 and 2, respectively. CP concentration in ingesta was greater (23.9 and 20.9%) and the NDF level (50.3 and 53.8%) was lower for F vs T ($P < 0.05$); in vitro true DM digestion was similar between treatments (80.8 and 80.7% for F and T, respectively; SE = 0.96). Intakes of DM (1,013 and 968 g/d; SE = 78.6) and ME (10.9 and 10.7 MJ/d; SE = 0.90) were similar between treatments. There was a difference ($P < 0.05$) in in vivo apparent digestibility of OM (78.0 and 81.4%; SE = 0.49) and no treatment effects on time spent ruminating, idle, or eating (346 and 347 min/d for F and T, respectively; SE = 42.5). EE was considerably greater ($P < 0.05$) for F vs T (571 and 489 kJ/kg BW^{0.75} for F and T, respectively; SE = 8.9). Based on estimates of ME intake and recovered energy and an assumed efficiency of use of ME for energy accretion, this difference equated to an energy cost for free movement of 111 kJ/kg BW^{0.75}. A greater distance traveled for F than for T presumably accounted for some but doubtfully all of this difference, suggesting that free movement influenced other physiological conditions impacting EE. In conclusion, in some instances tethering may offer a production advantage over free grazing of less activity energy. This project was supported by National Research Initiative Competitive Grant no. 2004-35206-14166 from the USDA Cooperative State Research, Education, and Extension Service.

Key Words: Energy, Goats, Tethering

M65 Effect of polyethylene glycol on *in vitro* gas production and substrate degradation of diets selected by grazing goats. M. A. Cerrillo-Soto*, M. Guerrero-Cervantes, G. Nevárez-Carrasco, R. Montoya-Escalante, E. Herrera-Torres, M. Murillo-Ortiz, and A. S. Juárez-Reyes, *Universidad Juárez del Estado de Durango, Durango, Dgo. Mexico.*

The study was conducted to evaluate the effect of polyethylene glycol (PEG-6000) on *in vitro* gas production and substrate degradation of diets selected by goats grazing a shrub and oakland range in the semiarid region of Durango, Mexico. Six Spanish criollo goats (35 to 40 kg BW) were used to obtain diet samples utilizing the hand-plucking method during Spring (Apr-Jun), Summer (Jul-Sep), Autumn (Oct-Dec) and Winter (Jan-Mar). A total of three days each month from 0900 to 1200 were used to collect samples. Operators followed and observed the animals and manually mimicked animal forage preferences. Collections from six goats were composited to obtain a representative monthly sample. Five hundred mg (DM) samples were incubated in calibrated glass syringes in triplicate with or without PEG-6000 (1 g). The *in vitro* gas production was recorded at 0, 3, 6, 9, 12 and 24h after inoculation. Moreover, after 24 h of incubation the content of the syringes was completely transferred into a pre-weighed nylon bag (5 cm x 10 cm: pore size 40-60 µm) and thoroughly washed for estimation of the *in vitro* substrate degradation. Data were analyzed using ANOVA for a completely randomized block design. The addition of PEG-6000 increased the *in vitro* gas production ($P < 0.05$) at 24h of incubation by 13, 13, 16 and 10% during Winter, Spring, Summer and Autumn, respectively. The *in vitro* degradation of the substrate was also affected ($P < 0.05$) by the addition of PEG-6000. Increments of 46, 21, 22 and 36% were recorded during Winter, Spring, Summer and Autumn, respectively. Increases in gas production and substrate degradation by addition of PEG-6000 evidence the *in vitro* detrimental effects of phenolic compounds contained in the forage selected by grazing goats.

Table 1. Effect of PEG-6000 on *in vitro* gas production and substrate degradation in goat diets

	Seasons			
	Winter	Spring	Summer	Autumn
Degraded substrate (% DM)				
With PEG	43.0 ^a	40.0 ^a	37.7 ^a	42.8 ^a
Without PEG	29.4 ^b	33.0 ^b	30.9 ^b	31.4 ^b
Mean	26.2	36.4	34.3	37.1
sem	4.79	5.15	5.08	4.50
Cumulative gas production at 24h (ml/500 mg DM)				
With PEG	71.4 ^a	81.4 ^a	71.0 ^a	78.5 ^a
Without PEG	62.9 ^b	72.2 ^b	61.2 ^b	71.2 ^b
Mean	67.1	76.8	66.1	74.8
sem	3.52	7.50	7.60	6.50

Columns with different superscript differ ($P < 0.05$)

Key Words: Grazing goats, *In vitro* gas production, Polyethylene glycol

M66 Evaluation of cultivated summer pastures for meat goats in Tennessee. M. Lema*, K. Souleymane, R. Opio, and C. Fenderson, *Tennessee State University, Nashville.*

A grazing trial was conducted to evaluate Puna forage chicory *Cichorium intybus L.*, Hybrid Penleaf pearl millet *Pennisetum glaucum* and Sahara bermudagrass *Cynodon dactylon* as summer pasture for meat goats. Thirty weaned F1 does (18 Spanish x Kiko, 6 Spanish x Boer and 6 Boer x Kiko) were blocked by body weight and genotype and randomly assigned to the three pasture types. Each pasture type was stocked with 10 does (5 does per replicate) at a stocking rate of 5 does per acre. Puna chicory was 28.3 and 67.7 % higher ($P < 0.05$) in crude protein (CP), 28.1 and 35.4 % lower ($P < 0.05$) in acid-detergent fiber (ADF) and 40.0 and 46.0 % lower ($P < 0.05$) in neutral detergent fiber (NDF) than Penleaf pearl millet and Sahara bermudagrass, respectively. Penleaf pearl millet was 37.7 % higher ($P < 0.05$) in CP, 10.2 and 10.0 % lower ($P < 0.05$) in ADF and NDF than Sahara bermudagrass, respectively. Relative Feed Value (RFV), Ca, P, Mg and K contents were significantly higher ($P < 0.01$) for Puna chicory than for Penleaf pearl millet and Sahara bermudagrass. Penleaf pearl millet was higher ($P < 0.01$) than Sahara bermudagrass in P, K and Mg content. Puna chicory and Pearl millet produced 73 and 70 % higher ($P < 0.05$) forage CP per ha, respectively than Sahara bermudagrass. Average daily gain and live weight gain per acre of does grazing Puna chicory were significantly higher ($P < 0.05$) than does grazing Sahara bermudagrass and Penleaf pearl millet.

Key Words: Meat goat, Penleaf pearl millet, Puna chicory

Growth and Development

M67 Differences in adipogenesis between bovine intramuscular and subcutaneous preadipocytes are not related to expression of PPAR γ_2 or secretion of PGI $_2$. G. Ortiz-Colón*, A. C. Grant, M. E. Doumit, and D. D. Buskirk, *Michigan State University, East Lansing.*

The objectives of this study were to determine if intramuscular (IM) and subcutaneous (SC) bovine preadipocytes differ in their expression of peroxisome proliferator-activated receptor γ_2 (PPAR) or in their

secretion of prostacyclin (PGI $_2$). Preadipocytes isolated from IM and SC adipose tissue of three steers were propagated in culture and upon confluence were exposed to 0 or 25 nM dexamethasone (DEX) for 48 h. After exposure to differentiation media for 12 d, cell lysates were subjected to PPAR immunoblot analysis, which detected an immunoreactive band of ≈ 53 kDa. The relative expression of PPAR was equivalent between IM and SC cells ($P = 0.39$), and DEX did not affect PPAR abundance ($P = 0.98$). Heterogeneous preadipocytes

isolated from one steer and clonal preadipocytes derived from a second steer were grown to confluence and exposed to 0 or 25 nM DEX for 48 h. Media were collected every 12 h for 48 h and were assayed for the stable PGI₂ derivatives 6-keto-prostaglandin F_{1α} and 2,3-dinor-6-keto-prostaglandin F_{1α}. After 12 d in differentiation media, glycerol-3-phosphate dehydrogenase (GPDH) analysis was performed. Intramuscular cells secreted more PGI₂ derivatives than SC cells ($P = 0.046$) and DEX decreased secretion of PGI₂ equally in cells from both depots ($P < 0.001$). The concentration of PGI₂ increased with time ($P < 0.001$), until 36 h. Although 25 nM DEX increased GPDH activity in both cell populations ($P < 0.001$), IM cells were less adipogenic than SC cells ($P < 0.001$). In clonal SC cells, 48 h exposure to 10 μM ibuprofen (an inhibitor of prostaglandin synthesis) had no effect ($P = 0.99$) on DEX (25 nM) induction of GPDH activity. Supplementation of differentiation media for 48 h with 123 pg/mL cPGI₂ did not affect adipogenesis of clonal SC cells, either alone, or in combination with DEX, or DEX and ibuprofen ($P = 0.99$). We conclude that adipogenic differences between IM and SC bovine preadipocytes are not explained by differences in PPAR expression or PGI₂ secretion.

Key Words: Bovine, Preadipocyte, Peroxisome proliferator-activated receptor gamma two

M68 Effect of retinoic acid on sheep preadipocyte gene expression during terminal differentiation. P. Martinez, A. Arana, I. Encio, L. Alfonso, and B. Soret*, *Universidad Publica de Navarra, Pamplona, Navarra, Spain.*

Adipogenesis program and its regulation have been extensively studied, mainly using cell lines and primary culture from human, rodents and pigs. Retinoic acid (RA) has been shown as inhibitor of preadipocyte differentiation using those models but its effects on ruminant adipose cells are not well described. We have used sheep primary preadipocyte cells from two anatomical depots (omental and subcutaneous) as a ruminant model to study at a molecular level the effect of RA on preadipocyte differentiation. In brief, stromal-vascular cells were obtained by collagenase digestion and after a period of proliferation were allowed to differentiate by adding serum-free differentiation induction media containing 1.6 μg/ml insulin, 2nM tri-iodothyronine, 10 nM dexamethasone and 10 μM rosiglitazone. To analyze the effect of RA treatment, preadipocytes were treated with 10 μM all-*trans* retinoic acid through the differentiation period (10 days) and mRNA expression levels of C/EBPβ, PPARγ, C/EBPα, ADD1, lipoprotein lipase (LPL) and Acetyl CoA carboxylase (ACC) were estimated by quantitative real time PCR. Relative gene expression was performed by normalizing samples (three per treatment) against GAPDH or cyclophilin housekeeping genes, following the Ct method, and RA effect tested computing 95% confidence intervals. Number of differentiated cells was assessed by flow cytometry.

Addition of RA decreased differentiated cells number by 50% in the subcutaneous depot ($p < 0.001$). The expression of adipocyte genes PPARγ and C/EBPα also decreased ($p < 0.05$, day 10) but there was not effect on C/EBPβ and ADD1 level in subcutaneous cells. This effect was similar but less apparent in omental cells, which showed less differentiated cell numbers than subcutaneous cells ($p < 0.05$) and a low level of gene expression. These results suggest that the inhibitory action of RA on sheep subcutaneous preadipocyte differentiation is mediated by PPARγ and C/EBPα expression and that sheep omental preadipocytes respond less to *in vitro* differentiation.

Key Words: Sheep preadipocytes, Retinoic acid, Transcription factors

M69 Localization of IGFBP-3 and IGFBP-5 in cultured porcine embryonic myogenic cells. X Gang, E. I. Kamanga-Sollo, M. R. Hathaway, M. E. White*, M. S. Pampusch, and W. R. Dayton, *University of Minnesota, St. Paul.*

The proliferation-suppressing actions of myostatin and TGF-beta in porcine embryonic myogenic cell (PEMC) cultures are mediated, at least in part, by insulin-like growth factor binding protein (IGFBP)-3 and IGFBP-5. Consequently, understanding the mechanism of action of these IGFBPs in myogenic cells is important to understanding how TGF-beta and myostatin regulate growth of muscle. We have used anti-rpIGFBP-3 (anti-BP3), anti-rpIGFBP-5 (anti-BP5) and anti-desmin antibodies to localize IGFBP-3, IGFBP-5 and desmin, respectively, in PEMC. IGFBP-3 was detected in the cytoplasm and nuclei of desmin-positive, mononucleated cells in proliferating PEMC cultures; thereby, establishing that IGFBP-3 is present in PEMC (controls using non-specific IgG show no staining). Similarly, IGFBP-3 was detected in cultured PEMC myotubes. In proliferating PEMC cultures, treatment for 24 h with 20 ng TGF-beta/ml medium resulted in an 80% increase ($p < 0.01$) in the number of nuclei containing IGFBP-3. Myogenic cells pre-treated with anti-BP3 for 24 h prior to immunohistochemical localization showed dramatically reduced intracellular levels of IGFBP-3 as compared to control cells that received no pre-treatment. This confirms reports in other cell types that a significant portion, if not all, of the intracellular IGFBP-3 represents uptake of secreted IGFBP-3. Additionally, these results establish that anti-BP-3 interferes with the transport of IGFBP-3 into myogenic cells. IGFBP-5 was detected in the cytoplasm and nuclei in proliferating and fused PEMC cultures (controls with non-specific IgY show no staining). Localization of IGFBP-3 and IGFBP-5 in PEMC at different stages of differentiation or after treatment with specific growth factors should lead to a greater understanding of the roles of these IGFBPs in muscle growth and differentiation.

Key Words: IGFBP-3, IGFBP-5, Muscle

M70 Use of RNA interference (RNAi) to silence IGFBP-3 and IGFBP-5 expression in porcine embryonic myogenic cell cultures. X. Gang, M. R. Hathaway, M. E. White, E. I. Kamanga-Sollo, M. S. Pampusch, and W. R. Dayton*, *University of Minnesota, St. Paul.*

Insulin-like growth factor binding proteins (IGFBP)-3 and -5 play a significant role in the mechanism by which TGF-beta and myostatin suppress proliferation of porcine embryonic myogenic cells (PEMC) and porcine muscle satellite cells (PMSC). RNA interference (RNAi) utilizing small inhibitory RNA (siRNA) is currently extensively used to silence specific genes in mammalian cells. Consequently, we have cloned a small hairpin (sh) IGFBP-3 RNA sequence (complementary 19mer siRNA sequences separated by a hairpin loop) into the pSilencer 2.1 (Ambion) siRNA expression vector. Electroporation was used to transiently transfect this construct into PEMC cells (IGFBP-3-silenced PEMC). As a control, the same electroporation procedure was used to transfect the vector containing a nonsense sequence supplied by the manufacturer into PEMC (mock-silenced cells). As compared to mock-silenced or non-transfected control cells, IGFBP-3-silenced PEMC showed a 90% reduction ($p < 0.01$) in IGFBP-3 protein and mRNA levels. Neither IGFBP-2 nor IGFBP-5 mRNA or protein levels were significantly affected in the IGFBP-3-silenced cell population, indicating that the suppression of IGFBP-3 production was specific. Suppression of IGFBP-3 production in IGFBP-3-silenced PEMC persisted for at least 120 h after transfection, providing ample time to accomplish experiments assessing the effects of IGFBP-3 knock-down

on proliferation and cell signaling. Additionally, immunohistochemical studies show that intracellular IGFBP-3 levels were dramatically reduced in IGFBP-3-silenced cells as compared to mock-silenced cells. We also have identified an shRNA that reduces IGFBP-5 mRNA in PEMC by 95% (as compared to mock-silenced control PEMC) ($p < 0.01$) without significantly altering the levels of IGFBP-2 or -3 mRNA or protein. Silencing IGFBP-3 and IGFBP-5 production in PEMC cells will provide a valuable research tool for use in assessing the role of these IGFBPs in mediating the anti-proliferative effects of myostatin and TGF-beta on these cells.

Key Words: IGFBP-3, IGFBP-5, Muscle

M71 Effects of clenbuterol and serum on the activation of mitogen-activated protein kinase in cultured bovine satellite cells. J. M. Scheffler* and S. J. Jones, *University of Nebraska, Lincoln.*

The direct effects of β -adrenergic agonists such as clenbuterol on satellite cells is poorly understood. The mitogen-activated protein (MAP) kinase cascade has been implicated in the regulation of skeletal muscle growth. Therefore, the objective of this study was to examine the effects of clenbuterol and serum on MAP kinase activity of cultured bovine satellite cells (BSC). BSC were seeded onto 6 well plates and grown to 80% confluence and pretreated with either serum-free media or media containing 10% fetal bovine serum (FBS) for 16 h. At the end of pretreatment, cells were fed with serum-free media, media with 10% FBS or pretreatment media with the addition of 2×10^{-11} M clenbuterol. Serum-starved cells were solubilized at 0, 0.5, 1, 2, 4 or 8 h post treatment then frozen until analysis. Cells pretreated with 10% FBS were solubilized at 0, 1 and 4 h post treatment. Activation of MAP kinase was determined by western blot analysis using anti-phosphorylated MAP kinase antibodies. Administration of 10% FBS media to serum-starved cells resulted in a 7.5-fold increase ($P < 0.0001$) in phosphorylated MAP kinase at 0.5 h compared to cells fed serum-free media. The level of MAP kinase phosphorylation declined over the 8 h study and dropped to levels similar to that observed in cells fed serum-free media at 8 h ($P > 0.05$). Clenbuterol had no effect ($P > 0.05$) relative to cells fed serum-free media. Removal of serum from BSC resulted in a dramatic reduction ($P < 0.001$) in MAP kinase phosphorylation compared to cells fed 10% FBS at 1 and 4 h. MAP kinase phosphorylation in BSC fed a combination of 10% FBS and clenbuterol were intermediate ($P < 0.01$) to those fed 10% FBS media and cells fed serum-free media at 1 hr. At 4 hr there was no difference in MAP kinase phosphorylation in serum-fed cells with or without clenbuterol. These results indicate that factors in serum play an important role in MAP kinase activation while clenbuterol has little effect on MAP kinase phosphorylation under the conditions used in this study.

Key Words: Clenbuterol, Mitogen-activated protein kinase, Bovine satellite cells

M72 Production of a polyclonal antibody against unprocessed chicken myostatin and the effects of in-ovo administration of the antibody on post-hatch broiler growth and muscle mass. N. K. Bobbili*, Y. K. Lee, and Y. S. Kim, *University of Hawaii, Honolulu.*

Myostatin, a member of the TGF- β superfamily, is a potent negative regulator of skeletal muscle growth. The objective of this study was to produce a polyclonal antibody against unprocessed chicken myostatin and to examine the effects of in-ovo administration of the antibody

on post-hatch broiler growth and muscle mass. Unprocessed form of chicken myostatin, which had been expressed in *E. coli* and purified by electro-elution of myostatin bands after fractionation by SDS-PAGE, was used as an immunogen in producing a polyclonal antibody against unprocessed myostatin in rabbit. In Western blot analysis, the antibody showed a strong binding affinity to commercially available myostatin prodomain with little binding affinity to mature myostatin. The antibody also demonstrated a certain level of cross-reactivity with pTGF- β 1 and rhBMP2, but not with pTGF- β 2, rhTGF- β 3, rhBMP3 and rhBMP5 in Western blot analysis. To examine the effects of in-ovo administration of the antibody, eggs were injected once with 35 μ g antibody in 50 μ L PBS per egg either into the albumen (Alb) or yolk (Yolk) on day 3 of incubation. Controls (Con) received no injection. After hatch, chicks were raised for 28 d. The broilers of the Yolk group had significantly ($P < 0.05$) lower body wt (8.5%) at 7 d than the Con group. At 14, 21 and 28 d, the mean body wt of the Yolk group was lower (5%) than that of the Con, but the difference was not statistically significant. Thigh and leg muscle wt of the Yolk group was significantly ($P < 0.05$) lower (10%) than that of the Con at 28 d. In contrast, no significant effects on body and muscle mass were observed when the antibody was injected into the albumen. In summary, the polyclonal antibody raised against the unprocessed chicken myostatin binds to myostatin prodomain, and injection of this antibody to the yolk of eggs appeared to decrease muscle mass in chicks hatched from these eggs.

Key Words: Polyclonal anti-myostatin antibody, Myostatin, In-ovo administration

M73 Maternal immunization against myostatin enhances post-hatch broiler growth and muscle mass. Y. S. Kim¹, Y. C. Huh², and C. J. Kim*², ¹*University of Hawaii, Honolulu,* ²*Chungnam National University, Daejeon, Korea.*

Myostatin, a member of the TGF- β superfamily, is a potent negative regulator of skeletal muscle growth. The objective of this study was to examine the effect of maternal immunization against myostatin in broiler hens on post-hatch broiler growth and skeletal muscle mass. Twelve 5 month-old Cobb broiler hens were divided into four groups: CON, rMYO, MYO1 and MYO2. The CON group was immunized with 1 mg of keyhole limpet hemocyanin (KLH), rMyo with 1 mg of recombinant active form of myostatin, MYO1 with 1 mg of 24-mer myostatin peptide-KLH conjugate, and MYO2 with 1 mg of 15-mer myostatin peptide-KLH conjugate. Hens in each group were housed together with one 5 month-old Cobb rooster, and the roosters in each group were rotated weekly. Antibody titers were detected in hens' sera, yolk IgY and post-hatch chicks' sera of the rMYO, MYO1 and MYO2 groups, indicating a transfer of antibodies into fertilized eggs and post-hatch chick's circulation. Post-hatch broilers from the rMYO and MYO2 groups showed significantly enhanced growth as compared to the CON group, resulting in 7.6% (rMYO) and 9.1% (MYO2) increase in body weight at 28 d after hatch. Similar to the body weight response, the carcass weight of the MYO2 was significantly heavier than that of the CON. The weights of breast muscle and thigh-leg of the rMYO and MYO2 groups were significantly heavier than those of the Con group. The percentages of breast muscle mass to body mass of the rMYO and MYO2 groups were significantly higher than that of the CON group, indicating that the growth-enhancing response was more selective in skeletal muscles than in other tissues of the body. In contrast, the growth of the MYO1 group was not significantly different from that of the CON group. No significant difference was also observed between the CON and MYO1 in carcass and muscle

weight. The results of this study indicate that maternal immunization against myostatin is a potential means to improve skeletal muscle growth of broilers.

Key Words: Myostatin, Maternal immunization, Broiler

M74 Effects of colostrum (C) feeding and dexamethasone (Dexa) treatment on sodium-dependent glucose co-transporter-1 (SGLT1) in the small intestine of neonatal calves. H. M. Hammon* and U. Schoenhusen, *Research Institute for the Biology of Farm Animals (FBN), Dummerstorf, Germany.*

Glucocorticoids and C feeding affect glucose metabolism in neonatal calves, but less is known concerning effects on intestinal glucose transport. We have studied the effects of Dexa and C supply on gene expression and protein content of SGLT1 in the duodenum and jejunum of neonatal calves to test the hypothesis that glucocorticoids and C feeding differently affect SGLT1 in neonatal calves. Twenty-eight male calves were randomly divided into four groups (FD⁻, FD⁺, CD⁻, CD⁺). Calves of FD⁻ and FD⁺ were fed milk-based formulas (same protein and energy content than C, but only marginal amounts of bioactive substances and immunoglobulins), whereas calves of CD⁻ and CD⁺ received C for 3 d. On d 4 all calves received a milk replacer twice daily. Calves of FD⁺ and CD⁺ were injected Dexa [30 µg/kg BW per d] twice daily at feeding times. Calves were euthanized on d 5 of life after 16 h without food, mid-duodenum and mid-jejunum were removed quickly, frozen in liquid nitrogen and stored at -80°C until analyzed. Total RNA was extracted from duodenal and jejunal mucosa and mRNA abundances for SGLT1 were quantified by real-time RT-PCR relative to housekeeping genes. Protein expression of SGLT1 in brush border membrane vesicles (BBMV) was quantified by SDS PAGE and immunoblot. The General Linear Model of SAS was used to examine feeding and Dexa effects on gene and protein expression of SGLT1. Abundance of SGLT1 mRNA and protein were higher ($P < 0.05$) in duodenal than jejunal mucosa, but mRNA levels showed no differences with regard to feeding or Dexa treatment. Protein content of SGLT1 in jejunal BBMV showed a significant feeding × treatment interaction with highest protein content of SGLT1 in FD⁺. Mucosal SGLT1 gene and protein expression depend on intestinal site and Dexa effects on SGLT1 protein expression in jejunal BBMV depend on diet. Lack of feeding effects on intestinal SGLT1 expression is probably due to measuring intestinal SGLT1 in the fasting state.

Key Words: Neonatal calf, SGLT1, Colostrum

M75 Oral nucleotides enhance immune status of neonatal dairy calves. K. M. Ballou*, D. E. Schimek, W. L. Keller, M. L. Bauer, and C. S. Park, *North Dakota State University, Fargo.*

The aim of this study was to evaluate the effect of a one-time oral dose of nucleotides at birth on subsequent calf health and immune status. Eighteen colostrum-deprived, newborn Holstein calves (46.4 ± 4.0 kg initial body weight) were assigned randomly to purified milk replacer or purified milk replacer plus nucleotides (one-time dose, at birth) at twenty times the level found in cow milk (adenosine monophosphate = 1.60, cytidine monophosphate = 3.20, guanosine monophosphate = 1.33, inosine monophosphate = 1.74, and uridine monophosphate = 27.55 µmol/kg body weight). Milk replacer was fed by dry powder weight at 0.7% of the body weight and reconstituted with 1.9 L of warm water twice daily. Calves were housed in hutches at the North Dakota State University Dairy Research Unit. Signs of morbidity (ocular and nasal discharge, depression/lethargy, respiratory abnormalities, and rectal temperature) were noted daily. Scours scores [4 point scale (1

= normal; 4 = watery)] were assessed daily for 4 wk. Calves were weighed weekly for 8 wk. Blood was taken by jugular venipuncture at h 0 and 24, and d 7, 14, 21, and 28. Serum was analyzed for glucose, nonesterified fatty acids, immunoglobulins G (IgG) and M (IgM). Nucleotide supplementation did not affect body weight on d 28 (49.0 ± 5.5 vs. 50.7 ± 5.2 kg) or on d 56 (68.0 ± 6.4 vs. 66.1 ± 6.9 kg); morbidity; mortality; or serum nonesterified fatty acids (359.8 ± 32.7 µEq/L), glucose (97.9 ± 4.57 mg/dL), IgM on d 28 (113.9 ± 19.9 mg/dL), or scours scores (1.23 ± 0.08) for the first 2 wk. Nucleotide-fed calves had higher ($P = 0.01$) serum IgG on d 28 than control-fed calves (647.7 ± 87.8 vs. 1006.6 ± 93.8 mg/dL). Results suggest that a one-time oral dose of nucleotides at birth may enhance immune status of neonatal calves by increasing serum IgG.

Key Words: Nucleotide, Immune status, Dairy calf

M76 Effects of nutrition and weaning age on performance of ewes and lambs and incidence of subclinical mastitis in santa inês breed. S. Fenandes, E. R. Siqueira, P. F. Domingues, E. V. Z. Estasienuik, L. S. Serrão, and R. M. S. Emediato*, *São Paulo State University, Botucatu, São Paulo, Brazil.*

Twenty nine multiparous Santa Inês ewes, all of them at the same reproductive age, were submitted to two nutrition levels over the last gestation month and lactation (corn silage diet and corn silage plus concentrate diet) and two weaning ages (45 and 70 days). The aim of this study was to evaluate the effects of these treatments on ewe and lamb performance and on the incidence of subclinical mastitis. Treatments 1 (corn silage and weaning age 45 days) and 3 (corn silage and weaning age 70 days) diets were composed of corn silage (7.43 % CP; 69.65 % TDN; 28.97 % DM; 22.45% CF; 4.37% FC and 3.73% ash) which simulated pasture condition. The animals in treatment 2 and 4 were fed corn silage plus concentrate, in a 65:35 ratio. The whole diet composition was 13.4% CP and 65% TDN, according to NRC (1985) requirements for lactation. Milk production was determined weekly, starting in the second week after parturition, according to Susin et al. (1995). Subclinical mastitis diagnostic was performed by California Mastitis Test (CMT), microbiological culture and somatic cell count. Corn silage plus concentrate diet treatments presented the best parturition weight, milk production and lamb performance from birth to weaning ($P < .05$). Regardless nutritional levels and weaning age, subclinical mastitis was reported in 37.93% of the ewes.

Key Words: Lamb, Sheep lactation, Sheep milk

M77 Opioid agonist modulation of long term food intake in sheep. F. Y. Obese¹, B. K. Whitlock¹, F. C. Buonomo², and J. L. Sartin^{*1}, ¹Auburn University, Auburn, AL, ²Monsanto Co, St Louis, MO.

Opioid receptors mu and kappa have been suggested as regulators of food intake and have further been suggested as downstream regulators of agouti related peptide function. Syndyphalin-33 (SD33), Tyr-Dmet (o) -Gly-methylphenethylamide, is a mu opioid receptor ligand suggested to activate central receptors after intravenous administration. Experiments were conducted to determine the effect of SD33 on food intake and to assess its ability to alter food intake in an endotoxin disease model. Five mixed-breed, castrate male sheep were housed indoors in individual pens in a temperature-and light-controlled facility. Animals had ad libitum access to water and concentrate feed, which contained 12% crude protein and was calculated to meet 100% of daily requirements. Saline (0.9%) or SD33 (0.05 or 0.1 µmol/kg BW) were injected iv into sheep. Each treatment was administered to each sheep with at least 1-wk interval between treatments. The order of treatments

was randomized. The 0.1µmol/kg BW dose of SD 33 increased feed intake at 24 h ($P = 0.006$) and 48h ($P = 0.019$) relative to saline. Exp 2 determined whether SD33 effects on food intake were mediated by actions on opioid receptors and whether its activity can counteract the reduction in feed intake associated with administration of bacterial endotoxin (lipopolysaccharide; LPS). Saline (0.9%), SD 33 (0.1 µmol/kg BW), Naloxone the opioid receptor antagonist (NAL; 1mg/kg BW), LPS (1µg/kg BW), NAL plus SD 33 and LPS plus SD33, were injected i.v. The naloxone or LPS were injected to the sheep 5 min before SD33. Cumulative feed intake at 24 and 48h following injections were determined. The administration of naloxone reduced food intake at 24h and 48h ($P < 0.05$) while the SD 33 combined with NAL did not, suggesting SD33 acted on food intake through the opioid receptor. LPS alone decreased food intake at 24 ($P < 0.05$) and 48 h ($P < 0.05$) relative to saline controls and SD33 failed to reverse the reduction in feed intake induced by LPS. These data suggest that SD33 activates food intake after iv injection and its effects are mediated via the opioid receptors in sheep. Supported by USDA Grant no. 2004-35206-14136.

Key Words: Opioid, Sheep, Appetite

M78 Effects of feeding *ad-lib* fresh milk or milk replacer during nursing and added protein at pre-puberty period to Holstein heifers on growth rates and production during first lactation.

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The objective of this study was to test the effects of feeding *ad-lib* fresh milk vs. milk replacer and 2% added protein at pre-puberty period on growth rates and production during first lactation. Forty-six 3 d old Israeli-Holstein calves were individually housed and randomly assigned to one of two treatments: 1) Milk replacer (MR- 12% fat and 23% protein; DM basis) – free access to milk replacer in two 60-min meals per day until weaning (60 d of age) and; 2) Milk (M) – free access to fresh milk as in treatment 1. Water and starter mix (18% protein; DM basis) were offered freely and daily individual feed intakes were recorded until 90 d of age. From 60 d of age, all heifers were fed the same diet and from 90 d of age they were housed together. During 150 to 300 d of age, M and MR calves were divided into two subgroups: each control (C) subgroup was fed a regular growing diet (13.2% protein; DM basis) and each treatment subgroup was supplemented with 2% of protein (P), creating 4 groups: MC, MP, MRC and MRP. From 300 d of age all heifers were fed the same diet until calving. Weekly measurements of live body weight (LBW), hip height (HH), withers height (WH), hip width (HW) and heart girth (HG) were taken until 90 d of age, and then every two wks. Average daily total DMI was higher in MR than in M group (1.35 vs. 1.26 kg/d; $P < 0.0001$). At weaning, LBW of M calves was significantly higher than of MR calves ($P < 0.01$), while HG and HW tended to be higher ($P < 0.09$). Neither nursing management nor protein supplementation affected skeletal measurements at first calving; however, the LBW and HW of MP group were significantly higher than in MRP group. Milk and FCM (3.5%) production during the first lactation were significantly higher in MP group than in all other groups ($P < 0.007$). In conclusion, nursing *ad-lib* milk compared to *ad-lib* milk replacer tended to increase LBW but not skeletal size, and increased milk production during the first lactation. These results are in agreement with our previous findings.

Key Words: Nursing management, Skeletal growth, Milk production

M79 Performance of calves fed whole milk and milk replacer in different sequences. M. C. Scott*, R. E. James, and M. L. McGilliard, *Virginia Polytechnic Institute and State University, Blacksburg.*

Previous studies have compared performance of calves receiving either pasteurized waste milk or whole milk to that of calves receiving 20% protein and 20% fat milk replacer on an equal volume basis. The objective of this study was to compare performance of calves fed different sequences of whole milk (M), 25% protein and 30% fat, to a 28% protein and 20% fat milk replacer (MR). Milk replacer was reconstituted to 14% DM to be isocaloric to M, both providing 5 mcal/kg of metabolizable energy on an as fed basis. Holstein, Jersey, and reciprocal crosses, both bull (n=17) and heifer calves (n=46) were fed for 8wk. Treatment (TRT) 1 calves received M for 28 d and then MR until weaning at 56 d. Treatment 2 calves represented the reverse of TRT 1, whereby calves received MR for 28 d and switched to M until weaning. Calves on TRT 3 were fed MR for the entire 8 wk. Feeding rates were determined by calf birth weight. Liquid diets were fed twice daily at the rate of 5.5, 7.3 and 8.2 kg/d as-fed for birth weights of less than 27, 27-36 and greater than 36 kg. Calf body weight (BW), wither height (WH), hip height (HH), hip width (HW), body length (BL), and heart girth (HG) were recorded at 1 d, 28 d \pm 3 d, 35 d \pm 3 d, and 56 d of age. Starter grain intake (GI) was measured twice weekly. Starter grain and water were offered ad libitum after 1 w of age. Four periods of time were evaluated; birth to weaning, the first four weeks (P1), the transition period (TP) of wk 4 to wk 5, after calves switched diets, and until 8 wk (P2). Measures of BW, WH, HH, HW, BL and HG gain were not different among treatments over the entire period. Similarly, GI through 8 wk was not different. Calves on TRT 1 had a more rapid ADG, 0.67 kg/d \pm .07 SE during TP than TRT 2, 0.57 kg/d \pm .07 SE ($P < 0.05$). This was probably caused by increased water retention due to greater mineral content of MR relative to the M. The trial demonstrated similar growth through 8 wk with either sequence of M and MR or only MR when offered on an isocaloric basis.

Key Words: Calf, Milk replacer

M80 Development of specific breeds equations to estimate chemical empty body composition using the 9-10-11th rib cut composition.

A. Berndt¹, G. M. da Cruz³, G. F. Alleoni⁴, M. M. Alencar³, and D. P. D. Lanna^{*2}, ¹*APTA/SP, Andradina, São Paulo, Brazil*, ²*ESALQ/USP, Piracicaba, São Paulo, Brazil*, ³*EMBRAPA/CPPE, São Carlos, São Paulo, Brazil*, ⁴*IZ/SP, Nova Odessa, São Paulo, Brazil*.

Simple linear regressions were obtained from empty body chemical composition and Hankins & Howe 9-10-11th rib cuts chemical composition for purebred and crossbred Nellore bulls. One hundred and eighty eight (188) Nellore (NE) and crossbred Canchim x Nellore (CN), Angus x Nellore (AN) and Simental x Nellore (SN) young bulls were used. Bulls came from a 300 Nellore dams randomly mated to several representative bulls for each breed. Bulls initial empty body weight (EBW) was 288 kg and they were fed for 57-186 days. Animals were slaughtered when estimated hot carcass weight was greater than 225 kg and ultrasound back fat thickness reached 4-5 mm. Diet had 60% corn silage and 40% concentrate, 13.8% CP and 71.5% TDN on a DM basis. Direct empty body composition was collected on 115 animals, for which all tissues including blood, head, hide, feet, viscera and carcass were frozen, ground, homogenized and sampled for chemical analysis. Of these 115 bulls, 48 animals were slaughtered before feeding to obtain baseline body composition and 67 were slaughtered after the feeding period. The individual predictive equations

for percent empty body water and ether extract using the percentage water in the 9-10-11th rib cut are presented on table 1.

Table 1: Regression equations using %water of 9-10-11th rib cut as independent variable to predict empty body composition.

Genetic group	Dependent variable (% EBW)	Regression equation	R ²
AN	EE	$y = -1.2124x + 111.1$	0.8051
AN	Water	$y = 0.5294x + 31.96$	0.8950
CN	EE	$y = -1.2744x + 114.22$	0.8196
CN	Water	$y = 0.581x + 28.61$	0.8870
NE	EE	$y = -1.1648x + 107.09$	0.8716
NE	Water	$y = 0.5348x + 31.70$	0.8986
SN	EE	$y = -1.4296x + 124.54$	0.9151
SN	Water	$y = 0.6447x + 23.63$	0.9129

Key Words: Empty body composition, Nellore crossbred, 9-10-11th rib cuts

M81 Phenotypical characterization of genetically different cattle in segregating family structures, growth and carcass characteristics. R. Pfuhl*, O. Bellmann, J. Wegner, K. Ender, and C. Kühn, *Research Institute for the Biology of Farm Animals, Dummerstorf, Germany.*

The physiological mechanisms which affect the transformation of nutrients into body fat in bulls of secretion type or into muscle tissue in bulls of accretion type is still not fully revealed. Hence, we designed a study of segregating family structures using Charolais (Ch) cattle as a representative for the accretion type and German Holstein (GH) cattle as a representative for the secretion type of cattle. In further experiments, the P₀ generation was characterized phenotypically. This study compares selected phenotypical results of the F₂ bull generation (n= 65) with the P₀ data to get first insights in potential segregating of growth and carcass traits. The F₂ bulls of five segregating families showed an average final weight at 18 mo between 676.69 kg and 739.18 kg. These data were intermediate between the P₀ Charolais bulls, which gained a final weight of 750.6 kg and were 84.7 kg heavier than the GH bulls with 665.9 kg ($P < 0.001$). The Charolais bulls exhibit a hot carcass weight (HCW) of 450.26 kg, the GH bulls 356.74 kg ($P < 0.001$). The average HCW of the F₂ bull families extends from 387.85 kg to 414.46 kg and is within the P₀ data ($P < 0.001$). The Rib eye area of the F₂ bulls (103.18 cm² – 108.17 cm²) varies ($P < 0.001$) within the P₀ bulls (Ch = 125.82 cm² and GH = 82.14 cm²). The average dressing percent in the F₂ bull families (56.46 %– 58.01 %), was between the P₀

bulls (Ch = 60.31, GH = 53.96) with ($P < 0.001$). The inner fat content of the F₂ bulls varies from 39.6 kg to 43.3 kg and is within the P₀ range (Ch = 35.4 kg, GH = 51.06 kg) with ($P < 0.001$). In conclusion, the F₂ animals showed intermediate data with high variation between the values of the P₀ animals in the observed traits, which confirms the expected results for the F₂ generation. No atypical effects of these traits were recorded. Further experimentation will be conducted on the F₂ bulls.

Key Words: Cattle, Carcass, Growth

M82 Residual feed intake (RFI), behavioral, and physiological measures in Angus Bulls. J. P. Cassady*, C. S. Whisnant, M. H. Poore, and G. B. Huntington, *North Carolina State University, Raleigh.*

The objective was to measure RFI in 56 registered Angus bulls (285 ± 34 kg BW, 275 ± 21 d old) from one herd and to relate RFI to physiological and economically important traits. After completing a post-weaning vaccination and parasite elimination program, bulls were adapted to a corn silage-based diet (140 g CP, 1.73 Mcal NEm and 1.22 Mcal NEg per kg DM), and trained to use individual feeding gates. They were blocked based on BW and sire into groups of 12 and fed the same diet for 84 d. They were weighed every 14 d, and measures of temperament, chute escape velocity, hip height, scrotal circumference, blood samples, for determination of circulating concentrations of testosterone, triiodothyronine (T3) and thyroxine (T4), and ultrasound measures of body composition were collected at d 8, d 58, and d 84. At the end of the study rate of eating was measured on the eight bulls with the highest and lowest RFI (n = 16). Mean ± SD RFI (predicted minus measured) was 0.12 ± 0.73 kg DM/d. Mean ± SD ADG and DMI were 1.42 ± 0.20 and 7.3 ± 1.7 kg. Residual feed intake was positively correlated with eating rate, BW, BW gain, hip height, scrotal circumference, and testosterone on d 8 ($P < 0.05$) and negatively correlated with T3 on d 8 ($P < 0.08$). Increased ribeye area ($P < 0.07$) and calmer temperament ($P < 0.13$) tended to correlate with RFI. For 6 bulls greater than 1 SD from the mean, RFI was 1.40 ± 0.37, and for 7 bulls less than 1 SD from the mean RFI was -1.10 ± 0.56. Compared to the 8 bulls with lowest RFI (-1.03 kg/d), the 8 bulls with the highest RFI (1.24 kg/d) ate faster, were taller and heavier, gained weight faster ($P < 0.05$), and tended (0.05 < $P < 0.20$) to be calmer in the weigh box, slower to leave the chute, had larger ribeye area, greater increases in subcutaneous fat over the rib and rump, and less increase in hip height from d 58 to d 84. We conclude that differences in physiological and behavioral traits of bulls likely explain important components of RFI.

Key Words: Beef cattle, Residual feed intake, Efficiency

Meat Science and Muscle Biology

M83 Fatty acid profile in selected rodent and fish species from Colombia. L. L. Betancourt*¹ and G. J. Díaz², ¹Universidad de La Salle, Facultad de Zootecnia, Bogotá, Distrito Capital, Colombia, ²Universidad Nacional de Colombia, Facultad de Medicina Veterinaria y Zootecnia, Bogotá, Distrito Capital, Colombia.

The fatty acid profile of muscle tissue of three rodent species and nine fish species was investigated. Rodent species included capybara (*Hydrochaeris hydrochaeris*), guinea pig (*Cavia porcellus*), and agouti (*Agouti* sp.), which are commonly eaten by native Colombian people. The fish species investigated were: trout (*Oncorhynchus mykiss*), tilapia (*Oreochromis* sp.), common two-banded seabream (*Diplodus*

vulgaris), black capu (*Colossoma macropomum*), tiger shovelnose catfish (*Pseudoplatystoma fasciatum*), jau catfish (*Paulicea luetkeni*), matrincha (*Brycon* sp.), pictus catfish (*Pimelodus grosskopfii*) and capitán (*Eremophilus mutisii*). A total of 500 gr of muscle tissue was lyophilized, and its fat content was extracted with organic solvents. Fatty acids extracted from the fat were analyzed as methyl-esters using gas chromatography with flame-ionization detection. Individual fatty acids were reported as percent of total fatty acids. The capybara, agouti, and guinea pig omega-3 (n-3) fatty acid content in muscle tissue was 21.3, 13.0, and 9.3%, respectively. These levels of n-3 fatty acids are higher than those observed in beef, pork or poultry. Among

fish the highest content of n-3 fatty acids was observed in jau catfish and tilapia (both from warm waters) followed by trout, and capitán (from cold waters). The n-3 fatty acid content in these four fish species was 20.7, 15.6, 14.3 y 10.3%, respectively. Most of the n-3 fatty acid content in fish samples corresponded to eicosapentaenoic (C20:5, n-3), docosapentaenoic (C22:5, n-3), and docosahecaenoic (C22:6, n-3) acids, whereas the main n-3 fatty acid found in rodent samples was alfa-linolenic (C18:3, n-3) acid. The results of the present study indicate non-conventional indigenous foods such as rodents can be a good and healthy source of n-3 fatty acids for humans. This observation is also valid for a number of fresh-water edible fish species, which accumulate high levels of n-3 fatty acids, independently of the water temperature where they live.

Key Words: Omega-3 fatty acids, Meat, Indigenous foods

M84 Fatty acid composition in bovine and buffalo beef. L. Betancourt*¹, C. Bustamante¹, and G. Diaz², ¹La Salle University, Bogotá Distrito Capital, Colombia, ²National of Colombia University, Bogotá, Distrito capital, Colombia.

The present study investigated the fatty acid composition of liver, and longissimus dorsi and semitendinosus muscles of bovine and buffalo fed on grazing pastures. The tissue samples were lyophilized and their fat content extracted with organic solvents. Fatty acids extracted from the fat were analyzed as methyl-esters using gas chromatography with flame-ionization detection. Individual fatty acids were reported as percent of total fatty acids. Buffalo liver had a greater content ($P<0.05$) of linoleic (C18:2, n-6), alfa-linolenic (C18:3, n-3), and eicosapentaenoic (C20:5, n-3) acids, while the content of docosahexaenoic (C22:6, n-3) and saturated fatty acids was greater ($P<0.05$) in bovine liver. Both buffalo and bovine liver had a relatively large content of omega-3 fatty acids with 13 and 11%, respectively. These high levels are comparable to those found in aquatic species such as trout and tilapia. The bovine longissimus dorsi muscle had a greater percentage ($P<0.05$) of palmitic (C16:0), linoleic (C16:2, n-6), monounsaturated and polyunsaturated fatty acids, and omega-6 and omega-3 fatty acids compared with buffalo. However the buffalo semitendinosus muscle had a greater content ($P<0.05$) of omega-6 and omega-3 fatty acids. It is important to note that both bovine and buffalo tissues had a low omega-6 to omega-3 ratio (0.8 to 2.2), which can be considered adequate for a proper fatty acid balance of a human diet.

Key Words: Buffalo beef, Bovine beef, Omega-3 fatty acids

M85 Prediction of melting point of intramuscular fat of Japanese Black cattle by image analysis method using high resolution digital image. M. Oishi*¹, S. Fukushima¹, S. Hidaka¹, H. Tsukuda², and K. Kuchida¹, ¹Obihiro Univ. of AVM, Obihiro-shi, Japan, ²Livestock Implan. Assoc., Makubetsu-cho, Japan.

Meat flavor might be related to the melting point of its fat in marbling. The lower this point drops, the more mellow and richer of the meat. Generally, melting points of marbling are measured by a chemical method; however this method requires the samples to be cut off, as well as time and high cost to obtain the values. Therefore, a nondestructive, simple and prompt method with low cost is desirable. The objective of this study was to predict the melting point of marbling in Japanese Black cattle with the image analysis method using high-resolution digital images. Data were collected from 204 Japanese Black steers slaughtered at 21 month for 8 investigation days. Samples were

collected from M. trapezius, and the melting point was measured with the rise melting point method. Characteristics of marbling shape (73 traits), rib eye shape (4 traits), rib eye color (46 traits), the length of muscle and fat measured for the cross sections (68 traits), and subcutaneous and intermuscular fat area and its proportion to the cross section area (25 traits) were calculated by image analysis. Using these 216 traits, the melting point was predicted by multiple regression analysis using the stepwise method. The selected traits were limited to 5 variables. The average melting point with the chemical method was 28.22 ± 3.24 °C (9.40-34.95). Correlation coefficients of melting points with carcass weight and marbling score were 0.15 and 0.05, respectively. There was no trait that highly correlated with melting points. For all 204 samples, R² of the multiple regression equation was 0.13. When the eight investigation days were included in the multiple regression analysis, the R² was high (0.60-0.82), indicating that the prediction of melting points is possible. Traits concerning rib eye color and length of muscle or fat in cross sectional images were chosen in the regression equation on seven investigation days.

Key Words: Beef, Melting point, Image analysis

M86 Comparison of belly and loin volumes between cattle breeds by image analysis using mirror-type photographic equipment. Y. Hamasaki*¹, T. Osawa¹, S. Hidaka¹, T. Hori², H. Kodaka³, Y. Sasaki⁴, and K. Kuchida¹, ¹Obihiro University of A&VM, Obihiro, Hokkaido, Japan, ²Hokkaido Indust. Res. Inst., Sapporo, Hokkaido, Japan, ³HAYASAKA Sci. and Engin. Corp., Sapporo, Hokkaido, Japan, ⁴SASAKI Livestock Corp., Obihiro, Hokkaido, Japan.

We have developed a mirror-type photographing equipment to use on beef carcass. The most important feature of this equipment is its ability to photograph between the narrow clearance of carcass cross section. The view angle of the mirror type (30×40cm) equipment was almost doubled in comparison with the former equipment. Photographs with clear and detailed images of *M. latissimus dorsi* and *M. serratus ventralis*, as well as *M. longissimus thoracis*(ribeye), have been possible using this equipment. The aim of this study was to compare in four breeds the characteristics of major muscles in the carcass cross section at the 6-7th rib using computer image analysis. Digital images of the 6-7th rib cross section from 20 Japanese Black (JB), 20 Japanese Brown (JBR), 23 Holstein (HOL) and 24 Angus (ANG) were used in this study. The area, length, maximum width and the ratio of marbling to each muscle area (ribeye, *M. trapezius*, *M. semispinalis capitis*, *M. semispinalis dorsi*, *M. atissimus dorsi* and *M. serratus ventralis*) were calculated with image analysis. Analysis of variance on their image analysis traits was performed, in which breed and sex were treated as crossclassified fixed effects. The results showed that the total area of the cross section (617.6, 682.8, 545.6, and 561.9 cm² for JB, JBR, HOL, and ANG, respectively), area of *M. latissimus dorsi* (57.3, 67.9, 42.2, and 47.8 cm²) and area of ribeye (50.7, 58.8, 43.6, and 48.1 cm²) were significantly larger for JBR ($P<0.05$). The ratio of the total area of the 6 muscles to the total area of the carcass section (36.7, 37.5, 33.7, and 35.5%) was significantly smaller for HOL ($P<0.05$). The ratio of marbling to (ribeye) area (43.3, 34.6, 22.9, and 23.8%) was significantly higher for JB ($P<0.05$), but there were no significant differences between JB and JBR for the ratios of marbling to *M. latissimus dorsi* area (31.3, 26.2, 10.1, and 17.4%) and to *M. serratus ventralis* area (48.5, 46.7, 30.9, and 37.3%). Correlation coefficients between marbling percentages in ribeye and *M. serratus ventralis* were 0.32, 0.70, 0.45, and 0.54 for JB, JBR, HOL, and ANG, respectively.

Key Words: Beef cattle, Image analysis, Belly

M87 Effect of suckling regimen on intramuscular collagen properties of *Comisana* lambs. G. Maiorano*¹, A. Ciarlariello¹, C. Cavone¹, R. J. McCormick², and A. Manchisi¹, ¹University of Molise, Campobasso, Italy, ²University of Wyoming, Laramie.

The effect of restricted suckling on intramuscular collagen (IMC) properties (collagen and crosslink concentrations) of different lamb muscles was determined. Twenty-one naturally suckled male *Comisana* lambs were divided into three equal weight groups with differing suckling management systems: 1) only maternal milk (C); 2) only maternal milk until 14d of age and, from 15d of age to slaughter, maternal milk, concentrate and Lucerne hay *ad libitum* (T1); 3) only maternal milk until 14d of age and, from 15d to 30d of age, maternal milk, concentrate and Lucerne hay *ad libitum*, and from 30d of age to slaughter only concentrate and Lucerne hay *ad libitum* (T2). At slaughter (63d) *semitendinosus* (ST), *semimembranosus* (SM) and *gluteus biceps* (GB) muscles were removed from chilled carcasses. Muscles were trimmed of fat and *epimysium*, lyophilized, and hydrolyzed in 6N HCl for determination of hydroxyproline and hydroxylysylpyridinoline (HLP) crosslinks, both of which are regarded as main connective tissue components influencing meat tenderness. ANOVA with GLM was performed using a 3x3 factorial design. Suckling system affected IMC ($P<0.01$) and HLP ($P<0.05$) amounts, and HLP/IMC ratio ($P<0.05$). T2 compared to T1 and C groups had higher amounts of IMC (33.19b, 27.29a, 26.80a $\mu\text{g}/\text{mg}$, respectively) and HLP (5.34b, 4.16a, 5.11ab $\mu\text{g}/\text{mg}$, respectively). IMC was more mature in C than in T1 and T2 groups, as indicated by the HLP/IMC ratio (0.13b, 0.11a, 0.12ab mol/mol, respectively). Muscle type influenced HLP/IMC ratio which was higher ($P<0.05$) in ST than in GB and SM (0.14b, 0.11a, 0.10a mol/mol, respectively). No differences ($P>0.05$) were found between SM, GB and ST in IMC (29.65, 29.10 and 27.44 $\mu\text{g}/\text{mg}$, respectively) and HLP (4.50, 4.58 and 5.50 $\mu\text{g}/\text{mg}$, respectively) concentrations. Suckling management systems can alter IMC amount and maturation, leading to variability in lamb tenderness.

Key Words: Lamb, Suckling regimen, Intramuscular collagen

M88 Image analysis of marbling in pork rib eye and prediction of crude fat contents. K. Kuchida*¹, M. Oishi¹, Y. Kuwabara², M. Hanada¹, and S. Hidaka¹, ¹Obihiro University of A&VM, Obihiro, Hokkaido, Japan, ²Fuji Nojo Service, Fujinomiya, Shizuoka, Japan.

Palatability can be expected from pig breeds that produce highly marbled pork. Computer image analysis (CIA) used for beef may objectively be used to evaluate marbling for pork as well. In comparison with beef which offers a better color contrast, marbling assessment in pork is more challenging. The aims of this study were to evaluate pork marbling by CIA with high accuracy using high resolution digital image, and to investigate the relationship between crude fat contents measured by a chemical method and by CIA. The rib loin between the 5th and 12th ribs (approx. length 20 to 25cm) of eight Landrace \times (Large White \times Duroc) was cut in 2.5 cm intervals. Images of eight slices from 1 pig were taken by photography equipment with a high resolution digital camera (13.5 M pixels), which was originally developed for beef carcass cross section by the authors. The tone of the image was adjusted using commercial image-processing software in order to easily distinguish between fat and muscle. The marbling particles were semi-automatically extracted by the borderline comparison method using a special software programmed by the authors, and the ratio of the marbling area to the ribeye was calculated. Crude fat contents of the front part of the rib loin (around the 5th rib) were determined by ether extraction, and the chemical values were

compared with the CIA values. The average marbling percentage for each pork, which is the average of the values for the 8 slices by CIA, was ranged from 0.95 to 4.03%. The marbling percentage in the 8 slices varied largely even in the same pork; the largest range was 2.93% (2.17 to 5.11%). The least square mean of the marbling percentage at the front part (around the 5th rib) of the rib loin was significantly ($P<0.05$) higher at 3.14% than that at the rear (around the 12th rib) at 2.18%. The correlation coefficient between the average marbling percentage of the 3 slices near the 5th rib loin and the crude fat contents was extremely high (0.96). These results indicated that the marbling degree can be evaluated and crude fat contents can be predicted with high accuracy using CIA method in pork, just as in beef.

Key Words: Image analysis, Pork marbling, Crude fat contents

M89 Effect of type of pasture and time of supplementation on fatty acid composition of grazing beef heifers. G. J. Depetris*¹, E. Pavan¹, F. J. Santini¹, E. L. Villarreal¹, and T. P. Garcia², ¹EEA INTA Balcarce- Fac Cs. Agrarias. UNMdP, Balcarce, Buenos Aires, Argentina, ²Inst. de Tecnología de Alimentos. INTA Castelar, Moron. Buenos Aires, Argentina.

The objective of the trial was to assess the impact of the pasture type and time supplementation before slaughter on meat fatty acid profile. Forty heifers (264 \pm 5.16 Kg) were allotted to one of five dietary treatments (n=8). Heifer grazed a ryegrass red pasture with no supplementation (RG) or a red clover pasture for 42 d; heifer grazing red clover were supplemented with 1.3% BW of cracked corn grain for 0, 14, 28, or 42 d before slaughter (RC, RC14, RC28 or RC42 respectively). Heifers were slaughtered the same day in commercial abattoir and the carcasses were cooled for 24 h at 3°C. Samples of *longissimus dorsi* at 10-12 ribs were obtained and frozen at -18°C for fatty acid (FA) analysis. Preplanned contrasts were used to test: effects of pasture type (RG vs RC), and linear and quadratic effects of supplementation time. Beef of RC had higher percentage of conjugated linoleic acid (CLA), linoleic acid and n-6/n-3 ratio than RG pasture. CLA decreased linearly and linoleic acid, polyunsaturated fatty acids (PUFA), n-6 and PUFA/SFA ratio increased linearly as time of supplementation increased. Quadratic effect of time on supplementation was observed ($P=0.08$) for n-6/n-3 ratio only. Neither type of pasture nor time of supplementation affected the ether extract percentage (2.12 \pm 0.24), monounsaturated fatty acids (MUFA) and saturated fatty acids (SFA). These results show that short time of supplementation before slaughter affect meat fatty acid composition.

Table 1.

Item	RG	RC	RC14	RC28	RC42	SEM	Linear ¹	RG vs RC ¹
Linoleic	3.03	3.72	3.44	3.95	4.26	0.220	0.04	0.04
Linolenic	1.49	1.65	1.49	1.51	1.52	0.076	0.30	0.15
SFA	39.21	39.45	38.97	37.82	37.5	0.085	0.18	0.84
MUFA	38.66	37.09	37.70	38.02	38.66	0.788	0.20	0.17
PUFA	8.67	8.31	8.90	10.16	10.35	0.601	0.01	0.68
n-3	3.87	3.04	3.46	3.89	3.69	0.353	0.11	0.07
n-6	4.80	5.26	5.44	6.26	6.66	0.296	0.01	0.37
n-6/n-3	1.25	1.86	1.62	1.62	1.82	0.111	0.84	0.001
CLA	0.53	0.70	0.56	0.57	0.48	0.044	0.01	0.02
PUFA/SFA	0.22	0.21	0.23	0.27	0.28	0.019	0.03	0.81

¹ Probability, $P=$

Key Words: Meat fatty acid, Time of supplementation, Red clover and ryegrass pastures

M90 Effect of type of pasture and time of supplementation on meat quality traits of grazing beef heifers. G. J. Depetris^{*1}, E. Pavan¹, F. J. Santini¹, E. L. Villarreal¹, G. Grigioni², M. Irurueta², and F. Carduza², ¹EEA INTA Balcarce- Fac Cs. Agrarias, UNMdP, Balcarce, Buenos Aires, Argentina, ²Inst. de Tecnolog&iactue;a de alimentos, INTA Castelar, Morón, Buenos Aires, Argentina.

The objective of the trial was to evaluate the meat quality of heifers grazing different pasture type and time supplementation before slaughter. Forty heifers of 264±4.10 Kg were allotted to one of five dietary treatments (n=8). Heifer grazed a ryegrass red pasture with no supplementation (RG) or a red clover pasture for 42 d; heifer grazing red clover were supplemented with 1.3%BW of cracked corn grain for 0, 14, 28, or 42 d before slaughter (RC, RC14, RC28 or RC42 respectively). Heifers were slaughtered the same day in commercial abattoir and the carcasses were cooled for 24 h at 3°C. Ultimate pH was measured at the 12th rib at 24 h post mortem. Samples of *longissimus dorsi* at 10-12 ribs were obtained and frozen at -18°C for subsequent colour (CIELAB), tenderness (shear force) and water holding capacity (WHC) assessment. Preplanned contrasts were used to test: effects of pasture type (RG vs RC), and linear and quadratic effects of supplementation time. Neither the type of pasture nor the length of the supplementation period had any effect ($P > 0.05$) on meat quality traits.

Table 1.

Item	RG	RC	RC14	RC28	RC42	SEM	RG vs		
							RC	Linear	Quad
Lightness (L [*])	34.20	36.51	33.20	34.48	34.94	1.07	0.40	0.50	0.10
Yellowness (b [*])	16.46	18.91	18.28	18.28	18.85	0.77	0.58	0.90	0.70
Redness (a [*])	15.40	17.50	16.12	16.63	17.61	0.69	0.60	0.81	0.13
WHC (%)	29.11	27.56	27.08	27.89	28.54	0.76	0.45	0.30	0.48
Shear force (lb)	11.21	10.80	11.49	11.65	13.56	1.14	0.80	0.10	0.59
Ultimate pH	5.50	5.42	5.42	5.39	5.44	0.10	0.28	0.99	0.23

¹ Probability, $P=$

Key Words: Meat quality traits, Time of supplementation, Red clover and ryegrass pasture

M91 Field pea inclusion in high grain diets for beef heifers improves beef tenderness without altering performance. K. R. Maddock Carlin^{*1}, G. P. Lardy¹, R. J. Maddock², B. Ilse³, and V. L. Anderson³, ¹North Dakota State University, Fargo, ²South Dakota State University, Brookings, ³Carrington Research Extension Center, Carrington.

The objective of this study was to determine the effects of increasing levels of field peas in feedlot diets on heifer performance, carcass quality, and sensory evaluation of steaks. One hundred eighteen heifers were blocked by BW (initial BW = 420 kg) in a randomized complete block design and allotted to 16 pens (four pens per treatment). Treatments were 0, 10, 20, and 30% dry rolled field peas (DM basis) replacing corn and canola meal in corn-based finishing diets. Heifers were fed for 74 d and transported to a commercial slaughter facility. Following a 24-h chill, ribeye area, fat depth, KPH, and HCW were measured and USDA grades were recorded. A 7-cm (approximate) portion of longissimus muscle was removed caudally from 12th rib location on the left side of each carcass. Longissimus muscle samples were vacuum packaged, aged for 14 d at 4°C, cut into 2.54 cm thick

steaks, and frozen. One steak from each carcass was evaluated for Warner-Bratzler shear force (WBSF). A second steak from each carcass was evaluated by a trained taste panel for tenderness, juiciness, and flavor intensity using a scale of 1 to 8 (1 = extremely tough, dry, and bland; 8 = extremely tender, juicy, and intense beef flavor), and off-flavor intensity (1 = no off flavors; 4 = intense off flavors). No treatment differences were observed for DMI, ADG, G:F, USDA quality grade or yield grade ($P \geq 0.13$). Increasing level of dietary field peas quadratically decreased ($P = 0.001$) WBSF (4.30 ± 0.15 kg; 3.63 ± 0.15 kg; 3.68 ± 0.16 kg; 3.71 ± 0.15 kg for 0, 10, 20, and 30% peas, respectively). Sensory panel analysis indicated a linear increase in tenderness ratings ($P = 0.002$) with addition of peas (4.56 ± 0.18; 5.14 ± 0.17; 5.28 ± 0.18; 5.34 ± 0.18 for 0, 10, 20, and 30% peas, respectively). Sensory panel ratings indicated a tendency for greater juiciness ratings ($P = 0.14$) and no differences in flavor ($P = 0.21$) or off flavor ($P = 0.32$). The improved tenderness observed in this study has implications for improving beef acceptability and may provide consumers with a more consistent, tender beef product.

Key Words: Field peas, Tenderness, Feedlot

M92 Physical and sensorial traits of meat from different ovine categories. A. G. da Silva Sobrinho^{*}, R. S. B. Pinheiro, H. B. A. de Souza, and S. M. Yamamoto, *Unesp- São Paulo State University, Jaboticabal, São Paulo, Brazil.*

Ovine meat consumers are very exigent in relation to physical and sensorial traits. So, it is important to know the specific meats characteristics from different ovine categories. In such circumstances, we should be able to increase our share of the market. For evaluating qualitative traits of meat from different ovine categories and muscles from different carcass cuts (shoulder-*Triceps brachii*, loin- *Longissimus lumborum* and leg-*Semimembranosus*), ½ Ile de France ½ Polwarth animals (6 uncastrated lambs, 6 discarded ewes and 6 discarded wether mutton) were used. Animals grazed *Cynodon dactylon* cv. Tifton - 85 and were daily concentrate supplemented with 1% of their live weight. Lambs were weaned with 17 kg and slaughtered at 32 kg of live weight, at around 5 months of age. Ewes and wethers were slaughtered with 55 kg and 60 months of age. There were no interactions between animal categories and carcass muscle cuts for pH_{45min} and pH_{24h}, with values of 6.49 and 5.58, respectively. In lambs, *Longissimus lumborum* and *Semimembranosus* luminosity was higher (40.42) than that of *Triceps brachii* (36.17). In adults, the evaluated muscles had the same luminosity value (34.40). The red level (18.97) was the same in all adults muscles. In relation to water holding capacity, there was no interaction between animal categories or muscles and the mean was 56.40%. Cooking losses were not affected by ovine categories, with exception of the losses observed in *Longissimus lumborum*, which were higher (46.44%) in lambs than in adult sheep (38.82%). In relation to shearing force, it was higher (2.77 kgf/cm²) in adults meat, but it was equal in *Longissimus lumborum* from different categories (1.65 kgf/cm²). The sensorial analysis did not differ in relation to flavor, color and preference, but lamb meats received higher scores (8.13) for tenderness than adults meat (6.90) and meat tenderness had negative correlation between instrumental and sensorial analyses ($r = - 0.41$). Meat of adult animals was tougher and darker than lambs meat, but other traits as pH, water holding capacity, flavor, color and preference were similar among lambs, ewes and wether.

Key Words: Meat, Color, Tenderness

M93 Changes in caspase activities post mortem and their relationships to shear force in porcine *longissimus* muscle. C. M. Kemp*, R. G. Bardsley, and T. Parr, *University of Nottingham, Nottingham, Nottinghamshire, UK.*

The objective of this study was to investigate the relationship between shear force and caspase activities and the levels of their specific substrates in porcine *longissimus* muscle (LM) during a post mortem conditioning period of 192 h. Caspases are a family of cysteine proteases predominantly associated with programmed cell death, targeting specific proteins for degradation. However, caspases are also essential in the development and remodelling of skeletal muscle (Fernando et al., 2002) and are also activated in early pathological events associated with hypoxia/ischemia (Gustafsson & Gottlieb, 2003), that are not too dissimilar to the hypoxic conditions that occur post mortem. Ten Large White gilts (81.2±1.98 kg) were slaughtered and samples of LM were taken at 0, 2, 4, 8, 16, 32 and 192 h post mortem. Samples were subsequently analyzed for caspase 3/7 and caspase 9 activity, protein levels of cleaved isoforms of known caspase substrates alpha spectrin and poly (ADP-ribose) polymerase (PARP), as well as shear force at 192 h. Immunoprobed Western blots detected the peptide fragments of alpha spectrin (120 kDa) and PARP (89 kDa), which are known indicators of caspase activity and apoptosis. Both caspase 3/7 activity and protein levels of the spectrin 120 kDa breakdown product peaked at 2 h post mortem and positive correlation between them was observed at this time point ($r = 0.59$, $P = 0.07$). There was a negative relationship between shear force and the 0:32 h ratio of caspase 3/7 ($r = -0.62$, $P = 0.053$), and caspase 9 activities ($r = -0.68$, $P = 0.044$). In addition there was a negative relationship between shear force and the level of alpha spectrin 120 kDa degradation product at 2 h ($r = -0.75$, $P = 0.012$). The findings of this study indicate that changes in caspase activity and caspase-mediated cleavage of spectrin are occurring in LM in situ and both these factors exhibit negative relationships with shear force.

Key Words: Proteolysis, Shear force, Porcine

M94 Effects of adding sunflower or soybean seeds on fatty acid composition of intramuscular fat in feedlot heifers. J. A. Navarro*¹, F. J. Santini¹, G. J. Depetris¹, E. L. Villarreal¹, D. H. Rearte¹, and P. T. García², ¹*EEA INTA Balcarce, Fac. Cs. Agrarias, UNMdP, Balcarce, Buenos Aires, Argentina*, ²*Inst. de Tecnología de Alimentos, INTA Castelar, Morón, Buenos Aires, Argentina.*

The objective of this study was to test the effects of fat supplementation with different proportions of sunflower or whole raw soybean seed on the heifers meat fatty acid profile. One hundred and five Angus heifers (147±19 kg) were used in a randomized complete block design. The lipid supplementation treatments, applied for 125 d., were: no oilseeds (CON), sunflower seed at 4% (LSF), at 6% (MSF), and at 8% (HSF), soybean seed at 15% (LSB), at 20% (MSB), and at 25% (HSB) on a dry matter basis. The basal diet consisted of corn silage, whole corn, sunflower meal and urea. Animals were slaughtered in commercial abattoir and the carcass was cooled for 24 h at 3°C. Samples of *longissimus dorsi* at 10-12 ribs were obtained and frozen at -18°C for fatty acids (FA) analysis. The results of the least square means comparisons are shown on the table. Control had less CLA than sunflower treatments, less PUFA/SFA ratio than sunflower and soybean treatments, higher *n-6/n-3* ratio than soybean treatments. Sunflower treatments had higher CLA, less PUFA/SFA ratio, and higher *n-6/n-3* ratio than soybean treatments. Increasing the proportion of sunflower in the diet caused a linear increase in the level of CLA, PUFA, *n-6*

FA, *n-3* FA, and in the PUFA/SFA and *n-6/n-3* ratio. Quadratic effect tended to occur for PUFA, *n-6* FA and *n-6/n-3* ratio when soybean was added. The data indicate that meat FA profile can be improved from a human health perspective by inclusion of oilseeds in the diet.

Table 1.

Item	CON	LSF	MSF	HSF	LSB	MSB	HSB	SEM
CLA*	0.31 ^{bc}	0.39 ^{abc}	0.40 ^{ab}	0.44 ^a	0.41 ^{ab}	0.29 ^c	0.33 ^{bc}	0.02
SFA*	40.15	38.91	38.44	38.41	40.02	38.62	37.64	0.84
MUFA*	40.57 ^a	40.56 ^a	37.31 ^{ab}	38.44 ^{ab}	38.93 ^{ab}	38.93 ^{ab}	35.98 ^{ab}	0.99
PUFA*	8.71 ^b	9.10 ^b	10.50 ^{ab}	10.95 ^{ab}	9.41 ^b	13.19 ^a	11.53 ^{ab}	0.59
<i>n-6</i> FA*	7.19 ^b	7.48 ^b	8.71 ^{ab}	9.10 ^{ab}	7.59 ^b	10.88 ^a	9.42 ^{ab}	0.51
<i>n-3</i> FA*	1.52 ^c	1.63 ^c	1.78 ^{bc}	1.85 ^{bc}	1.82 ^{bc}	2.31 ^a	2.12 ^{ab}	0.09
PUFA/SFA	0.22 ^c	0.23 ^{bc}	0.28 ^{abc}	0.29 ^{abc}	0.24 ^{bc}	0.34 ^a	0.31 ^{ab}	0.02
<i>n-6/n-3</i>	4.78 ^{ab}	4.66 ^{ab}	4.90 ^a	4.95 ^a	4.20 ^b	4.73 ^{ab}	4.46 ^{ab}	0.14

*g/100g FA. ^{abc}Means within a row with unlike superscripts differ ($P < 0.05$).

Key Words: Sunflower and soybean seeds, Heifers, Meat fatty acids

M95 Effect of different breeds on fatty acid composition and CLA concentration of beef cattle. A. A. Souza, L. Suguisawa*, H. N. Oliveira, and A. C. Silveira, *São Paulo State University, São Paulo, Brazil.*

Beef is the mainly source of fat on human diet. Manipulation of the fat acid composition becomes a way to produce a healthier cuts. The development of cuts with more tenderness and easier to prepare was the target of beef industries on last years, but now meat consumers are looking for not only tenderness and flavour, but healthier cuts too. The improve on unsaturated fat acid and CLA concentrations are possibilities to improve quality of beef cuts. Forty two bullocks approximately 8 months and 240 kg, from Nellore, Angus, Angus x Nellore, Brangus, Simmental x Nellore, Simbrasil (5/8 S 3/8 N) and Simmental were evaluated. Animals were housed with a high concentrate diet, and slaughtered with 450 kg and 3 mm of backfat thickness. Angus and its crossbred had thicker backfat and marbling, but smaller ribeye area than Simmental and its crossbred. Simmental and its crossbred had more unsaturated fatty acids and higher concentrations of CLA than zebu and Angus cattle.

Table 1. Effect of different breeds on fatty acid composition and CLA concentration

Fatty acid	1/2		1/2		Simbrasil	Simmental	SEM
	Angus	Brangus	Angus	Nellore			
	mg/g fatty acid						
C 18:2 cis							
9 trans 11	4.13 ^a	3.23 ^a	4.52 ^{ab}	3.82 ^a	4.79 ^{ab}	6.07 ^b	4.74 ^{ab}
Saturated (% total)	52.0 ^c	51.0 ^{bc}	47.3 ^{ab}	49.8 ^{abc}	48.5 ^{abc}	46.2 ^a	50.2 ^{bc}
Unsaturated (% total)	48.0 ^a	49.0 ^{ab}	52.7 ^{bc}	50.2 ^{abc}	51.5 ^{abc}	53.8 ^c	49.8 ^{ab}
Monounsatur. (% unsaturat.)	88.7 ^{abc}	90.9 ^{bc}	86.6 ^{ab}	92.4 ^c	84.9 ^a	85.9 ^{ab}	86.9 ^{ab}
Polyunsatur. (% unsaturat.)	11.3 ^{abc}	9.1 ^{ab}	13.4 ^{bc}	7.6 ^a	15.1 ^c	14.1 ^{bc}	13.1 ^{bc}
Total (%)	89.80	89.92	91.46	89.35	86.6	89.89	88.16

*means with unlike superscripts are different ($P < 0.05$)

Key Words: CLA, Fatty acids, Genetic Group

M96 Response of μ - and m-Calpains in the Presence of Calpastatin After Hydrogen Peroxide-Induced Oxidation. E. M. Steadham*¹, K. R. Maddock Carlin², E. Huff-Lonergan¹, and S. M. Lonergan¹, ¹Iowa State University, Ames, ²North Dakota State University, Fargo.

The purpose of this study was to determine if μ -calpain and m-calpain differ in their response to oxidation under similar conditions. Purified porcine μ - or m-calpain (0.6 units) in 50 mM HEPES buffer, pH 7.5, were incubated on ice with the following treatment combinations: 1) Oxidation by treatment with 100 mM H₂O₂ for five minutes. 2) Two units calpastatin/unit of calpain, without oxidation. 3) Exposure to H₂O₂ for five minutes followed by treatment with calpastatin (2 units). 4) Incubation with calpastatin followed by H₂O₂ oxidation for five minutes. All treatments included 10 mM CaCl₂. Control treatments of μ - or m-calpain without CaCl₂ were included. After treatment, reactions were stopped by dividing the reaction mixture into sample buffers containing EDTA for casein zymography (to determine enzymatic activity) as well as electrophoresis on reducing and non-reducing polyacrylamide gels (to evaluate autolysis of the calpains). Samples treated similarly were also evaluated for enzymatic activity *in vitro* for comparison to casein zymography results. Incubation of μ - and m-calpain with hydrogen peroxide in the presence of calcium resulted in retained activity on casein gels and notably less autolysis than incubation of calpain with calcium in the absence of hydrogen peroxide, indicating that oxidation inhibited activation of both enzymes and prevented autolysis-induced activity loss in solution. Oxidation of μ -calpain/calpastatin complex promoted autolysis of μ -calpain and resulted in less retained μ -calpain activity. In contrast, oxidation did not promote autolysis and activation of m-calpain bound to calpastatin as evidenced by retained activity of m-calpain on casein zymograms. Since oxidative conditions exist in postmortem muscle, these observations reflect some of the influences that exist on calpain activity and subsequent meat quality. While these conditions are likely inherent in the conversion of muscle to meat, understanding the mechanisms could allow for better evaluation of procedures to optimize meat quality.

Key Words: Calpain, Calpastatin, Oxidation

M97 Effects of postmortem storage on μ - and m-calpain in bovine skeletal muscle. J. P. Camou*, J. A. Marchello, and D. E. Goll, University of Arizona, Tucson.

It is generally believed that the calpains are responsible for proteolytically-induced tenderization during postmortem storage. It is unclear whether these changes are caused by μ - or m-calpain or both. We have used casein zymography to determine the effects of postmortem storage on activities of μ - and m-calpain in five different bovine muscles, and the effects of incubating muscle at four different pH values on the calpain activities in that muscle. The *longissimus dorsi thoracis* (LDT), and *lumborum* (LDL), *semimembranosus* (ST), *triceps brachii* (TB), and *psaos major* (PM) muscles were sampled after 0, 7, 24, 31, 48, 72, 96, 120, and 144 h postmortem storage at 2-4 °C. Activity of μ -calpain declined rapidly during postmortem storage and was 29% or 2% (both ave. of 4 muscles) of original activity after 24 and 72 h, respectively. Activity of m-calpain declined more slowly during postmortem storage;

57% or 38% (ave. of 4 muscles) of original activity remained after 24 and 72 h, respectively. Activity of μ - and m-calpain in the TB muscle decreased more slowly than in the other 4 muscles; 38% or 18% of μ -calpain activity remained after 24 and 72 h postmortem, respectively and 77% or 56% of m-calpain activity remained after 24 and 72 h postmortem, respectively. After 144 h postmortem, 7-18% of the original m-calpain activity, but only 1-2% of the original μ -calpain activity remained. The zymogram assays were done at 25°C, and activities would be even less *in situ* in muscle stored at 2-4°C.

Zymogram assays of calpain activity in 3x1x0.5 cm slices of bovine diaphragm muscle incubated for 0, 24, 48, or 144 h postmortem at 2-4°C in Tris-MES buffers containing EGTA at pH values 7.5, 7.0, 6.5, or 5.8 showed that activities of μ - and m-calpain decreased at similar rates during postmortem storage under these conditions and that pH values of 7.5, 7.0, or 6.5 had little effect on rate of decline in activity; 16-36% of the original μ -calpain activity and 26-30% of the original m-calpain activity remained after 144 h. Neither μ - nor m-calpain had any activity after 24 h in muscle placed at pH 5.8.

Key Words: Calpain, Tenderness, Postmortem

M98 Effect of substitution of concentrate by sweet potato (*Ipomoea batatas* L.) meal in carcass traits of finishing pigs. O. E. Moron*, S. Pietrosevoli, A. Paez, C. Chirinos, and A. Marrugo, Facultad de Agronomia. La Universidad del Zulia, Maracaibo, Zulia, Venezuela.

To assess the effect of substituting a commercial concentrate by sweet potato root (R) and foliage (F) meal on carcass traits of finishing pigs, 18 castrated males and female Duroc x Landrace (62 ± 3.9 kg and 165.2 ± 6.6 d of age) were balanced across 3 treatments in a completely randomized design: T1, 100 % commercial concentrate (CC); T2, 60 % CC + 30 % F + 10 % R; T3, 50 % CC + 40 % F + 10 % R. Pigs had *ad libitum* access to feed, and the trial lasted until they reached 90 ± 5 kg final weight. Most carcass traits were negatively influenced by the substitution of CC by sweet potato meal. However, no differences were observed between treatments for kidney (avg: 0.21±0.02 kg), heart (avg: 0.2±0.02 kg), and pancreatic weights (avg: 0.1±0.01 kg).

Table I. Carcass traits of pigs receiving sweet potato diet.

	T1	T2	T3
Cold Carcass Weight, kg	66.2 ± 2.4a	58.0 ± 1.9b	56.9 ± 1.9b
Weight Loss 24 h, %	1.2 ± 0.3a	2.9 ± 0.3b	2.4 ± 0.3b
Cold Carcass Yield 24h, %	53.9 ± 5.1a	67.5 ± 4.2b	66.8 ± 4.2b
Leg Yield, %	10.4 ± 1.2*	14.1 ± 1.0b	13.1 ± 1.0ab
Eye Rib Yield, %	15.7 ± 1.6	18.9 ± 1.3	19.1 ± 1.3
Shoulder Yield, %	10.6 ± 1.2a	14.5 ± 1.0b	13.5 ± 1.0b
Rib Yield, %	29.4 ± 0.2	29.5 ± 0.2	30.0 ± 0.2
Lung, kg	0.6 ± 0.07a	0.9 ± 0.07b	0.8 ± 0.07ab
Head, kg	7.9 ± 0.2a	6.9 ± 0.2b	6.3 ± 0.2b

a,b: Within a row differ (p < 0, 05)

Key Words: *Ipomoea batata*, Pig, Carcass traits

Nonruminant Nutrition: Dietary Influences in Nursery Pigs

M99 Validation of the NCCC-42 vitamin-trace mineral premix in starter pigs. T. D. Crenshaw^{*1}, M. J. Azain², G. H. Hill³, P. S. Miller⁴, and NCCC-42 Swine Nutrition Committee¹, ¹University of Wisconsin, Madison, ²University of Georgia, Athens, ³Michigan State University, East Lansing, ⁴University of Nebraska, Lincoln.

A multi-state (WI, GA, MI, and NE) experiment was conducted by the NCCC-42 Swine Nutrition Committee to evaluate a vitamin trace mineral premix (VMP). VMP was formulated to provide minimal quantities of vitamins and trace minerals needed to complement nutrients supplied by ingredients typical in US swine diets. In the current trial (18 to 23 d weaned pigs), VMP was added to a complex starter diet to supply either 0, 1X or 3X supplemental vitamin concentrations where X equals quantities of vitamins to meet minimum requirements if nutrients from other ingredients are considered. Because of limited data on bioavailability of several B vitamins (biotin, choline, folate, pyridoxine, and thiamin) in feed ingredients, a B vitamin premix (+B) was formulated to supply these vitamins at minimum concentrations. The +B was added to diets with either 1X or 3X (1X+B and 3X+3XB) VMP. A sixth treatment (St) involved standard premixes used at each respective station. Trace minerals were constant in all diets except St. Pigs were allowed continuous access to assigned meal diets and water throughout a 28-d trial. Differences among stations were detected ($P < 0.05$), but no interactions among stations and diets were detected for ADG or ADFI responses. Pigs fed diets with no VMP (0X) gained less and consumed less feed than pigs in other groups ($P < 0.05$). No advantages in ADG nor ADFI were detected in pigs fed diets with additional 3X VMP or VMP+B at 1X or 3X levels. Pigs fed St diets tended ($P < 0.10$) to gain faster and consumed more feed ($P < 0.05$) than pigs fed VMP diets at 1X or 3X. In conclusion, 1X VMP allowed adequate growth over a 4-wk nursery trial. Additions of higher quantities of VMP or supplemental B vitamins did not improve growth.

Table 1. Concentrations of Vitamin Premixes¹

Trait	0X	1X	3X	1X+B	3X+3XB	St	SEM
ADG, kg/d	0.295 ^a	0.308 ^b	0.313 ^b	0.314 ^b	0.320 ^b	0.335 ^{c*}	0.01
ADFI, kg/d	0.484 ^a	0.493 ^b	0.515 ^b	0.509 ^b	0.513 ^b	0.542 ^c	0.01

¹ Means based on 18 pens/treatment. Means within a row with different superscripts differ ($P < 0.05$) or * ($P < 0.10$).

Key Words: Swine, Premix, Vitamins

M100 True phosphorus digestibility and the gastrointestinal endogenous P outputs associated with brown rice in weanling pigs. H. Yang¹, Y. L. Yin^{*1,2}, T. J. Li¹, R. L. Huang¹, and M. Z. Fan¹, ¹The Chinese Academy of Sciences, Changsha, Hunan Province, China, ²University of Guelph, Ontario, Canada.

The objectives of this study were to determine true phosphorus (P) digestibility and the gastrointestinal endogenous P outputs associated with brown rice at the ileal and the fecal levels in weanling pigs. Six Duroc x Large White x Landrace barrows, with an average initial BW 12.5 ± 0.6 kg, were fitted with a simple T-cannula at the distal ileum and fed six diets according to a 6 x 6 Latin square design. The diets were cornstarch-based and contained six levels of P (0.80, 1.36, 1.93, 2.49, 3.04 and 3.61 g/kg DMI) from brown rice. Chromic oxide (3.5

g/kg diet, on as-fed basis) was included as a digestibility marker. Each experimental period consisted of 9 d with 6-d adaptation and 3d collection of representative ileal digesta and fecal samples. True ileal and fecal P digestibility values and the ileal and fecal endogenous P outputs associated with brown rice were determined by the regression analysis technique. There were no differences ($P > 0.05$) in true P digestibility values (ileal, 57.7 ± 5.4 vs. fecal, $58.2 \pm 5.9\%$, $n = 36$) and the endogenous P outputs (ileal, 0.812 ± 0.096 vs. fecal, 0.725 ± 0.083 g/kg DMI, $n = 36$) between the ileal and the fecal levels. In conclusion, about 58% of the total P in conventional brown rice is digested in weanling pigs. The large intestine does not play an role in the digestion and absorption of P associated with brown rice in the weanling pig.

Key Words: Brown rice, Phosphorus digestibility, Weanling pigs

M101 True phosphorus digestibility and the endogenous phosphorus outputs in diets for weaned pigs determined by the substitution method. Z. R. Wang¹, L. Liu², X. J. Yang², T. C. Rideout², C. Yang², Y. L. Yin^{2,3}, T. Archbold², and M. Z. Fan^{*2}, ¹Xinjiang Agricultural University, Urumqi, Xinjiang, China, ²Institute of Subtropical Agriculture, the Chinese Academy of Sciences, Changsha, Hunan, China, ³University of Guelph, Ontario, Canada.

The objective of this study was to determine true phosphorus (P) digestibility and the gastrointestinal endogenous P output associated with corn and soybean meal (SBM)-based diets for weanling pigs by the substitution method. Twelve Yorkshire weanling barrows, with initial BW between 10 and 12 kg, were fed two diets according to a completely randomized block design. The diets were corn and SBM-based and contained two levels of P (0.74 and 0.53% on DM basis) with the lower P diet formulated by replacing corn and SBM with 29% cornstarch. Chromic oxide (3.0 g/kg diet, on as-fed basis) was included as a digestibility marker. Each experimental period consisted of 8 d with 10-d adaptation and 4-d collection of representative fecal samples. True fecal P digestibility ($61.2 \pm 7.7\%$, $n = 6$) and the fecal endogenous P output (0.534 ± 0.481 g/kg DMI, $n = 12$) associated with the diet were determined by the substitution method. In conclusion, true fecal P digestibility and the endogenous P output associated with test dietary mixtures can be determined by the substitution method with dietary P levels meeting or close to recommended dietary P requirement levels in pigs.

Key Words: Phosphorus, Pigs, True digestibility

M102 Impact of genetics and dietary phosphorus restriction on growth performance and bone integrity in pigs. L. Alexander^{*}, S. Cutler, M. Yu, M. F. Rothschild, and C. H. Stahl, Iowa State University, Ames.

The costs associated with dietary phosphorus (P) supplementation, as well as public concerns, have driven research towards finding ways to reduce dietary P supplementation to, as well as P excretion from, pigs. Our previous work suggests differences in the regulation of P homeostasis exist between weanling pigs of different genetic backgrounds (Hittmeier et al., 2005). In this study, we examined the impact of genetic background and mild dietary P restriction on growth and bone integrity in 48 gilts sired by two different sire lines (LB and HB). They were fed either a P adequate (PA) or a P deficient (PD)

diet over a 14 wk trial. The PD provided 20% less available P than the PA. Plasma phosphorus concentration, ADG, ADFI, and G:F were determined biweekly. At the completion of the trial, radial bones were collected for bone strength analysis and intermediate carpal bones were collected for ash content determination. Data were analyzed using a mixed model with genetic line, diet, and line x diet considered as fixed effects and litter as a random effect. Initial BW and final BW were covariates for growth performance and bone strength, respectively.

After 4wk on trial, reduced ADG ($P < .05$) was seen among LB pigs fed the PD, but not among the HB pigs. The depressed ADG among LB PD pigs corresponded with a lower ($P < .05$) G:F. These differences were not seen by 14wk. Lower ($P < .05$) plasma P concentrations in PD fed pigs were seen at wk14. The bones of pigs fed PA were stronger than those fed PD ($P < .05$). Radial bones of HB pigs were more bendable ($P < .05$) than those of LB pigs, and this increased in both lines with the PD diet ($P < .05$). Pigs fed the PD had lower ($P < .05$) breaking strength and ash %. A line*diet effect was also seen in ash %. Among PA fed pigs, LB pigs had higher ($P < .05$) ash % than HB pigs. These differences suggest that genetic background affects bone integrity and altered regulation of mineral homeostasis between these lines may help explain these differences. Future research could lead to genotype specific dietary P requirements and/or breeding strategies to produce more "environmentally-friendly" pigs.

Key Words: Phosphorus, Bone, Pig

M103 Evaluation of plasma protein replacement strategies in complex and semi-complex phase 1 and 2 diets, followed by either high or low soybean meal subsequent nursery diets. G. Willis^{*1}, P. Wilcock¹, and B. Richert², ¹Primary Nutrition, Dundee, IL, ²Purdue University, West Lafayette, IN.

Three hundred fifty pigs (BW=5.3 kg; 7 pigs/pen) were utilized to evaluate alternative plasma replacement strategies in phase 1 and 2 nursery diets. The strategies evaluated were replacement of spray-dried plasma (SDP) with milk proteins (MP) or isolated soy protein (ISP). Treatment 1 (T1) was complex phase 1 and 2 diets containing 5 and 2.5% SDP, respectively. In T2, SDP was replaced by MP primarily from whey protein concentrate. T3 was like T2, but utilized approximately 2% more MP from whey in replacement for corn. T4 was semi-complex phase 1 and 2 diets with 5 and 2.5 % SDP. T5 was like T4 but SDP was replaced with ISP. After phase 2, treatments were fed either high soybean meal (HSBM, 30%) or low soybean meal (LSBM, 15%) phase 3 diets until d 21. Pigs were fed a common phase 4 diet from d 21-35. For d 0-7, replacing SDP with MP (T1, T2, T3; ADG 187, 198, 205 g/d and G:F 1.14, 1.16, 1.18, respectively) or ISP (T4-T5, ADG 130, 132 and G:F 0.90, 1.06, respectively) had no effect on performance. Similarly, d 14 BW was unaffected by SDP replacement strategy (8.13, 8.13, 8.32 kg for T1, T2, and T3; 7.82, 7.79 kg for T4-T5, respectively). However, complex diets (T1, T2, T3) had greater ADG ($P < 0.001$), ADFI ($P < 0.001$) and G:F ($P < 0.03$) during d 0-7 and were heavier ($P < 0.001$) at d 14 than pigs fed the semi-complex diets (T4-T5). In phase 3, HSBM diets tended to improve ADG (418 vs. 404 g/d; $P < 0.08$) and improved G:F (0.68 vs. 0.65; $P < 0.05$) from d 14-21. For the entire study (d 0-35) both SDP replacement strategies were effective (T1, T2, T3; ADG 392, 392, 400 g/d and G/F 0.64, 0.61, 0.63; T4-T5 ADG 379, 379 g/d and G/F 0.61, 0.61, respectively) in maintaining pig growth. Level of soybean meal in phase 3 did not alter overall nursery performance (ADG, 389 vs 387 g/d; G/F, 0.62 vs 0.62; HSBM vs. LSBM, respectively). Plasma protein can be replaced in both

complex and semi-complex nursery diets with milk proteins or isolated soy proteins, respectively, without impacting pig performance.

Key Words: Pig, Plasma, Milk proteins

M104 Nutrient digestibility of vegetable protein sources of different particle size in young pigs. D. G. Valencia, M. P. Serrano, R. Lázaro, and G. G. Mateos^{*}, *Universidad Politécnica de Madrid, Spain.*

Two trials were conducted to test the inclusion of vegetable protein sources in the diet on coefficient of total tract apparent digestibility (CTTAD) and ileal apparent digestibility (CIAD) of nutrients in young pigs. In addition, the effect of particle size of soybean meal (SBM) and full fat soybean (FFSB) on these coefficients was also studied. Seven isonutritive diets (2,490 kcal NE/kg and 1.28% available Lys) were fed from 21 to 48 d of age. The main difference among them was the protein source used; a) SBM, 45.2% CP with an average particle size (APS) of 883, 400, or 137 μm , b) FFSB, 34.9% CP with an APS of 780 or 82 μm , c) soy protein concentrate, 56% CP (SPC) with an APS of 200 μm , and d) pea protein concentrate, 52.5% CP (PEA) with an APS of 30.0 μm . In all cases the source tested supplied 5.5% of the protein of the diet. Each treatment was replicated five times (six piglets) in trial 1 (CTTAD study) and six times (one piglet) in trial 2 (CIAD study). At 36 d of age, the CTTAD of OM (90.3 vs. 89.3 %; $P \leq 0.05$), CP (84.8 vs. 81.3 %; $P \leq 0.001$), and GE (88.8 vs. 87.3 %; $P \leq 0.01$) was higher for piglets fed soy products (SOY) containing diets than for piglets fed the PEA containing diet, but no negative effects of PEA feeding were observed at 48 d of age. Piglets fed SOY diets tended to have better CIAD of CP (76.1 vs. 73.7 %; $P \leq 0.10$) than piglets fed the PEA diet. Piglets fed SBM containing diets had better CTTAD of OM and CP ($P \leq 0.05$) and CIAD of OM ($P \leq 0.001$) than piglets fed FFSB containing diets. Piglets fed SPC diets had better CIAD of OM (81.3 vs. 80.3 %; $P \leq 0.01$) and tended to have better CIAD of CP (78.0 vs. 75.6 %; $P \leq 0.10$) than piglets fed SBM containing diets. Reducing the APS of the SBM or the FFSB used did not affect nutrient digestibility ($P \geq 0.10$). We conclude that the inclusion of pea protein reduced nutrient digestibility, specially at young ages and that reducing particle size of either soybean meal or full fat soybean below 780 μm did not affect nutrient digestibility.

Key Words: Piglet digestibility, Vegetable protein sources, Particle size

M105 The evaluation of several protein sources on amino acids digestibility in early-weaned pigs. B. J. Min^{*1}, J. H. Cho¹, Y. J. Chen¹, H. J. Kim¹, J. S. Yoo¹, I. H. Kim¹, S. S. Lee², and W. T. Cho², ¹Dankook University, Cheonan, Chung nam, Korea, ²Genebiotech Co. Ltd., Gongju, Chung nam, Korea.

Twenty early-weaned barrows (Yorkshire \times Landrace \times Duroc, 3.98 \pm 0.38kg BW, weaned at 14 d) were used in metabolism trial to evaluate several protein sources on amino acids digestibility. Treatments included 1) SBM (soybean meal), 2) FSP (fermented soy protein), 3) RPC (rice protein concentrate), 4) FM (fish meal) and 5) DSM (dried skim milk). Diets were the protein sources preparations with only vitamins and minerals added as needed to meet or exceed NRC recommendations. Daily feed was provided following equations of $0.05 \times \text{BW}^{0.9}$. In amino acids digestibility, RPC (87.63%) has higher ($P < 0.05$) total essential amino acids (EAA) digestibility than SBM (67.57%) and FSP (64.15%). Also, there were numerical differences among DSM (75.45%), FM (78.56%) and RPC (87.63%) treatments. Total non- EAA and N digestibilities were improved which pigs

fed RPC and FM compared those fed other diets ($P < 0.05$). Also, biological value (BV) in pigs fed RPC diet was 76.30%, compared with 72.20, 66.42, 60.87 and 57.65% for those fed FM, DSM, FSP and SBM diet, respectively ($P < 0.05$). DM digestibility of DSM treatment was the highest value as 61.73% compared with other treatments ($P < 0.05$). Results were showed that RPC, FM has greater AA, N digestibilities than SBM, FSP and DSM.

Key Words: Protein source, Early-weaned pigs, AA digestibility

M106 The effects of fermented soy protein in simple or complex diet on growth performance and amino acids digestibility in weaned pigs. B. J. Min^{*1}, J. H. Cho¹, Y. J. Chen¹, H. J. Kim¹, J. S. Yoo¹, I. H. Kim¹, S. S. Lee², and W. T. Cho², ¹Dankook University, Cheonan, Chungnam, Korea, ²Genebiotech Co. Ltd., Gongju, Chungnam, Korea.

120 weaned pigs(D×Y×L, 5.68±0.80kg average initial BW, weaned at 21 d) were used to evaluate the effect of fermented soy protein in simple or complex diet on growth performance and amino acids digestibility during 30 days. Experimental diets consisted of simple(using soybean meal as protein sources) and complex(using SBM, rice protein concentrate, potato protein concentrate and fish meal as protein sources) diet which contained 0 or 5% fermented soy protein(FSP), respectively. Pigs were provided each experimental diet for 20 days (phase 1) and then, all pigs fed same common diet for 10 days (phase 2). In 0-10 days, pigs fed complex diet gained more than those fed simple diet($P < 0.05$). However, in 10-30 days, ADG was not affected by treatments. In 20-30 days, G/F was higher in pigs fed 5% FSP diet than those fed 0% FSP diet($P < 0.09$). In whole period, growth performance of pigs fed complex diet including 5% FSP was tended to increase without significant differences. Also, including FSP in both diets improved feed efficiency of pigs($P < 0.05$). DM and N digestibilities of pigs fed complex diet was higher than those fed simple diet at 10 d($P < 0.001$). However, there was no effect on N digestibility at 20, 30d. Lysine, methionine and valine digestibilities were greater($P < 0.02$) in pigs fed 5% FSP diet than in those fed 0% FSP diet. Pigs fed only soybean meal as protein source was increased NH₃-N in feces compared with pigs fed 5% FSP in simple diet and 0% FSP in complex diet($P < 0.05$).

Key Words: Fermented soy protein, Simple/complex diet, Growth performance

M107 Optimal lysine level of fermented soy protein diet in weaned pigs. B. J. Min^{*1}, J. H. Cho¹, Y. J. Chen¹, H. J. Kim¹, I. H. Kim¹, S. S. Lee², and W. T. Cho², ¹Dankook University, Cheonan, Chungnam, Korea, ²Genebiotech Co. Ltd., Gongju, Chungnam, Korea.

Twenty weaned barrows(Y×L×D, 6.15±0.45kg BW, weaned at 21 d) were used in metabolism trial to determine optimal Lys concentration of fermented soy protein diet. Pigs were provided 1.2, 1.3, 1.4, and 1.5% Lys concentration diets using 5% fermented soy protein. Through the 14 experimental days, growth performance was not affected by Lys concentrations. In digestibility assays at 7 d and 14 d, DM digestibility was showed quadratic response($P < 0.05$) to the highest in pigs fed 1.4% Lys concentration diet. Total essential amino acids(EAA) digestibility was increased in pigs fed 1.5% Lys compared with other diets(linear effect, $P < 0.001$) at 7 d. Also, Lys digestibility(85.83%) was high with 1.5% Lys than with 1.2, 1.3 or 1.4%(78.57, 80.89, and 82.43%), respectively, linear effect($P < 0.001$). There was linear improving in most amino acids except Ile, Leu, and Phe as increasing Lys concentration. In 14 d, Lys, Met, Thr, Arg and His digestibility were improved

linearly($P < 0.03$) as Lys concentration was increased. However, total EAA digestibility has no statistical difference at 14 d. Biological value of pigs fed higher Lys concentration diet was increased, however, there was no significant difference. BUN concentration in blood was decreased linearly as Lys was increased($P < 0.08$).

Key Words: Fermented soy protein, Lysine level, AA digestibility

M108 Lysine requirement of gilts following a protein restriction from 4 to 8 weeks of age. C. L. Collins^{1,3}, S. X. Fu², R. Hinson², B. J. Leury³, B. G. Tatham¹, G. L. Allee², and F. R. Dunshea^{*1,3}, ¹Department of Primary Industries, Werribee, Victoria, Australia, ²University of Missouri, Columbia, ³University of Melbourne, Parkville, Victoria, Australia.

Compensatory growth responses can be observed following short periods of protein restriction although the degree of compensation can be variable. One reason for this may be differences in the lysine requirement during realimentation. To examine this two hundred and sixteen TR4 x C22 gilts were weighed and allocated to 54 pens of 4 pigs per pen at approximately 30 days of age. Pigs were allocated to one of 6 treatment groups and fed either a corn/soybean diet with adequate nutrients (13.5 g total ileal digestible (TID) lysine/kg) (treatment 1), or a diet restricted in lysine content (10.8 g TID lysine/kg) (treatments 2 to 6) for a 4 week period. During the subsequent 5 weeks, treatments 1 to 6 received diets containing 10, 7, 8.5, 10, 11.5 and 13 g TID lysine/kg, respectively. All treatment groups received a common finisher diet for the final 7 weeks to 141 days of age. Daily gain of the restricted gilts was reduced compared to the controls during the weaner period (504 v's 539 g/d, respectively $P < 0.001$). During the subsequent 5 week realimentation period restricted gilts gained faster on the higher lysine diets (ADG 889, 696, 837, 918, 946, 943 g/day, respectively for treatment 1 to 6, $P < 0.001$). Despite this, post restriction response curves, best described by a quadratic function, estimated that the lysine requirement of the restricted gilts during the 5 week realimentation period was 9.8 g/kg. This lysine requirement was defined as the point at which 95% of the maximum ADG was reached. Final live weights at 141 days of age indicate that there were no differences between the treatments (110.4, 107.0, 108.8, 109.1, 110.8, 110.1 kg respectively $P = 0.307$). These data suggest that although gilts gained faster on a higher lysine diet immediately post restriction, a higher nutrient diet may not be necessary to achieve similar liveweights by 141 days of age.

Supported in part by Australian Pork Limited

Key Words: Pig, Compensatory growth, Dietary lysine

M109 Dietary lysine needs of a lean, late maturing strain of pigs. T. R. Lutz, R. C. Clayton, and T. S. Stahly^{*}, Iowa State University, Ames.

Pigs from a lean, late maturing strain (PIC Camborough x 337) were fed one of four dietary lysine (Lys) regimens from 6 to 30 kg BW. Four littermates in each of twenty litters were weaned (15-19 d), individually penned, fed a 1.74% Lys basal diet until they reached 6-7 kg BW and then randomly allotted within litter to dietary treatment. Pig weights and feed consumption were recorded every 4 days. A fortified basal diet consisting of corn, soybean meal (soy), 15% dried whey, 3% choice white grease containing 1.32, 1.46, 1.60, or 1.74% Lys was fed. As each pig reached a BW of 14 (+/- 1.1) kg, their respective basal was modified (-whey) and dietary Lys level was

lowered by .14 percentage units. Lys concentrations were achieved by altering the ratio of soy to corn. Other amino acids were maintained to provide a minimum of 100% of their ideal ratio to Lys. Pooled over BW of 6 to 14.5 kg, ADG (468, 489, 498, 527 g; $P < .01$) and G:F ratios (744, 788, 830, 859 g/kg; $P < .01$) increased with increasing increments of dietary Lys. From 14.5 to 30 kg BW, ADG and G:F ratios (658, 690, 709, 712 g/kg; $P < .01$) responded quadratically to increasing dietary Lys. As the pigs matured, G:F ratios were lowered, averaging 891, 915, 891, 770, 746, 753, 753, 713, 682, 669 g/kg, respectively, during each of ten consecutive, 2.3 kg incremental increases in pig BW. Based on G:F ratios of pigs during each 4 day period, Lys diets of 1.74, 1.60, 1.46-1.60, 1.32-1.46 and 1.18- 1.32 %, respectively, optimized pig performance from BW of 6-12, 12-14, 14-19, 19-23, and 23-30 kg.

Key Words: Lysine, Late maturing strain, Pigs

M110 Effect of dietary electrolyte balance (dEB) and source in high synthetic amino acid nursery diets. A. M. Gaines¹, B. W. Ratiff¹, B. Hinson^{*1}, G. L. Allee¹, and J. L. Usry², ¹University of Missouri, Columbia, ²Ajinomoto Heartland LLC, Chicago, IL.

A total of 951 (TR-4 × C22; 12.07 ± 0.21 kg) were used to evaluate the effect of dietary electrolyte balance (dEB, calculated as mEq/kg of diet for Na + K – Cl) and source in high synthetic amino acid nursery diets. Pigs were assigned to one of seven dietary treatments in a completely randomized design with 6 replicate pens/treatment. Treatments 1 to 5 consisted of diets with increasing dEB levels (216, 229, 243, 256, and 270 mEq/kg of diet, respectively) achieved through the addition of K as potassium chloride (KCl). To test the effect of dEB source, treatments 6 and 7 consisted of diets with dEB levels of 229 and 243 mEq/kg of diet, respectively achieved through addition of Na as sodium bicarbonate (NaHCO₃). All diets were corn soybean meal based (0.325% L-Lysine HCl) and formulated to be isocaloric (3.82 g TID lysine/Mcal ME). Both Na and Cl concentrations were held constant in all diets through alterations in sodium chloride (NaCl) or NaHCO₃ addition. Increasing dEB level through the addition of K did not improve ADG (Linear, $P < 0.90$; Quadratic, $P < 0.57$), ADFI (Linear, $P < 0.72$; Quadratic, $P < 0.08$) or G:F (Linear, $P < 0.77$; Quadratic, $P < 0.13$). Furthermore, increasing the dEB level through the addition of Na vs. K did not improve ADG ($P < 0.46$), ADFI ($P < 0.23$), or G:F ($P < 0.51$). These data indicate that growth performance of nursery pigs fed high levels of synthetic amino acids were not affected by dEB.

Key Words: Electrolytes, Pigs, Growth

M111 Efficacy of methionine hydroxy analog free acid relative to DL-methionine in growing pigs. F. O. Opapeju^{*1}, C. M. Nyachoti¹, M. Rademacher², and G. H. Crow¹, ¹University of Manitoba, Winnipeg, MB, Canada, ²Degussa AG, 63457 Hanau-Wolfgang, Germany.

A metabolism study was conducted to evaluate the effectiveness of methionine hydroxy analog free acid (MHA-FA, 88%) relative to DL-methionine (DLM, 99%) as a methionine source for pigs. Forty-two Cotswold barrows with an average initial BW of 9 ± 0.52 kg (mean ± SE) were obtained in two blocks of 21 pigs each. Pigs were randomly assigned from within block to 7 dietary treatments resulting in 7 replicate pigs per diet. Diet 1, basal diet (BD), was a corn-soybean meal diet and formulated to contain 15.54% CP and 0.21% methionine. Diets 2, 3 and 4 were BD supplemented with 0.034%, 0.068%, and

0.102% MHA-FA, respectively, on an equi-molar basis to the DLM. Diets 5, 6, and 7 were BD supplemented with 0.03%, 0.06%, and 0.09% DLM, respectively. The pigs were housed individually in metabolism crates that allowed for separate but total collection of urine and feces. Pigs had unlimited access to feed and water, and were allowed to adapt to the metabolism crates, feeding regimen and experimental diets for 7 d followed by quantitative collection of feces and urine over the subsequent 5 d. Urinary N (%) declined linearly with increasing supplementation of BD with DLM ($P = 0.003$) and MHA-FA ($P = 0.01$). There were quadratic ($P = 0.009$) and cubic ($P = 0.021$) effects of MHA-FA supplementation to BD on fecal N (%) output but no such effect was observed for DLM. There was a linear response in N retained (g/d) with increasing supplementation of BD with DLM ($P = 0.004$) and MHA-FA ($P = 0.025$). The results indicate that the supplementation of methionine deficient diet with either MHA-FA or DLM improved N retention. Determined with multiple linear regression analysis, the bioavailability of MHA-FA relative to DLM was estimated to be 65.8% (product to product comparison, wt/wt basis) or 74.8% (equi-molar basis) using N retention as a response criterion.

Key Words: DL-Methionine, Methionine hydroxy analog, Pigs

M112 Proteomic evaluation of brush border proteins in pig small intestine. X. Xiao, P. M. Williams, E. A. Wong, and K. E. Webb, Jr. *, Virginia Tech, Blacksburg.

Despite understanding much about intestinal function in pigs, factors governing intestinal development in pigs are poorly understood. A novel approach to studying intestinal development is the use of proteomics, which is the study of the complete set of translated proteins in a given biological sample. Piglets from each of seven sows were killed at birth (d 0) and during lactation (d 7 and 21). The jejunum was collected and the mucosa was gently scraped off with glass slides. Samples of the seven pigs from an age group were pooled and a brush border membrane (BBM) fraction was prepared and used in two-dimensional PAGE analysis. Triplicate proteome maps of BBM proteins from each age were constructed. A total of 733 individual protein spots were observed and densities of these were compared among the three age groups. Densities of 60 spots decreased three to 50-fold from d 0 to d 21. Density of 48 spots increased three to 114-fold from d 0 to d 21. Twenty six spots were observed at d 21 but not at d 0. To identify selected developmentally regulated proteins, 134 spots were excised from gels and identified by LC-MS/MS analysis. Most spots contained a single protein, but some contained more than one. Among the identified proteins, some were structural in function (i.e., beta actin, beta tubulin, and myosin), some were enzymes (i.e., lactase-phlorizin hydrolase, leucine aminopeptidase, neutral endopeptidase, sucrase isomaltase, and aminopeptidase N) and some had other functions (i.e., procadherin alpha 3, lactose binding protein, elongation factor Tu, calcium and integrin binding protein 1, and apolipoprotein A). Interestingly, there were seven forms of aminopeptidase N ranging in size from 40.2 to 112.3 kD. Three had the same MW of 112.3 but different pI (6.6, 6.7 and 8.3) suggesting differences in post translational modifications. Of particular interest was that there were at least 21 proteins, which are unnamed. Proteomic approaches to studying BBM development offer virtually unlimited discovery potential.

Key Words: Proteomics, Gene expression, Development

M113 Effect of probiotics supplementation on growth performance and intestinal microbiology in weaning pigs. H. J. Jung*, J. C. Park, Y. H. Kim, H. K. Moon, I. C. Kim, and S. J. Lee, *National Livestock Research Institute, RDA, Cheonan, Korea.*

This study was conducted to investigate the effects of probiotics on growth performance, hematological change and intestinal flora in weaning pigs. A total of 72 pigs (Landrace) with an average initial body weight of 6.79 ± 0.08 kg were used in this 6 week experiment. Pigs were allotted to three treatments (six replicates per treatment and four pigs per pen) according to a randomized complete block design. Dietary treatments were : 1) NC (negative control; basal diet), 2) PC (positive control diet; NC diet + 0.1% antibiotics, Avilamycin), 3) PRO (Control diet + 0.2% probiotics). During 0–2 weeks, ADG increased significantly in PRO treatment compared to NC and PC treatments ($P < 0.05$). In 3–6 weeks, ADG was increased slightly in PRO treatment without significant difference ($P > 0.05$). However, ADFI and gain/feed were not affected by treatments. Blood urea Nitrogen, albumin and total protein concentration of serum were not affected by pigs fed diets with probiotics ($P > 0.05$). In Lactobacilli concentration of intestine, pigs fed probiotics supplementation diets tended to be increase compare to the NC and PC diets ($P > 0.05$). Supplementation of probiotics in diet decreased *E. Coli* concentration ($P < 0.05$). In conclusion, dietary probiotics tended to increase growth performance, Lactobacilli concentration compared to the pigs fed the NC and PC diets.

Key Words: Probiotics, Growth performance, Weaning pigs

M114 Growth performance of pigs fed diets supplemented with an ammoniated formic acid (FA) solution. A. F. Harper*¹, M. J. Estienne¹, and H. Miettinen², ¹*Virginia Polytechnic Institute and State University, Blacksburg,* ²*Kemira Oyj, Helsinki, Finland.*

Crossbred weaning pigs ($n = 120$, 19 ± 3 d of age) were used to assess the growth response to dietary inclusion of FA (62 % formic acid, 37 % ammonium formate). Based on weaning weight and ancestry, pigs were assigned to blocks consisting of three pens of five barrows each and three pens of five gilts each (four total blocks). Within block and sex, pens were randomly assigned to receive the following dietary treatments: 1) control diet during the nursery period (d 1 to 36) and control diet during the growing-finishing period, 2) control diet during the nursery period and 0.8 % FA during the growing-finishing period, or 3) 1 % FA during the nursery period and 0.8 % FA during the growing-finishing period. Thus, there were a total of four gilt pens and four barrow pens per treatment. Pigs were weighed off-study as intact blocks at approximately 116 kg BW. Diets were un-medicated and fed in two formulation phases during the nursery period and four formulation phases during the grower-finisher period. Feed and water were available ad libitum. Health of the pigs was excellent with no mortality and no pigs removed for veterinary reasons. During the nursery period there was no sex effect on ADG, ADFI or G:F ($P > 0.24$). There were no effects of diet on ADG or ADFI ($P > 0.13$), however, a trend ($P = 0.064$) for improved feed efficiency with FA was observed with control pigs having G:F of 0.627 ± 0.008 compared to 0.643 ± 0.008 for the FA-supplemented pigs. For the nursery and grower-finisher periods combined, barrows had greater ADFI and ADG than gilts ($P < 0.003$) with no difference in G:F ($P = 0.19$). There was no effect of dietary treatment on ADG, ADFI or G:F ($P > 0.51$) and no sex by diet interaction ($P > 0.63$). Under the conditions of this study, supplementing FA showed a trend for improved feed efficiency during the nursery period but did not influence overall performance from weaning to market weight.

Key Words: Pigs, Ammoniated formic acid, Growth

M115 Effect of inorganic acids on growth performance and health status in piglets. D. T. Liem¹, C. Lückstädt², and G. Schatzmayr*³, ¹*University of Agriculture and Forestry, Ho Chi Minh City, Vietnam,* ²*Biomim Deutschland GmbH, Zell u. A., Germany,* ³*Biomim GmbH, Herzogenburg, Austria.*

At weaning pigs are exposed to physiological and environmental stress, which often results in reduced feed intake and little or no weight gain. During the last few decades, diets for weaning piglets have been boosted with various antibiotics in prophylactic doses against gastrointestinal disorders in order to obtain the economic benefits in terms of improved growth rates (4 to 15%) and feed efficiency (2 to 6%; Mroz, 2003). However, in recent years there has been growing public concern about the use of antibiotics in animal agriculture and the risk of developing cross-resistance of pathogens to antibiotics used in human therapy. This has prompted the pig industry to look for alternatives to antibiotic growth promoters that will give similar pig performance. The objective of this study was to evaluate the potential of inorganic acids as alternatives to antibiotic growth promoters (AGP's) in nursery pig diets in order to see their the efficacy on BW, diarrhea and resistance to illness of piglets. The trial was conducted in a commercial pig farm in Vietnam. The aim of the trial was to test the acidifier Biotronic P (2 kg per t of feed) against a commercial piglet diet containing no acidifying additive. Feed and water were available ad libitum. 120 piglets (Yorkshire x Landrace x Duroc hybrid) at 25 d old were randomly selected and divided into 2 treatment groups. Piglets were housed in individual weaner cages (4 m x 3 m x 0.6 m) over a 28 d trial period. Performance data were measured on a weekly basis. Piglets in the treated group weighed 15.63 kg compared to 14.15 kg in the negative control group and the final BW and ADG of 43 day old piglets differed highly significantly ($p < 0.001$). The G:F was improved by 6% (0.69 and 0.65 for treatment and control respectively) and this increase was again statistically significant ($p < 0.05$). Finally, the daily diarrhea rate was improved and differed highly significantly at $p < 0.001$ (1.11% and 2.83% for treatment and control respectively). It can be concluded that the use of the inorganic acidifier Biotronic P improved significantly performance data and health status of treated piglets under Vietnamese conditions.

Key Words: Acidifier, Piglet growth, Diarrhea

M116 Impact of various dietary cereals on clinical response to *E. coli*. J. Buckingham¹, F. Ji*², P. J. Laski², and J. E. Pettigrew², ¹*QAF Meat Industries Pty Ltd.,* ²*University of Illinois, Urbana.*

Two experiments were conducted to determine the impact of cereals on clinical response to *E. coli*. Pigs weaned at about 21 days of age were housed in disease containment chambers with 3 pigs/chamber and given ad libitum access to feed and water throughout the experiments. Rectal temperature (RT) and subjective fecal diarrhea score (DS, 5-point scale: 0 = normal; 1 = mild diarrhea; 2 = medium; 3 = severe; 4 = watery) were measured. A pathogenic *E. coli* (K88+) derived from a field outbreak was orally inoculated once after adaptation to the chambers at a dose of 2×10^9 CFU/pig, near the range shown in a preliminary experiment to produce mild clinical signs. In each experiment, 48 pigs were randomly allotted into 8 treatments in a 4×2 factorial arrangement, with 2 chambers of 3 pigs per treatment. Type of cereal (corn, barley, rolled oats, and rice) and *E. coli* challenge (yes or no) were the main factors. In Exp. 1, diarrhea due to *E. coli* occurred during the adaptation period, so the pigs were not given the challenge dose; RT was measured at 0 and 120 h and DS at 0, 24, 48, 72, 96, and 120 h from the start of measurements after the confirmation

of clinical signs. In Exp. 2, the same 4 cereal treatments were imposed; RT and DS were measured at 0, 24, 48, 72, 96, 120, 144, 168, and 192 h after challenge. In Exp. 1, the RT was not affected ($P = 0.45$) by cereals. Pigs fed corn had higher DS ($P < 0.01$) than others (1.81, 0.65, 1.17, 0.88, SEM = 0.22, for corn, barley, rolled oats, and rice, respectively). In Exp. 2, there were no differences among diets and no diet by challenge interactions, but there were complex interactions ($P < 0.01$) of challenge with time in both RT and DS and diet with time in RT. Overall values were for RT (mean = 39.68, SEM = 0.02) and DS (mean = 1.16, SEM = 0.06). The mild *E. coli* challenge did not affect RT but increased DS (0.91 vs. 1.41; $P < 0.01$). In summary, these results suggest that cereal may influence resistance to enteric disease, but further research is needed to evaluate this finding.

Key Words: Cereals, *E. coli* Challenge, Nursery pigs

M117 Efficacy of a mannan oligosaccharide and antimicrobial on the gastrointestinal microbiota of young pigs. J. C. Miguel*, P. J. Laski, and J. E. Pettigrew, *University of Illinois at Urbana-Champaign, Urbana.*

An experiment was conducted to evaluate the effects of a mannan oligosaccharide product (MOS) and antimicrobial (carbadox) on the gastrointestinal microbiota of young pigs. Twenty-four pigs were weaned at 21.2 d and 5.95 kg BW and randomly allocated to one of four dietary treatments arranged in a 2 x 2 factorial, with the factors being 0.2% MOS and 55 ppm carbadox. Twelve pigs, representing 3 pigs per treatment, were euthanized at either 7 or 21 d post-wean. Luminal contents and mucosal scrapings were collected from the pars esophagea, fundus, jejunum, ileum, proximal colon and distal colon for genomic DNA isolation. The variable region 3 (V3) of 16S rDNA was amplified by PCR and denaturing gradient gel electrophoresis (DGGE) was utilized to generate microbial profiles. An evaluation of the PCR-DGGE band numbers, with each band representing one or more microbial species, indicated there was a stronger effect of carbadox at 7 d post-wean seen as an increase ($P < 0.05$) in the number of bands in the luminal contents of the proximal segments of the gastrointestinal tract. At 21 d post-wean, MOS had an opposite effect of decreasing ($P < 0.05$) the number of bands in both the luminal contents and mucosa throughout the gastrointestinal tract. At both 7 and 21 d post-wean, the Sorenson's pairwise similarity coefficients (C_s), a measure of microbial diversity among samples according to PCR-DGGE banding patterns, revealed there was more similarity ($P < 0.05$) in the gastrointestinal microbiota of pigs within compared to between diets indicating treatment-dependent alterations. Gastrointestinal microbiota analysis revealed that carbadox, in the absence or presence of MOS, made pigs more similar (higher C_s) to each other during the first 7 d post-wean. This same effect was not seen at 21 d post-wean, in that pigs fed MOS, in the absence or presence of carbadox, were more similar (higher C_s) to each other. These observations suggest that both MOS and carbadox alter microbiota in the gastrointestinal tract of young pigs.

Key Words: Pigs, Gastrointestinal microbiota, 16S rDNA PCR-DGGE

M118 Evaluation of three mannanoligosaccharide products in swine nursery diets. H. Yang¹, T. Shipp^{*2}, J. Less³, T. Radke¹, and M. Cecava¹, ¹ADM Animal Nutrition, Quincy, IL, ²ADM Animal Health and Nutrition, Quincy, IL, ³ADM Specialty Feed Ingredients, Decatur, IL.

Two 42-d studies were conducted to evaluate the effect of three mannanoligosaccharide (MOS) products on nursery pig performance. Weaning pigs (n=180; BW=3.93 ± 0.20 kg in Exp1 and n=150; BW=4.66 ± 0.20 kg in Exp2) were blocked by initial BW to one of five dietary treatments (trt), with six pens per trt and five or six pigs per pen. Exp1 trts were: control (NC; no MOS); NC + commercial MOS (PC); and 0.2, 0.4, or 0.8% of test MOS (CitriStim). PC diets contained 0.2, 0.2, 0.1 and 0.1% commercial MOS for phase (P) 1-4, respectively. Exp2 trts were: control (C; no MOS); C+0.2 or 0.4% drum-dried MOS (DDM); and C+ either 0.2% spray-dried test MOS (CitriStim; CS) for all P (CS1) or 0.2, 0.2, 0.1 and 0.1% CS for P1-4, respectively (CS2). ADG, ADFI and G:F were measured at end of each P (d 7, 14, 28, and 42). Feeds were pelleted in P1 & P2 and meal thereafter, and all diets changed with phase. Exp1 ADG, ADFI and G:F were similar for NC and PC ($P > 0.13$). Increasing test MOS from 0.0 to 0.8% did not affect ADG or ADFI (data not shown; $P > 0.13$), but tended to cubically affect G:F (0.636, 0.648, 0.630, 0.636; $P = 0.13$), suggesting 0.2% test MOS as the optimal inclusion level. In Exp2, increasing DDM from 0.0 to 0.4% did not affect ADG or ADFI ($P > 0.10$), but tended to improve G:F (quadratic effect; $P = 0.09$). Statistical contrasts revealed that the mean ADG and ADFI ($P < 0.01$) and G:F ($P = 0.09$) of the pigs fed CS1 and CS2 were greater than for pigs fed no MOS, and were 1.69 kg heavier at the end of the study. In summary, test MOS improved performance of nursery pigs.

Table 1.

Exp2	CS						P value		
	Con	DDM	CS1	CS2	SE	DDM	Con	CS	
% MOS	0.0	0.2	0.4	.2/.2/.2/.2	.2/.2/.1/.1	Lin	Quad	v CS	
ADG, g (d 0 to 42)	438	452	448	470	473	8	0.37	0.37	0.003
ADFI, g (d 0 to 42)	592	604	606	630	630	11	0.36	0.72	0.010
G:F (d 0 to 42)	0.740	0.749	0.740	0.747	0.751	0.004	0.99	0.09	0.093
End Weight, kg	22.89	23.59	23.46	24.47	24.68	0.38	0.30	0.38	0.002

Key Words: Pigs, Mannanoligosaccharide, DFM

M119 Growth performance of nursery pigs fed different cereal grains on a commercial farm. V. G. Perez-Mendoza*¹, M. U. Steidinger², G. R. Hollis¹, and J. E. Pettigrew¹, ¹University of Illinois, Urbana-Champaign, ²Swine Nutrition Services Inc, Anchor, IL.

Variation among cereal grains in carbohydrate composition may affect bacterial populations in the gut, which may in turn alter growth performance and resistance to enteric infection. This experiment was conducted on a commercial farm to test whether corn, barley, rolled oats, or rice as the main energy source in the diet for newly weaned pigs affects growth performance. The experiment was a RCBD; pigs were blocked by weight and room (3 wt categories and 4 rooms). Pens were experimental units with 21 pigs 20 d old; gender distribution always was equal within blocks. There were 12 replicates per treatment,

a total of 1008 pigs. There was a 4-stage feeding program with decreasing diet complexity: 1, 1, 2 and 2 wk per phase. Calculated ME value for all phases was 3.5 Mcal/kg; SID Lys was per phase: 1.45%, 1.45%, 1.30%, and 1.15%. Amounts of soybean meal and soybean oil were varied to meet the ME and SID Lys targets. Diets for phases 1 and 2 were in mini-pellet form; those for phases 3 and 4 were in meal form. The rice diets were low in fat and difficult to pellet, and may have been heat-damaged. During the first week pigs fed corn or rolled oats ate more and grew faster (Table). Over the 6-wk period, pigs fed rice or corn grew fastest. Gain:Feed ratio was not different among treatments ($P>0.20$). Pigs removed, including mortality, was lowest (3.6%) for barley and rice. These results show significant differences among dietary cereals, with rice and corn supporting the fastest growth under these conditions.

Table 1. Growth performance of nursery pigs fed different cereal grains

	Corn	Barley	Rolled oats	Rice	SEM
ADG, wk 1, g	124.7 ^a	102.1 ^b	116.5 ^a	98.2 ^b	5.0
ADFI, wk 1, g	145.5 ^a	126.7 ^b	139.4 ^a	120.2 ^b	4.1
ADG, overall, g	330.5 ^{ab}	307.0 ^c	322.7 ^b	336.7 ^a	4.6
ADFI, overall, g	495.2 ^a	462.0 ^b	488.6 ^a	503.6 ^a	7.9
Pig removals, %	7.1 ^{ab}	3.6 ^b	8.3 ^a	3.6 ^b	1.5

^{abc} Means within a row without a common superscript differ ($P < 0.05$)

Key Words: Cereals, Weaned pig, Growth performance

M120 Glycemic index in young pigs fed rice or corn either raw or cooked. B. Vicente, D. G. Valencia, J. M. González, D. Menoyo, R. Lázaro, and G. G. Mateos*, *Universidad Politécnica de Madrid, Spain.*

The glycemic index (GI) is useful to rank carbohydrates in humans according to their postprandial blood glucose responses. A low GI of a meal indicates a high level of satiety. Starch structure, heat processing of the cereal (HP), and degree of starch gelatinization (SG) have been shown to affect GI values of cereals in humans but no data is available for pigs. We conducted a trial to study the influence of cereal source, HP of the cereal, and degree of SG of rice on the GI in young pigs. There were four experimental diets and seven replicates (individual pig) per diet. The control diet was a complex diet that included fish meal, soybean meal, and 50% raw corn. The experimental diets were similar to the control diet but the raw corn was substituted by HP corn, raw rice, or HP rice. The percentage of SG was 15% for raw corn, 83.6% for HP corn, 15% for raw rice, and 63.7% for HP rice. Predicted GI of the experimental diets was determined using the International Tables of GI values (2002) and was higher for piglets fed rice than for piglets fed corn. Also, the predicted GI of the cereals increased with HP. The GI was determined *in vivo* at 33 d and 49 d of age using glucose as reference food. Piglets were fasted for 12 h and then, they were fed their experimental meals that contained approximately 50g of available carbohydrates. Pigs were sampled (capillary blood) at 0, 20, 60, 120, and 180 min after feeding to obtain the glucose curves. The GI was calculated by expressing the incremental blood glucose area in the test sample as a percentage of the corresponding area from a reference standard food. GI was higher for pigs fed rice than for pigs fed corn (48.1 vs. 43.3%; $P<0.001$). Heat processing of the cereal also increases GI values (51.2 vs. 40.2%; $P<0.001$). Results of this

study indicate that rice feeding increases the GI with respect to corn feeding and that HP of the cereal also increases the GI. These data might explain, at least in a part, the increase in feed intake observed when rice is fed to piglets in substitution of corn.

Key Words: Rice, Glycemic index, Starch gelatinization

M121 Development of a model to determine preferences for feed ingredients in young pigs. E. van Heugten*¹, K. Ange-van Heugten¹, W. Zhang¹, and E. Roura², ¹*North Carolina State University, Raleigh,* ²*Lucta SA, Barcelona, Spain.*

The objective of this study was to develop a model in young pigs to evaluate preferences for feed ingredients. Twenty-two pigs (BW = 8.33 ± 0.10 kg) were adjusted to solid feed (corn-soybean meal based) for 21 d and subsequently housed one pig per pen. Each pen contained two identical feeders, positioned side-by-side. During the first four d, pigs were offered one of two complete diets with either corn or rice as the major grain source (60% of the diet) in both feeders. Diets were identical with the exception of grain source and grains were ground through the same screen. Thus, pigs were not offered a choice and this period served to determine potential side preferences (i.e., the left versus the right feeder) and to determine whether previous exposure to grains had an effect on subsequent preference when offered a choice. Following this initial period, pigs were offered the rice-based diet (Rice) in one feeder and the corn-based diet (Corn) in the other feeder. Pigs were allowed to consume feed freely from either feeder for 72 h and feed disappearance was measured every 24 h. Pigs consumed 249 g/d from the left feeder and 329 g/d from the right feeder ($P = 0.22$) during the four-day period when no choice was offered. Total consumption of Rice (556 g/d) was not different ($P = 0.34$) from Corn (600 g/d) during the pretest period. When offered a choice, pigs clearly preferred Rice compared to Corn on d 1 (489 vs. 248 g/d; $P = 0.02$), d 2 (589 vs. 155 g/d; $P < 0.001$), d 3 (680 vs. 132 g/d; $P < 0.001$), and overall (586 vs. 178 g/d; $P < 0.001$). Preference was impacted by prior exposure only on d 1 ($P = 0.02$). Pigs previously exposed to Corn highly preferred Rice (623 vs. 159 g/d; $P < 0.001$), but pigs previously exposed to Rice did not demonstrate a preference (336 vs. 355 g/d; $P = 0.75$). Results of this study demonstrate that prior exposure will impact preferences briefly and that two d is adequate for determining preferences for ingredients and flavors in future studies.

Key Words: Pigs, Preference, Feedstuffs

M122 Effects of diet type and an artificial high intensity sweetener (SUCRAM®) on weaned piglet performances. P. Schlegel*¹ and R. Hall², ¹*Pancosma S.A., Le Grand-Saconnex, Geneva, Switzerland,* ²*Cooperative Research Farms, Richmond, VA.*

Three hundred sixty crossbred (PIC; Cambrough 22 X 337 and Primer combination) 18-d old weaned piglets, were blocked on the basis of initial BW and gender and allotted to 36 pens in a randomized complete-block design. The 2x3 factorial arranged treatments consisted of three types of diets (iso-energetic, iso-lysine iso-vitamin and iso-mineral) varying in their formulation complexity for feeding phase 1 (d 0 to 11) and 2 (d 11 to 25) and in the inclusion or not of a sweetener SUC (SUCRAM®; Pancosma S.A.) for feeding phases 1 through 3 (d 0 to 46). Diet complexity (High, Medium, Low) was varied by modifying levels of dried whey, cheese by-products, fish meal, spray-dried porcine plasma and dried red blood cells. Medium was considered as representative to common U.S. nursery formulations.

SUC was included in phases 1 to 3 at 500, 250 and 130 g/ton FM respectively. All diets were fed ad-libitum. Diet complexity effect: ADFI and ADG were increased ($p < 0.001$) using High compared to Medium and Low during phase 1, 2 and overall (769 vs. 690 and 710 g/d, respectively for overall ADFI and 540 vs. 486 and 501 g/d respectively for overall ADG). SUC effect: ADFI and ADG were increased ($p < 0.05$) using SUC during phase 2 (ADFI by + 7.6% and ADG by + 8.9%), 3 (ADFI by + 4.2% and ADG by + 6.1%) and overall (ADFI by + 3.7% and ADG by + 5.5%). Overall FCR was improved ($p < 0.01$) using SUC by -1.6% (1.429 vs. 1.406). Diet complexity*SUC effect: No interactions ($p > 0.05$) between the two factors were observed for ADFI, ADG or FCR during any feeding phase nor overall. Finally, the improved ADFI and ADG of High and SUC were independent from each other. Sweetening the piglet diets with SUCRAM[®] permitted to improve feed intake, weight gain and feed conversion ratio for the whole post-weaning period.

Key Words: Piglet, Sweetener, Diet

M123 Adding a milky flavor in drinking water and an enhanced milky flavor in feed improves piglet growth compared to the use of no flavor or a sweetener. E. Roura^{*1}, J. Coma², and D. Torrallardona³, ¹*Lucta SA, Barcelona, Spain*, ²*Vall Companys, Lleida, Spain*, ³*IRTA, Centre Mas Bové, Reus, Spain*.

The effects of adding a high intensity sweetener (HIS) to feed and of the combination of adding a milky flavor (MF) in drinking water and in feed on the performance of weanling pigs were investigated. One hundred and twenty newly weaned 26 d-old pigs (Landrace x Pietrain) in 24 pens of 5 animals each were used. The animals were offered free access to 4 experimental diets consisting of a basal diet (T-1) and the same diet with three different flavour preparations: HIS (T-2), MF (T-3) and the same MF enhanced with an orosensorial supplement (T-4). The composition of the basal diet changed from a pre-starter to a starter specification on day 13 of trial. Additionally, the animals from each experimental treatment had free access to different water supplies that in the case of treatments T-3 and T-4 contained the same MF up to d 22 of trial. For the first 4 d after weaning the animals on T-4 had a higher ($P < 0.05$) ADFI than those on T-2 (90 vs 41 g/d). For the whole pre-starter phase, the animals on T-3 and T-4 also had a better ($P < 0.05$) G:F ratio than those on T-2 (0.484 and 0.532 vs 0.303 g/g, respectively). During the starter phase, the animals on T-2 and T-4 had a higher ($P < 0.05$) ADFI than those on T-3 (698 and 682 vs 586 g/d, respectively). Overall the 28 day trial, the animals on T-4 had a higher ($P < 0.05$) ADFI than those on T-3 (463 vs. 394 g/d) while T-1 and T-2 were intermediate (435 and 449 g/d). Final average body weights at the end of the trial were 17.43, 16.79, 16.65 and 16.06 kg for animals on T-4, T-2, T-1 and T-3 respectively. It is concluded that, treatment with a HIS may reduce ADFI during the pre-starter phase. The addition of a milky flavour in the drinking water after weaning together with an enhanced milky flavour in the feed improved ADFI and G:F in the pre-starter phase as well as ADFI in the overall experiment resulting in apparently heavier piglets.

Key Words: Feed and water intake, Piglet weaning, Flavor

M124 The use of an enhanced milky flavor but not of standard flavors in feed improves growth of pigs at weaning compared to a non-flavored control feed. E. Roura^{*1}, L. Levrouw², D. Solà-Oriol³, and D. Torrallardona³, ¹*Lucta SA, Barcelona, Spain*, ²*DSM, Nutritional Products NV, Belgium*, ³*IRTA, Centre Mas Bové, Reus, Spain*.

The effect of adding an enhanced milky flavor to a post-weaning feeding program combined with a standard milky flavor in drinking water on piglet performance was investigated. Ninety-six newly weaned 26 d-old pigs (Landrace x Pietrain), in 24 pens of 4 animals each, were used. The animals were offered free access to 4 diets consisting of a basal diet (T-1) and the same diet with three different flavor preparations: red fruit (T-2), standard milky (T-3) and milky flavor enhanced with an orosensorial supplement (T-4). The composition of the basal diet changed from a pre-starter to a starter formula at d 13 of trial. Additionally, the animals from each experimental treatment had free access to different water supplies that in the case of treatments T-3 and T-4 contained a milky flavour for the first 13 d of trial. During the pre-starter phase, the animals on T-4 grew faster ($P < 0.05$) than those on T-1 and T-2 (145 vs. 104 and 97 g/d, respectively) although not significantly different from T-3 (108 g/d). Despite not being significantly different ($P > 0.05$), the animals on T-4 maintained the highest ADG during the starter phase and throughout the whole experimental period. Thus, at the end of the trial (28 d), piglets on T-4 achieved an ADG of 300 g/d, which was 10.7%, 17.6% and 12.3% higher than T-1, T-2 and T-3, respectively. It is concluded that the addition of a milky flavour in the drinking water after weaning together with a milky enhanced flavour in the pre-starter and starter feeds improves performance of weanling pigs. The enhancement of a standard milky flavor with an orosensorial supplement was highly effective particularly during the pre-starter phase.

Key Words: Feed and water intake, Piglet weaning, Flavor

M125 Effects of dietary delta-aminolevulinic acid and chitoooligosaccharide on growth performance, nutrient digestibility and hematological characteristics in weanling pigs. Y. J. Chen^{*1}, B. J. Min¹, J. H. Cho¹, H. J. Kim¹, J. S. Yoo¹, J. D. Kim³, D. K. Kang¹, H. R. Kim², and I. H. Kim¹, ¹*Dankook University, Cheonan, Chungnam, Korea*, ²*Pukyong, Busan, Korea*, ³*CJ Feed Co., Incheon, Korea*.

The influence of feeding delta-aminolevulinic acid (ALA) and chitoooligosaccharide (COS) on growth performance, nutrient digestibility and hematological characteristics in weanling pigs was investigated in a 5 wk experiment. A total of 105 pigs (BW of 4.94±0.73 kg) were allotted to seven dietary treatments in three replications (five pigs per pen) in a randomized complete block design. Pigs were fed diets in two phases corresponding to wk 0-2 and 3-5 with all nutrients met or exceeded NRC (1998) recommendations. Seven experimental diets were formulated as follow: 1) NC (Control diet), 2) PC (NC + antibiotic 0.1%; Chlortetracycline+Sulfathiazole+Penicillin), 3) ALA (NC + ALA 3 ppm), 4) COS (NC + COS 0.1%), 5) AC1 (NC + ALA 1 ppm and COS 0.1%), 6) AC2 (NC + ALA 3 ppm and COS 0.3%) and 7) AC3 (NC + ALA 5 ppm and COS 0.5%). Feed and water were provided ad libitum during all experimental period. No effects were observed in ADG and ADFI during wk 0-2, 3-5 and all experimental periods ($P > 0.05$). The G:F was improved in ALA and AC3 treatments compared with NC and AC1 treatments over the entire experimental period ($P < 0.05$). DM digestibility was higher in AC3 treatment than

NC and AC1 treatments ($P < 0.05$). N digestibility was higher in both PC and AC3 treatments compared with NC and AC1 treatments ($P < 0.05$). The RBC count was increased in ALA treatment compared with NC treatments ($P < 0.05$). Hemoglobin in AC2 treatment was higher than NC treatment ($P < 0.05$). Lymphocyte, WBC, IgG and total iron binding capacity were not affected among all treatments ($P < 0.05$). The reduction of total protein was higher in NC treatment than PC, ALA, COS and AC3 treatments ($P < 0.05$). Iron concentration was higher in ALA and all of the AC treatments than NC treatment ($P < 0.05$). In conclusion, supplementation of 3 ppm ALA or 5 ppm ALA with 0.5% COS may have beneficial effects on weanling pig.

Key Words: Delta-Aminolevulinic acid, Chitoooligosaccharide, Weanling pigs

M126 Dietary supplementation with the Chinese herb improves growth performance and tissue integrity in weanling piglets. F. G. Yin¹, X. F. Kong¹, Y. L. Yin^{*1}, H. J. Liu¹, Y. P. Liao¹, and G. Y. Wu^{1,2}, ¹*Institute of Subtropical Agriculture, The Chinese Academy of Sciences, Changsha, Hunan, P.R. China,* ²*Texas A&M University, College Station.*

The experiment was conducted to determine the effects of dietary supplementation with the Chinese herb on growth performance, diarrhea incidents, serum biochemical parameters, and tissue integrity in weanling piglets. Sixty pigs were weaned at 21 days of age, housed individually and assigned randomly into one of three treatment groups (20 pigs/group), representing the corn- and soybean meal-based diets

supplemented with 0 (control) or 0.2% Chinese herb or 0.02% Colistin (an antibiotic). The genus and species of the herbs used in the study were *Astragalus membranaceus* (Fisch.) Bge. var. *mongholicus* (Bge) *hsiao*; *Acanthopanax senticosus* (Rupr. Et Maxim) Harms; *Codonopsis pilosula* (Franch.) Nann.; *Crataegus pinnatifida* Bge.; and *Salvia miltiorrhiza* Bge. Pigs had free access to diets and drinking water. Feed intake and BW were measured weekly. Blood samples were obtained randomly from 5 piglets of each treatment group at wks 1, 2, 3, and 4 post-weaning. Results indicated that dietary supplementation with the Chinese herb for 4 wks increased ($P < 0.05$) ADG by 18.8% (432.1 vs 363.8 g), did not affect ($P > 0.05$) F:G (1.57 vs 1.62), and reduced ($P < 0.05$) diarrhea incidence by 40% in piglets, when compared with the control group. Dietary supplementation with Colistin did not affect ($P > 0.05$) ADG (385.9 vs 363.8 g) and had no effect ($P > 0.05$) on F:G (1.67 vs 1.62). At wk 1, serum concentrations of triglycerides in the herb-supplemented piglets were lower ($P < 0.05$) than those in the control group. At wk 2, the activity of serum creatine kinase (an indicator of tissue integrity) was lower ($P < 0.05$) in the herb-supplemented piglets in comparison with the other two groups. At wk 4, the activity of stomach amylase in the herb-supplemented piglets was higher ($P < 0.05$) than in the control and Colistin-supplemented piglets. These findings suggest that the Chinese herbal formula is a highly effective and safe feed additive for improving growth performance, preventing diarrhea, and protecting tissue integrity in weanling piglets. Supported by funds from the Chinese Academy of Sciences and China NSF.

Key Words: Growth performance, Chinese herb, Pigs

Physiology and Endocrinology: Estrous Synchronization

M127 Post-AI interventions in lactating dairy cattle. I. Ovarian responses to GnRH, hCG, and exogenous progesterone (CIDR). J. S. Stevenson*, D. E. Tenhouse, M. A. Portaluppi, and A. Lloyd, *Kansas State University, Manhattan.*

We hypothesized that increasing concentrations of progesterone (P4) after AI would increase fertility. Our objective was to assess changes in ovarian structures and ovulation rate in response to GnRH, hCG, or exogenous progesterone (CIDR insert) beginning 4 to 8 d after AI (d 0) and again 7 d later (d 7). Blood was collected from 749 cows in 3 herds on d 0 and 7. Ovaries of 161 cows were scanned for the presence of early diestrus corpus luteum (CL). Once confirmed, cows were assigned randomly to serve as controls (CON) or receive a CIDR insert for 7 d, 100 µg of GnRH, or 3,300 IU of hCG. Ovarian structures were scanned and mapped before treatment and on d 7. More ($P < 0.01$) cows were induced to ovulate in response to GnRH and hCG. Diameter of follicles that ovulated did not differ (13.8 ± 0.5 ; $n = 70$ vs. 12.7 ± 0.4 ; $n = 78$), respectively, for GnRH and hCG cows. Compared with CON, cows treated with GnRH or hCG had fewer ($P < 0.01$) follicles ≥ 5 mm on d 7 than d 0, more ($P < 0.01$) induced CL (d 7), and more ($P < 0.01$) total CL (d 7), but serum P4 was only increased ($P < 0.01$) after hCG. Largest follicle diameter on d 7 were less ($P < 0.05$) after GnRH and hCG, but total follicular volume on d 7 (data not shown) was reduced ($P < 0.05$) by GnRH, hCG, and CIDR compared

with CON. Volume of the original luteal structures were increased ($P < 0.05$) by hCG, but tended ($P = 0.07$) to be reduced by CIDR and GnRH compared with CON. Total CL volume was increased ($P < 0.05$) by hCG, but reduced ($P < 0.05$) by CIDR compared with CON. We concluded that GnRH and hCG effectively induced ovulation, increased number of CL (not total CL volume after GnRH), but only increased serum P4 in hCG-treated cows.

Table 1.

Trait	CON	CIDR	GnRH	hCG
Ind. ov., %	4.9 (41)	4.9 (41)	60** (40)	77.5** (40)
Ind. CL/cow (d 7), no.	0.1 ± 0.1 (41)	0.1 ± 0.1 (41) (41)	0.7* ± 0.1 (40)	1.1* ± 0.1 (41)
Incr. P4 (d 0-7), ng/mL	2.5 ± 0.2 (190)	2.2 ± 0.2 (179)	2.3 ± 0.2 (193)	3.7* ± 0.2 (187)
Change in orig. CL vol., mm ³	3131 ± 619 (55)	1350 ⁺ ± 662 (50)	1446 ⁺ ± 652 (50)	4766* ± 640 (52)
Follicle diam. (d 7), mm	14.3 ± 0.7 (41)	13.2 ± 0.8 (40)	11.6* ± 0.8 (36)	11.0** ± 0.7 (38)
Total CL vol. (d 7), mm ³	12,298 ± 1106 (41)	8,008** ± 1101 (41)	12,373 ± 1117 (40)	18,410** ± 1108 (40)

Different (⁺ $P = 0.07$; * $P < 0.05$; ** $P < 0.01$) from control.

Key Words: hCG, GnRH, Luteal capacity

M128 Post-AI interventions in lactating dairy cattle. II. Conception rates and pregnancy survival in response to GnRH, hCG, and exogenous progesterone (CIDR). J. S. Stevenson¹, D. E. Tenhouse¹, M. A. Portaluppi¹, D. R. Eborn¹, S. Kacuba², and J. M. DeJarnette², ¹Kansas State University, Manhattan, ²Select Sires, Plain City, OH.

We hypothesized that increasing concentrations of progesterone in the early luteal phase after AI will increase conception rates and pregnancy survival in lactating dairy cows. Holstein cows in 5 herds were assigned randomly on d 5 to 8 after AI to serve as controls or to receive either an i.m. injection of 100 µg of GnRH, 3300 IU of hCG, or a CIDR insert for 7 d. Conception rates (CR; 30-42 d after AI) and pregnancy survival (44-73 d after AI) were assessed by ultrasonography in 2 herds and by palpation per rectum in 3 herds. Tendencies for interactions of treatment × herd ($P < 0.11$) and treatment × lactation group ($P = 0.08$), but no 3-way interactions were detected. Treatment with hCG increased ($P < 0.05$) CR in second-lactation cows (see Table). The CIDR and hCG tended to ($P < 0.10$) or increased ($P < 0.05$) CR in 2 herds, whereas the CIDR decreased CR in herd 4. Pregnancy survival [controls (97.3%), CIDR (93.1%), GnRH (92.1%), and hCG (95.7%)] was reduced ($P < 0.05$) by GnRH compared with controls. We concluded that post-insemination treatment with the CIDR or hCG tended to increase CR, but only in some herds. Treatment with hCG increased CR in second-lactation cows.

Table 1. Conception Rates

Herd	Control	CIDR	GnRH	hCG
1	31.0 (41)	47.3† (41)	31.1 (40)	36.4 (39)
2	26.9 (158)	32.0 (158)	29.6 (159)	35.3† (158)
3	24.8 (143)	38.3* (162)	29.2 (153)	35.8* (153)
4	33.3 (206)	23.0* (204)	29.4 (209)	33.3 (209)
5	25.7 (164)	23.0 (150)	21.1 (163)	27.1 (165)
Lactation group				
First	32.7 (247)	34.4 (254)	35.7 (250)	32.6 (253)
First	32.7 (247)	34.4 (254)	35.7 (250)	32.6 (253)
First	32.7 (247)	34.4 (254)	35.7 (250)	32.6 (253)
First	32.7 (247)	34.4 (254)	35.7 (250)	32.6 (253)
First	32.7 (247)	34.4 (254)	35.7 (250)	32.6 (253)
Second	25.5 (206)	33.2 (204)	26.7 (212)	39.1* (212)

Different from control (* $P < 0.05$; † $P < 0.10$) by Chi-Square.

Key Words: Conception rate, Pregnancy survival, Progesterone

M129 Induction of cyclicity in postpartum anestrus beef cows using progesterone, GnRH and estradiol cypionate (ECP). J. Wheaton¹ and G. Lamb², ¹University of Minnesota, St. Paul, ²University of Minnesota, Grand Rapids.

The objective of the study was to determine whether treatment of postpartum multiparous and primiparous anestrus Angus beef cows with a CIDR and PGF_{2α}, with and without the addition of GnRH or ECP at the time of CIDR insertion, is effective in stimulating cyclicity. Lactating primiparous (n = 47, 2 yr of age, 495 ± 6 kg) and multiparous (n = 76, ≥ 3 yr of age, 553 ± 9 kg) cows were assigned by calving date to four treatment groups: 1) PGF_{2α} (n = 30), 2) CIDR-PGF_{2α} (n = 30), 3) GnRH-CIDR-PGF_{2α} (n = 33), and 4) ECP-CIDR-PGF_{2α} (n = 27). CIDR were in place from d -7 to 0. GnRH (100 µg) or ECP (2 mg) were administered sc on d -7, and 25 mg PGF_{2α} was given on d 0. Day 0 averaged 38 d postpartum. Blood samples were collected on days -19, -9, 0, 5, 9, 12, 16, 19, 23, 26 and 30 for progesterone analysis.

Pretreatment luteal activity was detected in 26% of primiparous and 14% of multiparous cows. Progesterone levels on day 0 were greater ($P \leq 0.001$) in primiparous (3.2 ± 0.3 ng/mL) than multiparous (2.0 ± 0.2 ng/mL) cows. Following CIDR withdrawal, progesterone levels from day 5 to 30 were used to categorize response profiles as either 1) treatment-induced cyclicity, 2) continued anestrus, or 3) spontaneous ovulation and subsequent formation of a CL. Incidence of treatment-induced cyclicity was influenced by treatment and parity. Percentages of cyclic cows were greater in the three CIDR-treated groups ($P = 0.002$) than in the PGF_{2α} group (53 and 0%, respectively). Percentages of cyclic cows in the CIDR-PGF_{2α}, GnRH-CIDR-PGF_{2α} and ECP-PGF_{2α} groups were 54, 56 and 50%, respectively. Incidence of treatment-induced cyclicity was greater ($P = 0.01$) in primiparous (75%) than multiparous (41%) cows. Treatment of early postpartum anestrus primiparous and multiparous beef cows with CIDR-PGF_{2α} provides an approach to increase the percentage of cows that have reinitiated estrous cycles by the start of the breeding season. Findings indicate that the cyclicity response rate is influenced more by management conditions than by parity.

Key Words: Beef Cows, Postpartum Anestrus, CIDR

M130 Effects of feeding palm oil fatty acids on milk production and composition and follicle size in early lactating cows. A. Heravi Moussavi* and M. Danesh Mesgaran, *Center of Ferdowsi University of Mashhad, Mashhad, Iran.*

The study was designed to test the effects of dietary fatty supplementation on milk production and composition, dry matter intake (DMI), and size of dominant follicle in early lactating cows. From d 5 to 50 postpartum, sixteen cows were used and fed isonitrogenous diets containing 0 (n = 8) and 2% (n = 8) palm oil fatty acid. Milk production and composition, DMI, body weight, and body condition score were analyzed using the MIXED model for a completely randomized design with repeated measures. The model included treatment, parity (2nd or 3rd to 5th), time and the interactions. For analysis of milk production the previous 305 d milk yield was used as the covariate. Dry matter intake (22.58 and 21.82 ± 0.22 kg/d, respectively) was significantly reduced by the supplementation ($P < 0.05$). Cows fed palm oil fatty acids produced more milk than the control ($P < 0.05$; 37.54 and 40.93 ± 1.01 kg/d, respectively). The interaction between parity and treatment was significant ($P < 0.05$) and 2nd lactation cows produced more milk than the older in the supplemented group. Milk fat and lactose percentages and also milk constitute yields were not affected by diet but milk protein percentage (3.25 and 3.09 ± 0.05 , respectively) was significantly reduced by the supplementation ($P < 0.05$). Body condition score and body weight changes were similar between the groups. At day 43 postpartum, cows were induced to a synchronized ovulatory cycle with an i.m. injection of 100 µg of GnRH followed after 7 days by i.m. administration of 30 mg of PGF_{2α} and a second injection of GnRH 48 h later. The size of dominant follicle after a synchronized ovulatory cycle was analyzed using the GLM model for a completely randomized design. Follicle size on the day preceding synchronized ovulation (day of second GnRH) was not affected by diet (14.37 and 14.43 ± 0.91 mm, respectively). Results from this experiment demonstrate the improvement in milk production in early lactation cows when feeding palm oil fatty acids.

Key Words: Cow, Palm oil, Follicle size

M131 Effect of timing of the second GnRH injection of a timed AI protocol on fertility of lactating holstein cows after first postpartum and Resynch AI services. R. A. Sterry¹, P. W. Jardon², B. Ryzebol³, and P. M. Fricke¹, ¹University of Wisconsin, Madison, ²West Central, Ralston, IA, ³Ryzebol Dairy, Bailey, MI.

Lactating Holstein cows (n=810) were assigned to one of two Ovsynch protocols with either a 48 or 72 h interval between PGF_{2α} (PG) and the second GnRH (G) injection. Cows not previously inseminated received their first postpartum timed AI (TAI) after presynchronization (Presynch) using two doses of PG (25mg) administered 14 days apart, with the second PG injection 14 d before initiation of Ovsynch. Previously inseminated cows received their second or greater TAI (Resynch) using Ovsynch. Approximately half of the cows received Ovsynch using PG and G (100 mg) as follows: (G, d 0; PG, d 7; G+TAI, d 9; Cosynch-48), whereas the remainder received Ovsynch using a 72 h interval between PG and the second G injection as follows: (G, d 0; PG, d 7; G+TAI, d 10; Cosynch-72). Cows were randomized to treatment based on breeding pen, with treatments alternated weekly among four pens. No effect of pen, week, or pen by week interaction was detected. Pregnancy diagnosis was conducted using transrectal palpation at 40.0±0.1 d after TAI. Pregnancy rate per AI (PR/AI) did not differ statistically and was 34% for Presynch and 29% for Resynch, and 29% for Cosynch-48 and 33% for Cosynch-72. There was a tendency (P = 0.11) for Presynch cows receiving Cosynch-72 (n=203) to have a greater PR/AI than cows receiving Cosynch-48 (n=146) (37 vs. 29%); however, the interval between PG and G during Ovsynch did not affect PR/AI for Resynch cows, (Cosynch-48 = 28%, n=236; Cosynch-72 = 29%, n=225). Sex ratio of calves (n=153) resulting from Cosynch-48 and Cosynch-72 breedings did not differ (48 vs. 43% female, respectively). In summary, Cosynch-72 tended to improve PR/AI for Presynch cows by 8 percentage points, or 22% but did not affect Resynch cows. Thus, extending the interval between PG and the second G injection of Ovsynch by 24 h did not affect PR/AI and may offer more flexibility for implementing a systematic synchronization program.

Key Words: Presynch, Resynch, Ovsynch

M132 Characterization of follicular dynamics, timing of estrus, and response to GnRH and PG in replacement beef heifers after presynchronization with a 14-day CIDR. D. J. Schafer*, D. C. Busch, M. F. Smith, and D. J. Patterson, *University of Missouri, Columbia.*

The experiment was designed to characterize response after treatment with a 14-d CIDR insert (1.38 g progesterone) followed by GnRH (100 µg Cystorelin) and PG (25 mg Lutalyse) in 79 Angus crossbred heifers. Fifty-three heifers were pubertal (P) and 26 were prepubertal (PP) based on two blood samples for progesterone collected 10 d and 1 d prior to treatment. Mean ages and weights of the P and PP heifers were 405 and 411 d, and 382 and 386 kg, respectively. CIDRs were inserted in all heifers on the same day for 14 d, GnRH was injected on d 23, and PG on d 30. Estrus detection was performed continuously after CIDR removal using HeatWatch®. Sixty-nine heifers exhibited estrus (47 P, 22 PP) after CIDR removal. There was no difference (P > 0.05) in the interval to estrus after CIDR removal for P and PP heifers [50.0 ± 27.3 h (P), and 48.1 ± 28.3 h (PP), respectively]. Comparisons of follicular dynamics were made on the basis of the day of the estrous cycle that heifers were on at the time GnRH was administered based on the day estrus was expressed after CIDR removal. There was a

significant effect (P < 0.05) of day of the estrous cycle on mean follicle diameter at GnRH. Response to GnRH was highest among heifers with dominant follicles ≥ 10.0 mm (64/71, 90%) and lower among heifers with follicles < 10 mm (4/8, 44%). Mean follicle diameter was ≥ 10.0 mm among heifers that were on d 5, 6, 7 or 8 of the estrous cycle at GnRH. Concentrations of progesterone in serum at PG were higher (P < 0.05) among P versus PP heifers [7.9 (P) and 6.9 ng/ml (PP), respectively]. Estrous response after PG did not differ among P and PP heifers and peaked between 48 and 60 h. This study provides a descriptive comparison of response to presynchronization with a CIDR prior to GnRH and PG in P and PP beef heifers. Future studies are required comparing long- and short-term CIDR-based protocols to establish the merit of presynchronization among mixed populations of P and PP beef heifers.

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Key Words: Progesterin, Estrus synchronization, Beef heifer

M133 Factors affecting synchronization and conception rate (CR) after the Ovsynch protocol in lactating dairy cows. K. N. Galvao* and J. E. P. Santos, *University of California Davis, Tulare.*

Objectives were to evaluate risk factors affecting responses and CR to an ovulation synchronization protocol in lactating cows. Holstein cows, n=474, had their ovulation synchronized using the Ovsynch (d 0, 100 µg of GnRH1; d 7, 25 mg of PGF_{2α}; d 9, 100 µg of GnRH2) and 103 cows were inseminated 12 h after GnRH2 and had the pregnancy diagnosed 42 d later. Information on parity, d in milk at GnRH1, BCS (1 to 5), milk yield, heat stress, presynchronization with 2 PGF_{2α} 14 d apart, and the use of a CIDR insert from GnRH1 to PGF_{2α} were collected for all cows. Ovaries were scanned by ultrasonography at every injection of the Ovsynch, and at 2, and 5 d after GnRH2 to access ovulation after GnRH1 and GnRH2 and CL regression. Overall, 49.8, 9.5, 2.1, 81.9, 9.0, 91.51, and 36.9% of the cows ovulated after GnRH1, double ovulated after GnRH1, ovulated before GnRH2, ovulated after GnRH2, double ovulated after GnRH2, regressed the CL 96 h after the PGF_{2α}, and conceived, respectively. Ovulation after GnRH1 was higher (P<0.01) for cows with follicles ≥ 12 mm (54.4 vs 8.5%) and for cows not having a CL at the time of GnRH1 (65.4 vs 44.0%). Double ovulation after GnRH1 was not affected by any of the variables evaluated. Ovulation before GnRH2 was higher (P<0.05) for cows that did not ovulate after GnRH1 (3.9 vs 0.4%) and for cows with premature CL regression (CL≥17mm at GnRH1 and <17mm at PGF_{2α}) (21.1 vs 0.6%). Ovulation after GnRH2 was higher (P<0.05) for cows with follicles not regressing from the PGF_{2α} to the GnRH2 (83.4 vs 65.9%), and for cows that received a CIDR insert (84.5 vs 77.6%). Cows that had double ovulation after GnRH1 had higher (P=0.003) double ovulation after GnRH2 (28.6 vs 7.5%). CL regression (CL<17mm) 96 h after the PGF_{2α}, was similar (P=0.15) between the preexisting and newly formed CL after GnRH1 (94.9 vs 91.9%). However, CL regression was lower (P<0.01) under heat stress (84.9 vs 93.6%) and tended (P=0.08) to be lower for multiparous than primiparous cows (89.9 vs 95.0%). CR was higher (P<0.05) for cows that ovulated within 48 h of the GnRH2 (46.8 vs 4.17%), and for cows with BCS > 2.75 (51.2 vs 26.7%).

Key Words: Ovsynch, Synchronization, Dairy cow

M134 Conception rates after altered timing of AI associated with the CO-Synch + CIDR protocol. C. A. Dobbins¹, D. E. Tenhouse¹, D. R. Eborn¹, K. R. Harmony², S. K. Johnson³, and J. S. Stevenson¹, ¹Kansas State University, Manhattan, ²Agricultural Research Center, Hays, KS, ³Northwest Area Extension Office, Colby, KS.

Our objective was to determine the optimal time to AI after using the standard CO-Synch + CIDR insert protocol. Suckled beef cows from 3 Kansas herds were utilized in this study. Purebred Angus, Hereford, and Simmental cows from the Kansas State University Purebred Beef Unit (PBU), Angus-Hereford crossbred cows from the Kansas State University Cow-Calf Unit (CCU), and crossbred Angus cows from the Agriculture Research Center-Hays (ARCH). No 2-yr-old cows were treated at the ARCH location. Cows within herd were blocked by parity and days postpartum and randomly assigned to be inseminated at 4 different times after the PGF2 α (25 mg) injection: 48, 56, 64, or 72 h. Days postpartum and BCS at the time of PGF2 α are shown for each herd. Pregnancy diagnosis occurred at 28-35 and 60-68 d after insemination to determine conception rates and subsequent embryo survival. Blood samples were collected twice at 9 or 10 d before and immediately before GnRH (100 μ g) injection and CIDR insertion. Concentrations of progesterone were measured by RIA to determine cycling status of cows before initiating the protocol. Cycling status differed ($P < 0.01$) among herds. Conception rates (CR; $P < 0.01$) and embryo survival (ES; $P < 0.05$) at 48, 56, 64, and 72 h produced quadratic curves that peaked ($P < 0.01$) between 56 and 64 h. Conception rates were greater ($P < 0.001$) in 261 noncycling cows than in 344 cycling cows (60.4 vs. 45.8%). We concluded that timing of AI after the CO-Synch + CIDR protocol was maximized when inseminations occurred at 56 to 64 h after PGF2 α .

Table 1. Herd Characteristics, Cyclicity, Resulting Conception Rates and Embryo Survival

Herd	No. of cows	BCS	DPP ¹	% cycling
ARCH	212	5.1 (3.5 - 7.0) ²	61 \pm 0.6	62.0
CCU	249	5.0 (3.5 - 6.5)	68 \pm 1.3	46.3
PBU	144	4.1 (3.5 - 5.0)	57 \pm 1.2	52.0
Item	48 h	56 h	64 h	72 h
CR, %	43.7 (136)	62.5 (157)	55.3 (170)	51.0 (142)
ES, %	89.5 (58)	95.7 (98)	95.8 (92)	89.9 (73)

¹Days postpartum at PGF2 α \pm SE. ² Range in body condition score at PGF2 α .

Key Words: CIDR insert, Conception rate, Timing of AI

M135 Effect of progesterone therapy post AI via a previously used CIDR insert on embryonic loss and for the resynchronization of estrus in cattle. J. L. Fain*, W. M. Graves, J. M. Haslett, J. W. Durham, S. C. Nickerson, and J. K. Bernard, *University of Georgia, Athens.*

Beef (n = 12) and dairy (n = 32) heifers were synchronized utilizing a new CIDR insert (1.38 g P4) (d -10) with a 5-cc injection of PGF₂ at the time of CIDR removal (d -3) and were inseminated 12 h after detected estrus (d 0). At 14 d post AI (d 14), animals received the same previously inserted CIDR for a second 7-d period until removal on d 21, followed by reinsemination 12 h after detected estrus. There were no differences in the amount of discharge or rate of infections with use of the new or used CIDR ($P > 0.05$). Pregnancy rates were not different between initial synchronization in dairy (52.17%; 12/23) and

beef (75%; 3/4) heifers compared with resynchronization pregnancy rates of 40% (4/10) and 50% (3/6), respectively ($P > 0.05$) at d 35. Additionally, no differences in pregnancy rates occurred at the d 60 pregnancy recheck, therefore, no differences in embryonic loss were evident ($P > 0.05$). In resynchronization with a used CIDR, 64.7% of open heifers returned to estrus within 4 d. Use of the new CIDR insert increased ($P = 0.002$) P4 concentrations (+2.09 ng/ml) from d -10 to d -3 in heifers; however, there was no change in concentrations from d 14 to d 21 (-0.64 ng/ml) ($P > 0.05$) with the used CIDR. With individual animals, a mean increase in P4 concentrations from d 14 to d 21 was a positive predictor of pregnancy ($P = 0.0133$), while a mean decrease in P4 was a predictor of an open animal. Additionally, d-3 concentrations tended to be ($P = 0.061$) correlated with pregnancy at d 35 and d 21 concentrations were positively correlated with incidence of pregnancy at d 35 ($P = 0.004$). Beef heifers had lower P4 concentrations than dairy heifers on d -3, d 14, and d 21 of the trial ($P < 0.05$), with concentrations averaging 3.29 ng/ml lower on both d -3 and d 21. Implementation of a used CIDR for resynchronization did not increase P4 concentrations during the time of CIDR insertion, but successfully suppressed estrus and resynchronized return to estrus.

Key Words: Resynchronization, Used CIDR, Cattle

M136 Serum progesterone concentrations in ovariectomized cows bearing new or previously used CIDR devices with or without autoclaving. J. F. Zuluaga* and G. L. Williams, *Texas A&M University Agricultural Research Station, Beeville.*

Objective was to compare serum concentrations of progesterone (P4) in ovariectomized cows receiving new, re-used disinfected, and re-used autoclaved Eazy-Breed CIDR inserts (Pfizer Animal Health, New York, NY). Five ovariectomized (OVX) Brahman \times Hereford (F1) cows and one OVX Hereford cow were used in a replicated 3 \times 3 Latin square design. Mean (\pm SEM) age and BW were 7.8 \pm 0.9 yr and 604 \pm 9 kg, respectively. Each experimental period was 7 d, with at least 48 h between periods. Treatments were 1) New, 2) Re-used disinfected (DIS), and 3) Re-used autoclaved (AC). All re-used CIDRs had been inserted previously in beef cows for 7 d. Upon removal, DIS CIDRs were washed thoroughly and soaked in a chlorhexidine gluconate solution (0.03%) for 2 h, rinsed thoroughly with water and air-dried. For the AC treatment, CIDRs were not soaked in disinfectant but were autoclaved at 121 $^{\circ}$ C and 724 mm Hg for 20 min before use. Blood samples were collected at 0, 10, 30, 60, 180, and 480 min relative to time of insertion of CIDRs, daily until d 7, and at 30, 60, and 180 min relative to time of removal for RIA of P4. Mean serum concentrations (ng/mL) of P4 during the 7-d period of insertion were greater ($P < 0.03$) for New (3.7 \pm 0.2) and AC (3.4 \pm 0.3) than for DIS CIDRs (2.8 \pm 0.2). These effects were created primarily by differences occurring during the first 8 h after CIDR insertion. Within this interval, mean concentrations differed ($P < 0.05$) between all treatments (New, 4.6 \pm 0.5; DIS, 2.7 \pm 0.3; AC, 6.0 \pm 0.7). The majority (61 %) of maximum peak values occurred between 10 and 180 min after insertion. Mean concentrations during this period (New, 4.6 \pm 0.5; DIS, 2.8 \pm 0.3; AC, 5.8 \pm 0.7) also differed ($P < 0.01$) between all treatments. Autoclaving may be the best option when re-using CIDR inserts because it creates greater concentrations of P4 immediately after insertion and reduces maximally the risk of disease transmission.

Key Words: CIDR, Ovariectomized, Progesterone

M137 Induction of a new follicular wave in holstein heifers with persistent follicles, synchronized with norgestomet. E. Garcia^{1,2}, T. Sanchez¹, J. Peralta¹, J. Cordero¹, O. Montañez³, P. Molina¹, and R. Avila¹, ¹*Especialidad de Ganaderia Colegio de Postgraduados, Texcoco, Mexico*, ²*CUCSUR Universidad de Guadalajara, Autlan, Jalisco, Mexico*, ³*CUSUR Universidad de Guadalajara, Cd. Guzman, Jalisco, Mexico*.

Two experiments were performed to induce the atresia of the persistent follicles that develop when the stage of the estrous was synchronized with norgestomet in holstein heifers. In day 6 of estrous cycle (day 0 = day of estrous) received a norgestomet implant and 25 mg of PGF2 α im. On day 12, heifers were assigned to treatment 1, heifers received a second norgestomet implant (T1: N+N, n=6), treatment 2, received 100 μ g of GnRH im (T2: N+GnRH, n=6), Treatment 3, was control treatment with saline solution im (T3: N+SS, n=6). The implants were removed on day 14. Follicular development, progesterone concentration and LH secretion were determined. New wave of ovarian follicular development were induced in 3/6, 6/6, and 1/6 heifers and onset of estrous in 6/6, 0/6, and 6/6 for T1, T2 and T3, respectively. Heifers that ovulated a persistent follicle, showed estrous 54.7 \pm 5.4 h and ovulation occurred 2.5 \pm 0.2 d and heifers that developed a new wave showed it at 115.0 \pm 4.7 h and ovulation occurred 4.7 \pm 0.5 d (P<0.01). T3 showed more frequency, and LH concentration that T1 (P<0.05) and the T2 produced a preovulatory surge. In the second experiment, estrous were synchronized similar to experiment 1, on the day 12 cows were assigned to treatment 1 and 2 similar to these in experiment 1, Treatment 3, received 200 mg of progesterone im (T3: N+P, n=6), Treatment 4 was control with saline solution (T4: N+SS, n=6), and in Treatment 5, heifers received 100 μ g of GnRH im on day 9 and 25 mg of PGF2 α im (T5: N+GnRH+PGF2 α) at implant removal (day 16). The follicular development and progesterone concentration were determined. A new wave of ovarian follicular development were induced in 3/6, 6/6, 3/6, 1/6 and 6/6 and onset of estrous in 6/6, 0/6, 6/6, 6/6 and 6/6 for T1, T2, T3, T4 and T5, respectively. The heifers that ovulated a persistent follicle, showed estrous and ovulated earlier than heifers that developed a new follicular wave (P<0.05). The best results were obtained with T5, in which 100 % of the heifers had a new wave of ovarian follicular development induced, with onset of estrous and ovulation synchronized in a short time period.

Key Words: Follicles, Wave, Norgestomet

M138 The use of a progesterone releasing device (CIDR), with GnRH and prostaglandin F2 α (PGF), for a fixed-time artificial insemination in beef heifers. J. M. Howard¹, D. G. Falk¹, K. G. Carnahan¹, J. C. Dalton², R. C. Chebel², T. C. Blair¹, and A. Ahmadzadeh¹, ¹*University of Idaho, Moscow*, ²*University of Idaho, Caldwell*.

The pattern of follicular growth and the timing of the initiation of a fixed-time artificial insemination (TAI) protocols, relative to the stage of the estrous cycle, influence the conception rate in heifers. The objective of this experiment was to determine the effect of incorporating a supplemental GnRH injection into a CIDR-based TAI protocol on conception rate of heifers. Beef replacement heifers (n = 192) were paired by body condition score and body weight, and received a CIDR insert at random stages of the estrous cycle (d 0). On the same day, heifers were assigned randomly to receive either a single dose of 100 μ g of GnRH (GnRH-CIDR; n = 94) or physiological saline (Sal-CIDR; n = 98). On d 7, the CIDR was removed and all heifers received 25 mg PGF. Forty eight h later (d 9), all heifers were administered GnRH (100 μ g) and received AI by a single technician. Pregnancy was diagnosed

by ultrasound 35 d after AI. Blood samples were collected on d -7, 0, 7, and 9 and analyzed for progesterone (P4) concentrations. There was no difference (P = 0.46) in the proportion of anovular heifers between groups (Sal-CIDR = 97.8% vs. GnRH-CIDR = 97.8%). Serum P4 was similar between groups on d 0, but was greater (P < 0.05) for the GnRH-CIDR than the Sal-CIDR on d 7. Moreover, there was a tendency for greater proportion of heifers from the GnRH-CIDR group to have P4 > 1.3 ng/ml on d 9 (GnRH-CIDR = 23.6% vs Sal-CIDR = 14%; P = 0.11), resulting in a smaller (P = 0.11) synchronization rate in GnRH-CIDR compared with Sal-CIDR (76.4% vs 86%). However, conception rate at 35 d after AI was not affected (P = 0.52) by synchronization treatment (Sal-CIDR = 58.9% vs GnRH-CIDR = 55.9%). The results of this experiment indicate that GnRH administration at CIDR insertion did not affect conception rates when a CIDR-PGF-GnRH fixed-time AI protocol was used in beef heifers.

Key Words: Heifers, CIDR, GnRH

M139 Evaluation of GnRH administration at 17 days after timed AI on conception rates and pregnancy losses in lactating dairy cows. A. P. Cunha, A. H. Souza, E. P. B. Silva, D. J. Brusveen, C. D. F. Silva, J. A. Powell, P. M. da Cunha*, J. N. Guenther, and M. C. Wiltbank, *University of Wisconsin, Madison*.

We hypothesized that treatment with GnRH late in the estrous cycle (day 17 after timed AI [TAI]) would cause a new ovulation, delay luteolysis, and potentially improve conception rates in lactating dairy cows. Three experiments were done to test this hypothesis. In the first experiment lactating Holstein cows (n=702) underwent the Cosynch protocol (GnRH-7d-PGF2 α -48h-GnRH+AI) and 17 days after AI, cows were assigned to one of two groups 1) treatment: 100 μ g GnRH on day 17 after TAI; 2) control: received no treatment. Pregnancy diagnoses were performed by ultrasound on days 33 and 54 after TAI. The Logistic Procedure of SAS was used to evaluate conception rate (CR) and pregnancy loss (PL). Overall CR and PL were not different (P>0.10) between GnRH-treated (34.0%, n=350) (19.0%, n=116) and control (31.7%, n=341) (12.6%, n=103) cows. Parity did not have an effect (P>0.10) on CR. This experiment was replicated in another commercial dairy farm (n=271). Again, the overall CR was not different (P>0.10) between GnRH-treated (35.5%, n=138) and control cows (35.3%, n=133). In a subset of cows (n=117) more intensive ultrasonography and blood sampling was performed to assess whether GnRH on day 17 induced ovulation and delayed luteolysis. Treatment with GnRH induced ovulation in 61% of cows. Using the Mixed procedure of SAS there was no difference (P>0.10) in the volume of the previous CL in non-pregnant cows on Days 17, 19, 21, 24 or 26 in control (7337, 6534, 5131, 3745, 2812 mm³) or GnRH-treated (7824, 7100, 4816, 2697 and 1688 mm³) cows. Thus, our hypothesis was not supported as GnRH treatment on day 17 failed to increase CR or decrease PL. This lack of effect may be due to the apparent lack of an effect of the GnRH treatment on timing of luteolysis.

Key Words: GnRH, Conception rate, Dairy cows

M140 Conception rates at ET in lactating dairy recipient cows after estrous or ovulation synchronization. D. T. G. Jardina¹, R. M. Santos¹, D. G. B. Demetrio¹, C. A. Rodrigues², and J. L. M. Vasconcelos¹, ¹*FMVZ-UNESP, Botucatu, SP, Brazil*, ²*Clinica Veterinaria Samvet, Sao Carlos, SP, Brazil*.

The aim of this study was to evaluate conception and pregnancy rates after embryo transfer (ET) in cows after estrous or ovulation

synchronization. The trial was conducted at a dairy farm located in Descalvado, SP, Brazil in September 2005. Cycling cows producing 32.4 ± 9.5 kg of milk/d with 215.0 ± 160.0 DIM were divided in two groups. Group 1 (n=43) was treated with PGF2 α injection (Ciosin®Coopers, 2ml) and received ET 6 to 8 days after heat detection (41.8%; 18/43) if CL was present (66.7%; 12/18). Group 2 (n=49) received HEATSYNCH protocol, consisted in an implant of intravaginal P4 device (CIDR® 1,9mg Pfizer Animal Health, Brazil), plus an injection of GnRH (1mL Fertagyl® Intervet) on first day. After 7 days CIDR® was removed plus an injection of PGF2 α (5mL Lutalyse® Pfizer Animal Health, Brazil), followed by an injection of Estradiol Cypionate (0,5mL ECP® Pfizer Animal Health, Brazil), 24 hours later. Heat was also detected in Group 2 (57.1%, 28/49). Every cow treated with HEATSYNCH protocol was checked for a presence of CL 9 days after ECP injection, and cows with CL received ET 79.6% (39/49). All cows received an in vivo produced fresh embryo (grade 1 or 2) from lactating or non-lactating dairy cows, transferred by one trained technician. Pregnancy diagnosis was performed by US on day 25 and 39. The data was analyzed by qui-square test. Conception rate was 50.0% (6/12) and 53.9% (21/39) and pregnancy rate was 14.0% (6/43) and 42.9% (21/49) for Group 1 and 2, respectively. Group 2 (HEATSYNCH protocol) had the same conception rate, but the pregnancy rate was higher (P<0.01) than in Group 1 (PGF2 α + heat detection). Cows detected in heat after HEATSYNCH protocol had the same conception rate of cows which were not detected in heat (56.3 vs. 52.2%, respectively). Transfer of fresh embryo can be performed after HEATSYNCH protocol because it maintains conception rates and increases pregnancy rate.

Key Words: Embryo transfer, Conception rate, Dairy cow

M141 Effects of selenium (Se) sources on dairy cows. F. T. Silvestre*¹, D. T. Silvestre¹, J. E. P. Santos², C. Risco¹, C. R. Staples¹, and W. W. Thatcher¹, ¹University of Florida, Gainesville, ²University of California, Davis.

Objectives were to evaluate effects of organic Se on postpartum (pp) uterine health, pregnancy rates (PR) at the first two pp services and milk yield in summer. Cows were supplemented with Se (Se-yeast [SY; Sel-Plex®, Alltech; n=289] or sodium selenite [SS; n=285]) at 0.3 ppm in dry matter from 23 \pm 8 days (d) prior to calving to \geq 81 dpp. Rectal temperature (RT) was recorded daily for 10 dpp and vaginoscopies made at 5 and 10 dpp. Cows within diet were assigned randomly to two reproductive programs (RPs; Presynch–Ovsynch vs CIDR–Ovsynch [i.e., Ovsynch begins 3 d after withdrawal of a 7 d–CIDR]). After Timed (T) AI, all cows were resynchronized for a 2nd service with Ovsynch at 20–23 d after 1st service and pregnancy diagnosis at 27–30 d. Cows in estrus following Presynchs were AI up to the 2nd TAI service. Strategic blood sampling determined anovulatory status at Ovsynch and ovulatory response after TAI to 1st service. PR at 2nd service was made at ~42 dpp. Blood was sampled for Se (n=20 cows/diet) at -25, 0, 7, 14, 21 and 37 dpp. Plasma Se increased in SY fed cows ($87 > 69 \pm 4$ ng/mL; P<0.01). SY cows produced more 3.5% fat corrected milk (FCM; 36.2 vs 35.3 kg/d; P<.05); SY reduced frequency of multiparous cows with \geq 1 event of fever (RT > 39.5°C; 13.3% vs 25.5%; P<.05) but not in 1st parity cows (40.5%). Vaginoscopy scores for clear (47% vs 35%), mucupurulent (43% vs 48%) and purulent (9% vs 17%) discharges were affected by SY and SS, respectively (P<.05). Diets and RPs did not alter milk somatic cells (291,618 /mL), frequencies of retained fetal membrane (9.7%), mastitis (14.4%), anovulation (17.7%) and synchronized ovulation after TAI (82.5%). Diets and RPs failed to alter 1st service PR at ~d

30 (SY, 24.9% vs SS, 23.6%) or pregnancy losses between ~d 30 and ~d 42 (SY, 39.3% vs SS, 37.1%). SY improved 2nd service PR (17% vs 11.3%; P<.05). Feeding organic Se to periparturient cows increased concentration of Se in plasma, improved uterine health, FCM and 2nd service PR, but not 1st service PR in Florida.

Key Words: Selenium, Pregnancy rates, Uterine health

M142 The first ovulation of dominant follicle within three weeks postpartum closely relates to metabolic status and peak milk yield in high-producing dairy cows. A. Miyamoto*, M. Kataoka, Y. Masuda, C. Kawashima, E. Kaneko, N. Matsunaga, M. Matsui, M. Ishii, K. Kida, Y.-I. Miyake, and M. Suzuki, *Obihiro University of Agriculture and Veterinary Medicine, Obihiro, Hokkaido, Japan.*

There is evidence that the early commencement of luteal activity is directly related to higher fertility. The negative effects of milk production on reproductive function can be observed in high-producing dairy cows, because of severe negative energy balance (NEB) during the early lactation period. The present study aimed to determine the relationship among the occurrence of the first ovulation of the dominant follicle within 3 wk postpartum (pp), metabolic status and characteristics of lactation curve in high-producing dairy cows in Hokkaido, Japan. Blood sample was obtained weekly from 43 multiparous Holstein cows (9,000 kg/305 d) during 0 to 5 wk pp, and milk yield was recorded daily for 100 d pp. Over half of cows (63%) showed ovulation within 3 wk pp. Anovulated cows showed higher plasma NEFA and AST levels just after calving compared to those in ovulated cows (P<0.05). A logistic regression analysis showed the lower probability of the occurrence of the first ovulation within 3 wk pp associated with 1) higher peak milk yield (P<0.05), and 2) larger difference in milk yield between 1 wk and peak wk (P<0.005). When a correlation between metabolic status and characteristics of lactation curve in either ovulated or anovulated cows was independently examined, a positive correlation in anovulated cows was found between plasma NEFA and the difference in milk yield between 1 wk and peak wk (P<0.01), while a positive correlation in ovulated cows was found between plasma IGF-1 level and peak yield (P<0.05). In conclusion, the data imply that the degree of NEB or metabolic stress on liver function by acute increase in milk production after calving closely relates to the occurrence of ovulation within 3 wk pp in dairy cows.

Key Words: Dairy cow, First ovulation postpartum, Lactation curve

M143 Effectiveness of GnRH treatment before, or before and after ovarian stimulation with FSH on superovulation response and embryo quality. D. J. Ambrose*¹, R. Rajamahendran², G. Giritharan², J. Kurtu², and P. Madan², ¹Alberta Agriculture Food and Rural Development, Edmonton, Alberta, Canada, ²University of British Columbia, Vancouver, BC, Canada.

The objective was to determine if GnRH given prior to, or prior to and after FSH-induced ovarian stimulation would improve superovulatory response, number, and quality of embryos. Lactating Holstein cows (n = 41) were assigned to one of three treatments. Cows in the luteal phase were given PGF2 α and watched for estrus. Nine days after estrus, cows were assigned to receive FSH treatments (400 mg Follitropin-V) given in divided doses of 8 injections, one every 12 h. PGF2 α was administered to induce luteolysis, in conjunction with the 7th and 8th FSH treatments. Cows were inseminated 48 and 60 h after the first luteolytic treatment of PGF2 α . Control group cows (n=13) received no other treatments. One group of cows (n=14; GnRH1x) received a

single treatment of GnRH on d 5 (estrus = d 0), that is, 4 d prior to initiation of FSH treatments. Another group of cows (n=14; GnRH2x) received two GnRH treatments, first on d 5, then on d 14 concurrent with the first AI. The uteri of cows were flushed nonsurgically for recovery of embryos 7 d after insemination. Total number of CL and presence of anovulatory follicles were determined by transrectal ultrasonography. Mean (\pm SEM) number of CL (11.6 ± 1.5), eggs recovered (5.0 ± 1.7), and number of anovulatory follicles (3.7 ± 0.8) did not differ amongst treatment groups. The proportion of fertilized eggs tended to be higher ($P < 0.08$) in control (4.6 ± 1.0) than in GnRH1x (1.9 ± 1.0), but not different from GnRH2x (3.7 ± 1.0). The number of transferable quality embryos was also greater in Control (3.7 ± 0.6) than in GnRH1x (0.6 ± 0.6 , $P < 0.01$) and GnRH2x (1.8 ± 0.6 ; $P < 0.05$). GnRH treatment given prior to, or prior to and after ovarian stimulation with FSH neither improved superovulatory response or total eggs collected, nor reduced anovulatory follicles. The number of fertilized eggs was reduced in cows of the GnRH1x group. Transferable embryos were reduced in both GnRH treatment groups relative to control.

Key Words: GnRH, Superovulation, Embryo

M144 Effect of source of supplemental Se on uterine health and embryo quality in high-producing dairy cows. R. L. A. Cerri^{*1}, H. M. Rutigliano¹, F. S. Lima¹, D. S. Brito¹, J. Hillegass¹, W. W. Thatcher², and J. E. P. Santos¹, ¹University of California Davis, Tulare, ²University of Florida, Gainesville.

Objectives were to determine the effect of source of supplemental Se on embryo quality and uterine health of dairy cows. Holstein cows, 135, were assigned to Se yeast (SY, Sel-Plex[®]) or sodium selenite

(SS) supplemented at 0.3 ppm from 25 d prior to calving to 80 d in milk (DIM). Cows were fed as group in 4 pens/treatment, 2 prepartum and 2 postpartum pens. Health of cows was evaluated daily and rectal temperature taken in the first 10 DIM. Uterine cytology was performed at 30 ± 3 DIM by flushing the previously gravidic horn with 20 mL of saline. The collected material was then classified according to visual appearance, and evaluated for concentration of leukocytes and proportion of neutrophils. Cows were presynchronized at 33 ± 3 DIM (d 33 GnRH + CIDR insert, d 40 PGF2a + CIDR removal), and subjected to the Ovsynch protocol 2 d after presynchronization (d 42 GnRH, d 49 PGF2a, d 51 GnRH). Cows were time inseminated 12 h after the final GnRH of the Ovsynch with semen from a single sire. Uteri of cows were flushed 6 d after AI and collected structures were evaluated. Ovarian responses were evaluated by ultrasonography, and blood was analyzed for progesterone throughout the study and for glutathione peroxidase (GPx) activity at the day of embryo flushing. Incidence retained placenta (SY = 2.9 vs SS = 10.8 %), acute postpartum metritis (SY = 17.4 vs SS = 25.7 %), fever (SY = 21.7 vs SS = 29.7 %), mastitis (SY = 26.1 vs SS = 35.2 %), ketosis (SY = 11.6 vs SS = 12.2 %), and clinical endometritis (SY = 14.7 vs SS = 14.3 %) did not differ ($P > 0.10$) between treatments. Plasma GPx activity was similar ($P = 0.35$) for SY and SS, and averaged 571.18 nMol/mL/min. Fertilization rate did not differ ($P = 0.22$) between SY and SS (73.2 vs 84.1 %). Embryos classified as excellent and good as a percentage of fertilized (SY = 73.3 vs SS = 59.4 %) and total structures (SY = 53.6 vs SS = 50.0 %) were similar ($P > 0.10$) between treatments. Replacing a source of inorganic Se with Se yeast did not improve uterine health or embryo quality in lactating dairy cows.

Key Words: Selenium, Embryo quality, Dairy cow

Production, Management and the Environment I

M145 Postruminal survivability of *Fusarium graminearum* in infected barley kernels. Y. Wang^{*1}, D. L. McLaren², G. D. Inglis¹, S. L. Scott², T. K. Turkington³, and T. A. McAllister¹, ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, Alberta, Canada, ²Agriculture and Agri-Food Canada Research Centre, Brandon, Manitoba, Canada, ³Agriculture and Agri-Food Canada Research Centre, Lacombe, Alberta, Canada.

Survival of *Fusarium graminearum* (FG) in the post-ruminal environment was assessed following passage through the bovine intestinal tract, or incubation in fecal pats. FG infected barley kernels were studied as whole barley kernels (WBK), kernels halved longitudinally (H), steam pressure-treated whole (SPTW), tempered whole (TW), and tempered whole with surfactant (TSW). In Exp. 1, kernels of each treatment were sealed in mobile nylon bags, deposited through duodenal cannulae into three early-lactating Holstein cows (triplicate bags per treatment per cow), and retrieved from feces upon excretion. In Exp. 2, kernels sealed in nylon mesh bags (triplicate bags per treatment) were embedded in fecal pats from steers fed a barley-based finishing diet, and held at room temperature for 0, 2, 4, 7, 14, or 21 d. Upon retrieval of bags, 20 kernels per bag from Exp. 1 and 30 kernels per bag from Exp. 2 were surface sterilized with 0.3% NaClO, transferred onto selective medium (10 kernels per plate), and incubated for 5 d at 22°C. Survival of FG was expressed as the percentage of kernels plated that gave rise to FG colonies. With no intestinal or fecal incubation, FG grew in 36.7, 20.0, 0.0, 26.7 and 16.7% of WBK, H, SPTW, TW, and TSW kernels, respectively. No kernels from intestinal

incubations (Exp. 1) gave rise to FG colonies. In Exp. 2, viability was detected in 1 of 90 kernels in each of WBK, H, TW and TSW after 2 d of fecal incubation, but not after 4 d or beyond. A previous study revealed similar impairment of FG viability upon ruminal incubation of infected kernels. Thus, FG is unlikely to be spread by feeding infected barley grain to cattle. Contact of spilled grain with manure (e.g., pen floor) for ≥ 4 d will also inhibit FG survival. Care must be taken, however, to prevent spread of kernels during transportation and processing of infected barley.

Key Words: Viability, Intestinal digestion, Fecal incubation

M146 Response of bovine lateral saphenous vein to increasing concentrations of lysergic acid and ergovaline. J. L. Klotz^{*1}, B. C. Arrington², L. P. Bush², and J. R. Strickland¹, ¹USDA-ARS, FAPRU, Lexington, KY, ²University of Kentucky, Lexington.

Lysergic acid (ergoline alkaloid) and ergovaline (ergopeptide alkaloid) have been proposed as toxic components of endophyte-infected tall fescue. As many of the symptoms of fescue toxicosis are a result of compromised circulation, the objective of this study was to examine the vasoconstrictive potentials of D-lysergic acid (n = 12) and ergovaline (n = 12) using a bovine lateral (cranial branch) saphenous vein bioassay. Segments (2-3 cm) of the cranial branch of lateral saphenous vein were collected from healthy mixed breed cattle at local abattoirs. Veins were trimmed of excess fat and connective tissue, sliced into 2-3 mm sections and suspended in a myograph chamber containing 5 mL

of oxygenated Krebs-Henseleit buffer (95% O₂/5% CO₂; pH = 7.4; 37°C). Tissue was allowed to equilibrate at 1 g of tension for 90 min prior to initiation of treatment additions. Increasing doses of ergovaline or lysergic acid (1x10⁻¹¹ to 1x10⁻⁴ M) were administered every 15 min following buffer replacement. Data were normalized as a percent of contractile response induced by a reference dose of norepinephrine (1x10⁻⁴ M). Exposure of vein segments to increasing concentrations of lysergic acid did not result in an appreciable contractile response until the addition of 1x10⁻⁴ M lysergic acid (15.6 ± 2.3 %). Conversely, a vascular response to increasing concentrations of ergovaline was apparent at 1x10⁻⁸ M (4.4 ± 0.8%) and increased to a maximum of 69.6 ± 5.3% with the addition of 1x10⁻⁴ M ergovaline. These data indicate that only suprphysiological concentrations of lysergic acid results in vasoconstriction, but concentrations as low as 1x10⁻⁸ M ergovaline could elicit a vascular response. If other physiological systems in the animal are affected similarly, lysergic acid may only play a minor role in the manifestation of fescue toxicosis, whereas exposure to ergovaline, a much more potent vasoconstrictor, could result in appearance of fescue toxicosis symptoms.

Key Words: Bovine, Ergovaline, Lysergic acid

M147 Evaluation of the vasoconstrictive capacity of tall fescue alkaloids using fescue naïve bovine lateral saphenous veins. J. L. Klotz*¹, B. H. Kirch¹, G. E. Aiken¹, L. P. Bush², B. C. Arrington², and J. R. Strickland¹, ¹USDA-ARS, FAPRU, Lexington, KY, ²University of Kentucky, Lexington.

Vasoconstriction is associated with consumption of toxic endophyte-infected tall fescue. Because it is not known if endophyte-produced alkaloids act alone or in concert, the objective of this study was to examine the vasoconstrictive potentials of D-lysergic acid (LSA) and ergovaline (ERV) individually or in combination with N-acetyl loline (NAL) using bovine lateral saphenous veins biopsied from fescue naïve cattle. Segments (2-3 cm) of vein were surgically biopsied from healthy cross-bred yearling cattle (n=5; 360 ± 20 kg). Veins were trimmed of excess fat and connective tissue, sliced into 2-3 mm sections and suspended in a myograph chamber containing 5 mL of oxygenated Krebs-Henseleit buffer (95% O₂/5% CO₂; pH = 7.4; 37°C). Tissue was allowed to equilibrate at 1 g of tension for 90 min prior to initiation of treatment additions. Increasing doses of ERV or LSA (1x10⁻¹¹ to 1x10⁻⁴ M) with or without NAL (1x10⁻⁵ M) were administered every 15 min following buffer replacement. Data were normalized as a percent of contractile response induced by a reference dose of norepinephrine (1x10⁻⁴ M). Increasing concentrations of LSA did not result in an appreciable contractile response until the addition of 1x10⁻⁴ M LSA (22.6 ± 4.1%). A vascular response to increasing concentrations of ERV was apparent at 1x10⁻⁸ M (4.7 ± 2.2%) and increased to a maximum of 104.2 ± 6.0% with the addition of 1x10⁻⁴ M ERV. The presence of NAL did not alter the onset or magnitude of vascular response to either LSA or ERV (maximum responses of 24.9 ± 4.5 and 101.5 ± 10.9%, respectively). These data indicate that ERV is a more potent vascular toxicant than lysergic acid. Further, the presence of NAL did not inhibit or potentiate the effects of the ergot alkaloids on vascular activity. If these data persist in additional physiological systems, then tall fescue forages containing LSA and/or NAL should be safer for animal consumption than those containing ERV.

Key Words: Bovine, Alkaloids, Saphenous vein

M148 Effect of pulse grains on feedlot performance of newly weaned steers. V. L. Anderson*¹ and J. P. Schoonmaker², ¹North Dakota State University, Carrington, ²Land O' Lakes Inc., Madison, WI.

Pulse grains, especially field peas, are increasing in acres in the Northern Plains. Livestock feed is the default market for this relatively new category of nutrient dense grains that are 1.37 to 1.54 MCal/kg NEg and 22 to 26% crude protein. This study evaluated feed grade pulse grains in feedlot receiving diets. One hundred seventy six spring born steer calves from 40 different ranches in North Dakota and Montana (initial BW 253 ± 18.5 kg) were allotted by weight and source to one of four receiving diets that include approximately 17% (DM basis) chick peas, field peas, or lentils as the protein source compared to canola meal in the control diet. The 60% concentrate diets (15.75% CP, 115 Mcal/kg NEg) fed for 40 days included corn grain, corn silage, chopped hay, and an ionophore supplement. Steers were fed in 16 pens (11 steers per pen; 4 pens per treatment). Steers fed chick pea, field pea, or lentils during the first 20 d period gained 25.9% faster (1.41 vs 1.12 kg/d) and consumed more dry matter per day (5.40 vs 4.62 kg/d) compared to steers fed the control diet (P < 0.01). Feed efficiency did not differ (P > 0.32) among treatments for the first 20 d period. During the second 20 d period, no difference in gain, dry matter intake, or feed efficiency occurred (P > 0.38). Over the entire 40 d receiving period, steers fed pulse grains gained 9.2% faster (1.82 vs 1.67 kg/d; P < 0.05), and tended (P = 0.11) to consume more dry matter per day (7.39 vs 6.80 kg/d) compared to cattle fed the control diet. No differences were observed among the three pulse grains. Steers fed pulse grains during the receiving period continued to show increased gains (.25kg/d) for at least 7 weeks after the termination of the receiving trial when fed a standard finishing diet (13.3% CP, 137 Mcal/kg NEg). Field peas, chickpeas and lentils appear to support excellent feedlot performance.

Key Words: Pulse grains, Feedlot, Beef

M149 Effect of using a sheath protector at time of insemination on the pregnancy rate of beef cattle synchronized with CIDRs. W. A. Greene and M. L. Borger*, *The Ohio State University, Wooster.*

The main objective of this study was to determine the effect of using sheath protectors at time of artificial insemination on pregnancy rates (PR) in beef cattle synchronized with CIDRs. Ninety-three animals were allotted to two similar groups, sheath protector (P) and no sheath protector (N), based upon breed, age, postpartum interval, and postpartum cyclicity (as determined by estrus observation d -21 d to d 0). All cattle received an intravaginal releasing device (CIDR), containing 1.38 g progesterone, and 100 µg GnRH i.m. on d 0. On d 7, CIDRs were removed and all animals received 25 mg PGF_{2α} i.m. Each removed CIDR was evaluated for signs of vaginal infection and scored from 1 to 5 (1= clear, 5=heavy pus). Animals were observed for estrus 0700 and 1900 and were artificially inseminated (AI) 11-13 h after estrus was observed. If estrus was not observed, animals were timed AI (TAI) and received 100 µg GnRH i.m. 70-72 h after PGF_{2α}. Following the synchronization period, repeat breedings were done until d 53. Cows were pregnancy diagnosed by ultrasonography on d 83. P and N groups had similar (P>.05) PR to synchronization (50.0 and 66.6%) and overall PR (84.8 and 87.2). Estrus detection rates were higher (P<.05) for anestrous (60.9%) than cycling (37.9%) cattle following synchronization. Anestrous (n=64) and cycling animals had similar (P>.05) PR to synchronization (62.5 and 48.5%), and overall PR (79.3 and 89.1%). PR to synchronization were higher (P<.05) for

animals AI after estrus observation (70.0%, n= 50) than those TAI (44.2%). Cattle with high vaginal scores (4&5, n= 61) and low vaginal scores (1, 2, & 3) had similar ($P > .05$) PR to synchronization (59.0 and 56.3%) and overall PR (85.3 and 87.5%). Eleven of the 12 heifers compared to 61.7% of the cows had high vaginal scores. There were no apparent benefits to the addition of sheath protectors at time of AI in a beef synchronization program using CIDRs.

Key Words: Sheath protector, CIDR, Synchronization

M150 Intake and performance of beef steers with ad-libitum access to a balanced ration or the same ingredients of the balanced diet but delivered in separated bunks. J. Arroquy^{1,2}, J. Saravia¹, A. Fumagalli^{1,3}, F. Moretto³, A. Lopez³, and C. Lopez³, ¹*Instituto Nacional de Tecnología Agropecuaria, EEA-Santiago del Estero, Santiago del Estero, Argentina*, ²*Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina*, ³*Universidad Nacional de Santiago del Estero, Santiago del Estero, Argentina*.

The objective of this experiment was to evaluate the effect of feeding an uniform mixed diet compared with feeding the same proportion of each ingredient of the balanced diet delivered in separated bunks. Thirty beef steers (Braford, Criollo, and Braford × Criollo; initial average liveweight = 260 ± 21 kg) were used in a 87-d finishing study. Treatments consisted of a uniform mixed concentrate diet (control) vs. the same ingredients offered separately in equal proportion of the mixed ration (free-choice). Treatments were arranged in a completely randomised design (three pens/ treatment). Animals were fed daily ad libitum with the following proportion of feedstuffs, 75% whole corn grain, 10% whole cotton seed, and 15% grass hay (*Setaria italica*). All steers had ad libitum access to water and a mineral-salt. Final body weight did not differ between treatments (final average liveweight = 331 ± 28 kg; $P = 0.78$). Average daily gain was numerically superior to the control, but did not differ between control vs. free-choice (847 vs. 800 g/d for control vs. free-choice respectively; SEM = 100 g/d). Intra-pen variability for ADG was similar between control and free-choice ($P = 0.59$). Dry matter intake did not differ between control and free-choice (average dry matter intake, 7.2 vs. 7.1 kg/d for control vs. free-choice respectively, $P = 0.99$). Similarly feed to gain ratio was not affected by treatments (feed: gain ratio, 8.47 vs. 8.96 kg of DM/ kg of gain for control vs. free-choice respectively, $P = 0.30$). The proportion of whole corn grain was similar between treatments (75.4 vs. 74.2% for control vs. free-choice respectively, $P = 0.39$). However, steers in free-choice adjusted the proportion of ingredients selecting grass hay (14.6% control vs. 19.4% free-choice; $P < 0.01$) and rejecting whole cotton seed (10.0% control vs. 6.5% free-choice; $P < 0.05$). In conclusion under the conditions of this trial, free-choice selection of the components of a mix ration did not improve feed intake, liveweight gain, and feed efficiency with regard to a uniform mixed diet.

Key Words: Liveweight gain, Intake, Feed efficiency

M151 Evaluation of forage-based weaning systems in spring-born cross-bred beef calves. J. F. Odhiambo*, E. E. Felton, R. A. Dailey, and P. I. Osborne, *West Virginia University, Morgantown*.

Preconditioned calves have more market value per unit weight than normal-weaned calves. Therefore, development of a low cost forage-based weaning system allows producers to add value to their calf-crop. This study evaluated calf performance in three forage-based weaning systems; early-weaned calves were backgrounded in legume/grass forage plots and supplemented with commercial preconditioning

feed (Treatment I) or corn-mix (Treatment II). Control (Treatment III) calves suckled their dams for an additional 45 days. Diets were formulated to provide 2.17 kg TDN/calf/day. Weights were collected on days -30, 0 and 45 of the experiment from 135 and 150 calves in years 1 and 2, respectively. The effects of treatment, sex, age of dam, year and their interactions on calf weight gain were analyzed by analysis of covariance using GLM procedures of SAS. The data are reported as least squares means. Treatment affected ($P < 0.05$) calf weight gain in a similar fashion in both years. Overall calf weight gains averaged 1.21, 0.94 and 1.05 kg/calf/day, for commercial supplement, corn-mix and controls, respectively. Year by sex of calf interaction was significant ($P < 0.005$) for calf weight gain. Steer calves gained more ($P < 0.0003$) weight in year 1 compared to year 2 (54.6 and 46.8kg, respectively). Heifer weight gains did not differ between years (43.2 and 47.1 kg in year 1 and 2, respectively). Cow age also affected ($P < 0.005$) calf weight gain; calves from 2-year-old cows gained less weight compared to those from cows 3-5 and > 5 years of age (44.2, 48.8 and 50.8 kg, respectively). In year 1, there was a tendency ($P = 0.07$) for cow age by treatment interaction on steer weight gain; early-weaned steers from 2-year-old cows gained considerably more weight compared to control steers (59.9 and 46.7 kg, respectively). In conclusion, calf weight gain and profit potential can be improved by forage-based weaning systems as long as other inputs such as feed costs and labor are held within reasonable limits.

Key Words: Early weaning, Calves, Weight gain

M152 Relationship of two measures of disposition and gain performance of steers. R. L. Weaber and F. E. Creason*, *University of Missouri, Columbia*.

Data were collected on Angus cross steers (n=111) with known pedigree, to determine the effect of disposition on weight gain (WG) during the short-term post-weaning growing period. Disposition was measured by pen score (PS; 1=gentle, 5=aggressive) and exit velocity (EV; m/sec). Exit velocity was measured using infrared electronic triggers to start and stop an electronic recording device to time a steer as it traveled a fixed distance (1.83 m) upon exiting a squeeze chute. Exit velocity data were recorded when the initial weights were recorded, vaccinations for clostridial diseases and BRDC given, and the steers fit with electronic identification and visual ear tags. Pen scores were recorded when the final weights were collected and blood drawn. Steers weighed 242.70 (± 2.45) kg at the start (initial) of the trial and finished at 318.93 (± 3.08) kg 55 days later revealing an average WG of 76.23 ± 1.12 kg. Exit velocity averaged 2.25 ± 0.05 m/sec while PS averaged 2.09 ± 0.11. Pearson correlation coefficients (r) and PROC MIXED were used for statistical analysis. A linear model for WG was developed with EV and PS as fixed effects and sire as a random effect. In this model, EV ($p < 0.05$) was the only significant source of variation in WG. In a reduced model consisting of EV (fixed) and sire (random) effects, both EV ($p < 0.02$) and sire ($p < 0.05$) were significant sources of variation in WG. The estimated effect of EV on WG was -5.39 ± 2.13 kg/sec. Exit velocity was correlated with PS, $r = 0.36$ ($p < 0.001$), and WG, $r = -0.24$ ($p < 0.02$). Pen score was correlated with WG, $r = -0.21$ ($p < 0.03$). While the correlations between EV and WG were not significantly stronger ($p > 0.05$) than correlations between PS and WG, as an objective measure of temperament, EV was more desirable for explaining temperament effects on WG. Increases in EV (faster flight times) were negatively associated with WG during a short-term post-weaning growing period.

Key Words: Temperament, Gain, Beef cattle

M153 Effect of a mineral mix containing Tasco® meal on performance and reproduction in mature beef cows. J. E. Stegner^{*1}, B. Laudermilch¹, W. D. Whittier¹, R. Kasimanickam¹, D. Colling², and J. B. Hall¹, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²Acadian Agritech, Dartmouth, NS, Canada.

The objective of this study was to examine if inclusion of Tasco® meal into mineral supplements would improve reproduction in beef cows grazing endophyte infected fescue. Mature crossbred spring-calving beef cows (n = 1060) from 6 farms in Virginia were randomly assigned within farm to TASC0 (n = 465) or CONTROL (n = 595) mineral supplements. TASC0 and CONTROL mineral supplements were designed to provide equivalent amounts of macro and micro minerals except TASC0 contained 10% Tasco® meal. Mineral supplementation began 30 to 45 d before the initiation of breeding (April) and continued until the end of the breeding season (July). Cows were bred by AI plus natural service or natural service only. Body condition scores (BCS; 1 = emaciated to 9 = obese) and hair scores (HS; 1 = slick summer coat to 4 = winter coat) were obtained at the initiation and completion of mineral feeding. Pregnancy rates were obtained by ultrasound and via palpation between d 45 and d 60 after end of the breeding season. Body temperatures at AI were obtained on 205 and 254 cows for TASC0 and CONTROL, respectively. Cows had similar (P > 0.5) BCS and HS at the beginning of the study. Mineral supplement did not affect (P > 0.5) final BCS or HS. Hair scores improved (P < 0.05) but BCS did not change during the study. Body temperature at AI was similar (P > 0.5) between supplements and averaged 102.3 ± 0.2°. Overall pregnancy rate was not different (P > 0.4) for TASC0 (85.4%, 344/403) or CONTROL (83.7%, 462/552) cows. However, pregnancy rate was affected by farm (P < 0.04). We conclude that TASC0 supplementation was unable to overcome the effects of endophyte infected fescue on pregnancy rates in cows under conditions of this study.

Key Words: Nutrition, Reproduction, Beef cow

M154 Relationships between endocrine status, temperament, growth and carcass traits in replacement beef heifers supplemented with dietary fat. A. R. Dos Santos^{*1,2}, S. T. Willard¹, R. C. Vann², and B. Macoon², ¹Mississippi State University, Starkville, ²Brown Loam Experiment Station, Raymond, MS.

The use of dietary fat supplementation can stimulate reproductive function by enhancing metabolic hormone secretions. Feeding dietary fat increases circulating cholesterol (CHOL) and progesterone (PROG). In addition, supplementation with dietary fat may improve carcass traits and hasten puberty in beef cattle; while the effects of temperament on these factors have yet to be determined. The objective of this study was to evaluate the effects of dietary fat supplementation on endocrine status and its relationship with growth, temperament and carcass traits in beef heifers grazing ryegrass. Yearling beef heifers were assigned to treatments for 84 d as follows: Ryegrass pasture (RYP; n=14); flaxseed (FlaxLic™, FLX; n=14; 3% fat; 0.35 kg/hd/d), and pelleted whole cottonseed (Fuzzpellet™, FUZ; n=14; 1.5% fat; 0.8 kg/hd/d). Measurements for carcass traits and blood samples were collected on d 0, 21, 42, 63, and 84 for ribeye area (REA), rib fat (BF), rump fat (RF), gluteus medius depth (GMD), percent intramuscular fat (%IMF) and IMF stress score (IMF-S), with serum PROG, total CHOL and cortisol (CORT) determined by RIA. Heifer temperament was determined at d 77. Overall, FLX and RYP heifers had greater (P<0.03) CHOL than FUZ heifers. Among cycling heifers, PROG (d 0 to 63) tended to be greater (P<0.10) for RYP than FLX and FUZ heifers. CORT did not differ (P>0.10) among treatments throughout the study. Change in BF and RF were correlated (0.33; P<0.04) with CHOL

and not CORT (P>0.10). %IMF, GMD and REA were not correlated with CORT or CHOL (P>0.10) among treatments over time. Heifers stratified as temperamental were correlated (0.49, P<0.01) with IMF-S but did not differ (P>0.10) in %IMF (d 63 and 84), with no relationship (P>0.10) between temperament and CORT observed. Average daily gain (ADG) was not influenced (P>0.10) by CORT, CHOL or temperament. In conclusion, dietary fat supplementation did not enhance endocrine status over heifers grazing ryegrass pastures alone. Moreover, while some carcass traits had positive associations with CHOL (BF and RF), temperamental heifers had higher IMF-S.

Key Words: Carcass, Beef, Endocrine

M155 Crop-livestock production system for fattening lambs under desert farming. N. Eweedah*, Faculty of Agriculture, Kafr El-Sheikh, Egypt.

The present study was designed to investigate the response of growing lambs to different feeding systems under desert agriculture conditions. 255 Barki lambs with an average live body weight of 31.27 kg were used in feeding trials lasting 120 days. Animals were divided into three similar groups. The feeding systems based on grazing the lower portion of alfalfa remaining after cattle grazed the fodder in addition to different experimental rations were: RI, Concentrate feed mixture (CFM) + wheat straw (control). RII, Cracked barley grain (BG) + wheat straw (WS). RIII, CFM and BG 2:1 ratio + wheat straw. The concentrate portion was fed at a level 2% of live body weight with ad libitum wheat straw. Nutrient digestibility, determined previously using the acid insoluble ash technique, was (P<0.01) significantly lower for RI compared to RIII. Ration II had intermediate values between the lowest values for RI and the highest values for RIII. The differences between neither RI and RII nor RII and RIII were not significant for DM, OM and EE digestibilities. Moreover, no significant difference was detected between RI and RII for DM, OM, CP, CF and EE digestibilities. Nutritive values were significantly (P<0.01) higher for RIII than the other two rations. No significant differences were observed among the different feeding groups in ruminal pH values. Ammonia-N and total volatile fatty acids concentrations were significantly (P<0.01) increased for rations II and III compared to the control ration. Average daily gain was 135, 155 and 178 g/day for lambs fed rations I, II and III, respectively. It increased by 14.8 and 31.9% for rations II and III compared to the control ration. Feed conversion efficiency values (kg DM/kg gain) for animals fed rations RII or RIII were better than those fed the control ration, it improved by 4.0 and 13.7% for rations II and III, respectively. Moreover, economical efficiency improved by 30.5 and 17.0%, while feed cost, as LE/kg gain was decreased by 23.2 and 14.3% for lambs fed rations II and III, respectively compared to the control ration.

Key Words: Lambs, Feeding value, Animal performance

M156 Predicting fineness of instrument-classed wool lines using an Optical-based Fibre Diameter Analyser (OFDA2000). C. J. Lupton and F. A. Pfeiffer*, Texas Agricultural Experiment Station, San Angelo, TX.

The portable, computerized OFDA2000 (BSC Electronics, Ardross, Western Australia) was developed for measuring properties related to fiber diameter and staple length of raw wool. It has been widely used to facilitate sheep selection in the field based on the economically important wool trait average fiber diameter (AFD). This experiment

was conducted to establish the accuracy of predicting AFD of instrument-classed wool lines produced by measuring a single mid-side staple removed from each skirted fleece in the line. Two important assumptions are involved in the prediction: the AFD of a mid-side sample is not different than whole fleece AFD; and, fleeces are of equal weight. To take full advantage of the USDA's Wool Loan Deficiency Payment Program, target AFD ranges during the time period of the experiment (2003 to 2005) were typically < 18.6, 18.6 to 19.5, and > 19.5 μm . Actual AFD values (range 17.5 to 21.2 μm) of the lines were established by measuring representative core samples using standard methodology. Over the 3-yr period, 8 clips were measured and 26 classed lines (weight range 200 to 7500 kg) were evaluated. Actual were greater than predicted AFD values (0.25 μm , P for paired t-test = 0.0259). The relationship between actual (y) and predicted (x) AFD was $y = 6.02 + 0.70 * x$, $r^2 = 0.88$, SE of the y estimate = 0.35 μm . The range in (predicted – actual) AFD values was -1.2 to 0.7 μm . The r for actual versus (predicted – actual) AFD was 0.50 that indicates a positive and significant bias (P < 0.01). In summary, the technique used here did not provide accurate estimates of AFD for classed wool lines in the range 17.5 to 21.2 μm . The accuracy of the estimates varied considerably among clips (flocks) indicating the inadequacy of mid-side sample AFD values (and presumed constant fleece weights) to predict fleece and ultimately classed line AFD. The variable accuracy of prediction may also be a function of the varying degrees of uniformity present in the fleeces of the flocks tested.

Key Words: Fineness, OFDA2000, Wool

M157 Twin rate influences milk yield in Sarda dairy sheep in organic and conventional farms. G. Canu¹, C. Dimauro², A. Natale³, C. Patta¹, and G. Pulina^{*2}, ¹Istituto Zooprofilattico Sperimentale per la Sardegna, Sassari, Italy, ²Università di Sassari, Sassari, Italy, ³Associazione Regionale Allevatori della Sardegna, Cagliari, Italy.

Several studies have reported higher milk yields in dairy and non-dairy sheep with multiple births. The aim of this experiment was to investigate the influence of twin rate on milk yield in Sarda dairy sheep in both organic (O) and conventional (C) farms. Data derived from the PERSEO-ARA database and consisted of 235 farms (54 O and 181 C); 64,908 ewes (24.7 % in O); 7 years (1996-2002), and the 4 provinces of Sardinia (Italy), i.e. Sassari (SS), Nuoro (NU), Oristano (OR), and Cagliari (CA). Twin rate (expressed as the percentage of lambed ewes which had multiple births) was classified into four classes: low (L \leq 14%); medium-low (14% \leq ML \leq 24%), medium-high (24% \leq MH \leq 29%), and high (H \geq 29%). Mixed procedure of SAS was used to analyse the following model: $Y_{ijklmn} = \mu + Tc_i + F_j(Tc_i) + T_k + C_l + P_m + T * Tc + Tc * C + I_n + \epsilon$, where Y = total milk yield (in kg/ewe per year), μ = overall last square mean, Tc_i = twin-rate class, $F_j(Tc_i)$ = farm j on twin-rate class i (random effect), T_k = year, C_l = farm type, P_m = province, and I_n = abortion incidence (covariate). Twin rate ($\mu \pm se = 23.74\% \pm 0.54\%$) influenced total milk production ($\mu \pm se = 143.33 \pm 1.33$ kg/ewe per year) in farms belonging to the MH or H classes only, especially in the H class of O farms (149.0 and 164.8 kg/ewe per year in the H class of C and O farms, respectively), with a different trend among the years (interaction P=0.0127). Year and province contributed significantly to explain a relevant part of the variance, similarly to the covariate abortion incidence (P=0.0073; $\mu \pm se = 2.31\% \pm 0.15\%$). There were no differences in milk yield between O and C farms, even if the interaction between farm type and twin–rate class was highly significant (P=0.002).

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Table 1. Contribution of twin rate class, year, province and farm type to milk yield expressed as deviation from a mean of zero.

Twin rate class	Milk yield	Year	Milk yield	Province	Milk yield	Farm type	Milk yield
kg/ewe per year							
L	-8.11 a	1996	-7.01 ab	CA	+25.29 a	C	-0.72 a
ML	-5.44 a	1997	-8.36 a	NU	+1.60 b	O	+0.72 a
MH	+7.60 b	1998	+0.14 bcd	OR	-47.16 b		
H	+5.95 b	1999	-3.83 abc	SS	+20.27 a		
		2000	+4.45 $\chi\delta$				
		2001	+5.62 δ				
		2002	+9.01 δ				

Means with different letters within the column are significantly different at P<0.05.

Key Words: Dairy sheep, Twin rate, Organic farm

M158 The effect of two management systems of dairy ewes on milk production. S. A. Maestá, E. R. Siqueira, M. M. Stradiotto, C. C. Boucinhas, A. Piccinin, and R. M. S. Emediato*, São Paulo State University, Botucatu, São Paulo, Brazil.

Most of Brazilian breeds present capability for meat or wool production, but it is possible to find animals with dairy properties. Bergamasca ewes, for example, introduced in Brazil in 1940, are raised in the Northeast for meat production. Considering their Italian origin, they could be used for milk production; however, the amount of milk produced by lactation and its characteristics are not well known. In view of this, the objective of the present work, carried out at the Ewe Milk Production Research Unit of the College of Veterinary Medicine and Animal Science of the São Paulo State University (UNESP), is to evaluate the effect of the different management systems on milk production of Bergamasca ewes. Eighty seven ewes were used and submitted to two milk production systems. In the group without lambs, these were separated from their mothers 48h after birth, while, in the mixed group, lambs were kept with their mothers until to 60 days of age, when they were weaned. Both ewes from the group without lambs and from the mixed group were machine-milked for a period of 90 days and milk production was daily measured during the whole experimental period. The statistical analysis was performed by means of the GLM procedure of the Statistical Analysis System (SAS, 1985). Ewes managed in the group without lamb presented higher (P<.05) daily average milk production in comparison to the mixed group. This difference may be explained, in part, by milk injection inhibition during machine-milking. In the beginning of lactation, the absence of a proper sign during machine-milking, which is usually present when females are nursing their lambs, inhibits the release of oxytocin and milk ejection reflex.

Key Words: Dairy sheep, Machine-milking, Milk yield

M159 Effect of suckling management on skeletal development and productive performance of Comisana lambs. A. Ciarlariello¹, G. Maiorano^{*1}, C. Cavone¹, R. J. McCormick², and A. Manchisi¹, ¹University of Molise, Campobasso, Italy, ²University of Wyoming, Laramie.

A study on restricted suckling of lambs was conducted to evaluate skeletal development and productive performance of growing lambs.

Twenty-one naturally suckled male *Comisana* lambs were divided into three equal weight groups differing in suckling regimen: 1) only maternal milk (C); 2) only maternal milk until 14d of age and, from 15d of age to slaughter, maternal milk, concentrate and Lucerne hay *ad libitum* (T1); 3) only maternal milk until 14d of age and, from 15d to 30d of age, maternal milk, concentrate and Lucerne hay *ad libitum*, and from 30d of age to slaughter only concentrate and Lucerne hay *ad libitum* (T2). Average daily weight gain and milk and feed intake were calculated. At slaughter (63d) live weight and carcass traits (dressing percent, shrink losses, kidney fat and shoulder percent) were recorded. In addition *longissimus dorsi* (LD) muscle area, pH and color (45 min and 24 h *post mortem*) were recorded. Metacarpal and metatarsal bones were measured for length, diaphyseal diameter, weight, and moisture content. Metacarpal growth plate width was also assessed after AgNO₃ staining. ANOVA was performed and comparisons were tested by Scheffé's test. Suckling management system significantly affected milk and feed intake and ADG, while live weight, hot and chilled carcass weights and shrink losses were not different. Compared to T1 and T2, C had heavier (P<0.05) hot (71.34b, 67.53a and 66.97a %, respectively) and cold (69.79b, 66.30a and 65.22a %, respectively) dressing percentages. T2 compared to T1 and C groups showed a greater shoulder percentage (8.00b, 7.78ab and 7.50a %, respectively; P<0.05) and a lower kidney fat percentage (0.54a, 1.27b and 1.96c %, respectively; P<0.001). LD area, pH and color values were similar among experimental groups. No difference was observed in bone measurements. Suckling management appears to be an important factor affecting lamb growth and carcass quality.

Key Words: Lamb, Suckling management, Productive performance

M160 Effects of an aluminum-water treatment residual on performance and mineral status of feeder lambs. R. Van Alstyne, L. R. McDowell*, P. A. Davis, N. S. Wilkinson, and G. A. O'Connor, *University of Florida, Gainesville.*

Manure, which is often applied to grazing land, contains P that when in excess may lead to water pollution. Previous studies suggest that application of an Al containing water treatment residual (WTR), a byproduct of water purification, increases the soil's capacity to bind and retain P. An experiment was conducted to see if WTR was detrimental to ruminants. A 14 week experiment was conducted using 42 feeder lambs. Individual feeding was recorded between weeks 11 and 14. Diets, containing 0.25% P (as fed), included 1) control 10% sand, 2) 9.7% sand and 0.3% AlCl₃, 3) 2.5% WTR and 7.5% sand, 4) 5% WTR and 5% sand, 5) 10% WTR and 0% sand, and 6) 10% WTR, 0% sand, and additional P with double the supplemental trace minerals. Total Al varied from 910 to 8,000 ppm. Lambs fed the control and WTR had no decline in intake, BW or ADG which may be attributed to the non-available Al found in WTR. Whereas lambs fed AlCl₃ repeatedly had lower BW and intakes. During week 6, all treatments declined in plasma P, but the AlCl₃ treatment declined the most. Accumulations of Al in brain were greatest for lambs given 2,000 ppm Al from AlCl₃ and increased incrementally when Al as WTR was fed at levels higher than 2,000 ppm. With the exception of the brain, soft tissues did not accumulate large amounts of Al during this 14 week experiment. Apparent P absorption from a 14 day metabolic study was positive (P<0.05) (10.9-31.8%) for all lambs except those receiving 2,000 ppm Al via AlCl₃, with a negative P absorption of -12.9%. Aluminum, as AlCl₃, fed at 2,000 ppm reduced dietary P retention, but varying amounts of Al as WTR had no effect on P apparent absorption with similar absorption rates as the control. Therefore when dietary P is supplied in amounts of 0.25% or higher, Al (via WTR) fed to lambs

in amounts as high as 8,000 ppm did not negatively impact the feed intake, gain, BW, tissue P, plasma P, or P absorption.

Key Words: Aluminum, Phosphorus, Status

M161 Effects of age, location, and nutrition on body weight, fiber production, and fiber quality characteristics of penned alpaca males. C. J. Lupton*¹, R. P. Elvestad², F. A. Pfeiffer¹, and K. MacKinnon², ¹*Texas Agricultural Experiment Station, San Angelo, TX,* ²*Natural Fibre Centre & Testing Laboratory, Olds, Alberta, Canada.*

Yearling alpaca males (36, offspring of 9 sires, BW = 40.0 ± 7.7 kg) from a single Canadian flock were obtained for this study. Half the animals were re-located to research facilities in Alberta and the other half to Texas. The animals were sheared annually in April or May and 26 fleece and fiber traits were measured on each of the 5 fleece components. At both locations, alpacas were assigned to three groups (6 alpacas per treatment, 3 per rep) blocked by yearling BW and fleece weight (FW). In year 2, local hays and mixed ration (50/50) combinations were evaluated to produce monthly gains in BW of 3%. At the end of year 2, three nutrition treatments were imposed consisting of the diets that produced the 3% gain, and 10 and 20% less (hay and ration). Animals were weighed and assessed for body condition monthly and diets were adjusted accordingly. As the alpacas aged (1 to 3 yr), BW, FW, fiber fineness (AFD), staple strength (SS), resistance to compression (R2C), total medullated (TM) and objectionable fibers, and AFD of TM fibers all increased. In contrast, fiber production / unit BW, fiber curvature, and staple length (ASL) showed declines. Body condition score, clean yield (CY), vegetable matter present, and flat fibers did not change with age (P > 0.05). In year 3, the BW, FW, AFD, TM and R2C of AB > TX alpacas (P < 0.05). In contrast, CY and SS of TX > AB fleeces. Most other characteristics were unaffected by location. Young alpaca males fed to gain at moderate rates (2 to 3% increase in BW / mo) produced more fiber (actual and g/kg BW, P < 0.05) that tended to be slightly coarser (P = 0.1) and more heavily medullated (P < 0.05) than animals that received 20% less feed. In all other measured traits, fleeces produced in the three nutrition treatments were similar. In addition to the stated objectives, this study documented variability in and correlations between alpaca traits.

Key Words: Alpaca, Fiber, Nutrition

M162 Gestation length in Alaskan reindeer. M. P. Shipka* and J. E. Rowell, *University of Alaska Fairbanks, Fairbanks, AK.*

Estimates of gestation length for reindeer vary from 198 – 240 d, exceeding mean estrous cycle length (24 d) and limiting practicality in predicting calving. A negative correlation between conception date and gestation length has recently been identified in Alaskan (n=8) and Norwegian (n=13) reindeer. The negative correlation implies that females bred early in the season have a longer gestation. We investigated the relationship between gestation length and breeding date by examining historical data for captive reindeer at the University of Alaska Fairbanks to look at the impact of early or late breeding dates on gestation length and the association between gestation length and calf sex, birth weight, and dam body weight at conception. Historical data included only individuals that had known breeding dates confirmed by systemic progesterone analysis along with recorded date of parturition. These data include 39 individual cows from two separate reindeer facilities at UAF. When the historical data were

pooled, there was a negative correlation between gestation length and breeding date ($r = -0.628$; $P < 0.001$; $n = 39$). Neither birth weight ($P = 0.794$; $t_{df=31} = 0.264$) nor gestation length ($P = 0.239$; $t_{df=36} = 1.198$) differed between male and female calves and there was no significant correlation between pooled birth weight and gestation length ($r = 0.323$; $P = 0.067$; $n = 33$). Dam body weight at conception was positively correlated with gestation length ($r = 0.466$; $P = 0.016$; $n = 26$). While sample size in the historical data set is small, the negative relationship between conception date and gestation length coupled with the poor association between gestation length and both calf gender and birth weight is intriguing. The idea that gestation length may vary in response to social and environmental cues has been suggested in other species, although hard evidence and a mechanistic explanation are lacking. To address the phenomenon of a negative relationship between conception date and gestation length, a controlled study was initiated during the 2005 breeding season that included early and late season breeding to synchronized estrus in reindeer cows. These cows will calve in April/May, 2006.

Key Words: Reindeer, Gestation length

M163 The diversity of bacterial community in the gut differs between different hatches of broiler chicks. G. W. Tannock¹, S. Musa¹, K. Munro¹, and V. Ravindran^{2*}, ¹University of Otago, Dunedin, New Zealand, ²Monogastric Research Centre, Massey University, Palmerston North, New Zealand.

The aim of the experiment was to determine whether the gut microbiota of chicks entering a broiler shed was consistent in composition between

different hatches. A variable degree of contamination of the chick gut at hatching might influence the subsequent development of gut microbiota in the broiler and disease resistance. Male, day-old chicks (Ross) were obtained at monthly intervals from six different hatches from the same commercial hatchery. Upon arrival at the farm, the chicks were placed in the same broiler facility and fed the same standard commercial diet (without antibiotics). Twenty four hrs after the introduction into the facility, the chicks were killed by cervical dislocation and, digesta samples were collected from the crop, ileum and cecum of 10 chicks. Denaturing gradient gel electrophoresis (DGGE) of DNA fragments obtained by polymerase chain reaction (PCR) amplification was used to define the microflora profile. Bacterial DNA was extracted from each sample and the V2-V3 regions of the 16S ribosomal RNA gene were amplified by PCR using bacterial primers HDA1-GC and HDA2. The 16S rDNA fragments in the PCR products were separated by DGGE to generate a profile of the bacterial community in the gut samples. DNA fragments of interest were cut from the DGGE gel and sequenced to permit bacterial identification. There was hatch-to-hatch variation in the crop, ileal, and cecal microbiota profiles. One fragment was observed to be common to most chicks in all hatches. The bacterial community was dominated by *Lactobacillus* species, but distinctive ileal and cecal profiles were obtained for each hatch. These data show that the microbiota of broiler chicks entering sheds will be different for each production cycle.

Key Words: Gut microbiota, Polymerase chain reaction, Broiler

Ruminant Nutrition: Fat Feeding, Metabolism, and Composition

M164 Influence of short-term feed restriction on milk production traits of Sarda dairy ewes. G. Pulina*, A. Mazzette, G. Battacone, and A. Nudda, *Dipartimento di Scienze Zootechniche, University of Sassari, Sassari, Italy.*

The effects of short-term feed restriction on milk yield and milk composition of Sarda dairy ewes were studied in a 17-d experiment. Twenty sheep were housed in individual pens and divided in two isoproductive groups. Ten ewes (feed restricted group, FRG) were fed a total mixed ration pelleted diet (TMR-PD) *ad libitum* (average intake of 2.5 kg/head per day) for 7 days (preliminary period), followed by 3 days of feed restriction of 50% of their previous intake (1.25 kg/head per day of TMR-PD) and 7 days of recovery. The other ten ewes (control, C group) were fed TMR-PD *ad libitum* during all the experimental period (average intake of 2.5 kg/head per day). There were no differences in milk yield between the two groups during the preliminary period (1485 and 1493 g/d for FRG and C group, respectively). Milk yield for the FRG decreased during the feed restriction period and averaged 72% of the values of the C group (1009 vs 1389 g/d, $P \leq 0.001$). Milk yield of the FRG was not completely restored during the 7-d recovery period, remaining lower than that of the C group (1278 vs 1451 g/d, $P = 0.12$). Fat percentage tended to increase in FRG during the feed restriction period (5.87% vs 5.27%, $P = 0.08$), and remained higher than that of the C group during recovery (6.04% vs 5.20%, $P \leq 0.01$). No effects of feed restriction on protein percentage (5.52% vs 5.53% for FRG and C group, respectively) were observed. SCC was lower in the FRG than in the C group during the

preliminary period (Ln SSC 4.51 vs 4.71, $P = 0.06$), increased by more than 4 fold during the feed restriction period (Ln SSC 5.34 vs 4.76, $P = 0.02$) and remained higher during the recovery period (Ln SSC 5.4 vs 4.8, $P = 0.10$). Short-term feed restriction caused a permanent drop in milk production and an increase in SCC on dairy ewes.

Funded by the PRIN-MIUR, Intellatle project

Key Words: Feed restriction, Milk, Dairy ewes

M165 Influence of short-term feed restriction on milk fatty acid profile in dairy ewes fed complete pelleted diet. A. Nudda, S. Fancellu, A. Mazzette, G. Battacone, and G. Pulina*, *Università di Sassari, Sassari, Italia.*

During feed restriction, changes in metabolism occur and often result in the mobilization of energy from the adipose tissue. The objective of this work was to evaluate changes in the fatty acid (FA) profile of milk fat during short-term feed restriction in dairy ewes. Six ewes (3 at low-body condition score and 3 at high-BCS) were fed a complete pelleted diet (CPD) *ad libitum* (average intake of 2.5 kg/head per d) for 7 days, followed by 3 days of feed restriction of 50% of their previous intake (feed restriction group, FRG). Other 6 ewes (control, C group), divided into 3 low-BCS and 3 high-BCS sheep, were always fed CPD *ad libitum* (average intake of 2.5 kg/head per d). The CPD composition was (on a DM basis) 38.3% NDF, 16.0% CP and 4.5% EE (of which 2% of palm oil). The data of the 3-d treatment were analysed by a

mixed model using BCS, group and their interaction as fixed factors and ewe as random factor. Milk fat content was higher in the FRG than in the C group (5.92 vs 4.67%), whereas fat yield was similar between groups. No effects of short-term feed restriction on C4-C14 fatty acids were observed. The FRG showed a lower content of C16:0 (26.46 vs 29.59%; $P \leq 0.05$) and cis9,cis12 C18:2 (4.42 vs 5.38%; $P \leq 0.10$) and a higher content of cis9 C18:1 (20.81 vs 17.56%; $P \leq 0.05$) than the C group. The content of total CLA (1.47 and 1.27 in the FRG and C group, respectively) was not influenced by the feed restriction treatment. The extent of variation in milk fatty acid profile in FRG group (expressed as percentage respect to C group) was influenced by BCS of ewes. The results suggest that feed restriction for a 3-d period is enough to cause changes in the FA profile of milk fat. The different responses observed in animals with high and low BCS was probably due to a different extent of body store mobilization when feed restriction occurred.

Funded by the FISIR-MIUR project.

Key Words: Dairy sheep, Milk fatty acid, Feed restriction

M166 Fat stability and preservation of fatty acids with AGRADO® antioxidant in feed ingredients used in ruminant rations. J. Andrews* and M. Vazquez-Anon, *Novus International, St. Louis, MO.*

Oxidation can have negative effects on fat quality and animal performance. Nutrients most susceptible to oxidation are fats, fat soluble vitamins, carotenoids. A series of experimental trials were run to evaluate the stability of fats from soybean oil (SO), menhaden fish oil (FO), yellow-grease (YG), a blend of corn oil, yellow grease, and fish oil (BO), and wet distiller grains (WDG) in the presence and absence of AGRADO antioxidant (A). Fats were oxidized in the presence or absence of A by bubbling air through the fat at elevated temperatures and a given time period. Peroxide values, fatty acid profiles, Active Oxygen Method (AOM) and Oil Stability Index (OSI) were used to assess the quality and stability of the fats. All fats tested were readily oxidized under artificial oxidative stress, but were stabilized in the presence of A as indicated by the reduction in the AOM values of 191.5, 346, 288, and 191 meq of peroxides from control for SO, YG, BO, and WDG, respectively ($P = 0.05$). In the presence of A, the OSI values were improved by 7, 14.5, 6, 4.9, and 43 h compared to control for SO, FO, YG, BO, WDG, respectively ($P = 0.05$). The concentration of linoleic, linolenic in SO, YG, WDG and concentration of EPA and DHA in FO and BO were reduced during artificial oxidation but preserved in the presence of A. Across all sources of fats evaluated in the study, addition of A significantly improved the stability and quality of the fat as reflected by the AOM and OSI values and preservation of essential fatty acids. AGRADO is a trademark of Novus International, Inc. and is registered in the United States and other countries.

Key Words: Oxidized fat, Agrado, Antioxidants

M167 Meta-analysis on the effects of lipid supplementation on methane emissions and milk performance of lactating dairy cows. M. Eugène*, C. Benchaar, J. Chiquette, and D. Massé, *Agriculture and Agri-Food Canada, Dairy and Swine R&D Centre, Lennoxville, QC, Canada.*

The objective of this study was to statistically assess the effect of lipid supplementation on methane (CH₄) emissions from lactating dairy

cows. For this purpose, a meta-analysis was conducted using 20 trials from 7 scientific papers published between 1972 and 2004. Response variables evaluated were CH₄, DMI, milk yield, milk composition, and milk efficiency (kg of 4% FCM/kg of DMI). Lipid sources examined were oilseeds, either free oils or seeds, and tallow. Data were analyzed with PROC MIXED procedure of SAS to evaluate cow response to lipid supplementation (L) expressed as the difference from the control (C). The linear model included lipid supplementation as a fixed effect and study as a random effect. Responses to L were weighed by the number of animals used to test the response. Significance was declared at $P = 0.05$. Lipid supplementation decreased ($P < 0.05$) DMI (kg/d) by 5.6% and increased ($P < 0.05$) milk efficiency by 5.9% compared to C. There was no effect ($P > 0.05$) of L on milk yield (25.17 kg/d), 4% FCM (24.0 kg/d) and milk composition. Emissions of CH₄, expressed in g/d or as percentage of GE intake were lower ($P = 0.01$) for cows fed L compared to cows fed C (315.62 vs. 345.38 g/d and 5.63 vs. 6.17 %GE, respectively). When expressed relatively to milk yield or 4% FCM, CH₄ emissions were lower ($P = 0.01$) with L diets than with C diets (13.4 vs. 14.8 g/kg of milk and 14.0 vs. 15.4 g/kg of 4% FCM, respectively). Results from this study suggest that the addition of lipids to lactating dairy cow diets decreased methane emissions (g/d) by 8.6%. This reduction was mainly a consequence of a decreased DMI.

Key Words: Lipid supplementation, Methane, Lactating cows

M168 Fatty acid composition in milk from Flemish conventional and organic dairy farm management systems. V. Fievez* and B. Vlaeminck, *Laboratory for Animal Nutrition and Animal Product Quality, Ghent University, Melle, Belgium.*

The aim of this study was to compare the fatty acid composition (expressed as g/100 g fatty acid methyl esters) of organic certified raw milk and milk produced by conventional systems. Representative samples ($n = 12$) of both management systems were collected from a Flemish dairy plant in January, February and March (winter samples) and May, June and July 2005 (summer samples). No systematic linseed supplementation was applied in either of the systems. Both in winter (W) and summer (S) samples, significantly higher ($P < 0.05$) cis-9 trans-11 C18:2 (W: 0.61 vs. 0.41; S: 1.11 vs. 0.90; SEM = 0.038), C18:3 n-3 (W: 0.67 vs. 0.38; S: 0.71 vs. 0.55; SEM = 0.034) and trans-11 C18:1 (W: 1.36 vs. 0.96; S: 2.50 vs. 1.86; SEM = 0.105) proportions were measured in organic milk. Differences between both management systems are related to higher dietary proportions of grass/clover either as silage or grazed in organic management systems. As standard Flemish dairy practise allows grazing during the summer period, differences between both management systems were smaller in summer milk. This confirms results of Italian, German and Dutch research which earlier reported organic dairy products to be enriched in omega-3 and conjugated linoleic acids. Cholesterol-raising medium chain fatty acid proportions (sum of C12:0, C14:0 and C16:0) did not differ significantly between organic and conventional milk (W: 42.3 vs. 44.6; S: 38.2 vs. 38.4; SEM = 0.69). Milk odd and branched chain fatty acid (OBCFA) proportions, which recently gained interest as potential indicators of rumen function and dairy product intake in epidemiological studies as well as for their anticarcinogenic effects on cancer cells, did not differ between both management systems (W: 3.26 vs. 3.32; S: 3.54 vs. 3.30; SEM = 0.056), but consisted of a higher proportion (g/100 g OBCFA) of branched chain fatty acids in conventional summer milk (W: 48.5 vs. 47.9; S: 54.1 vs. 57.1; SEM = 0.55).

Key Words: Dairy, Organic, Fatty acid

M169 Feed a pound of fat strategy to improve productivity of dairy cows. B. F. Richards*¹, T. R. Dhiman¹, D. R. Mertens², A. J. Young¹, and L. C. Solorzano³, ¹Utah State University, Logan, ²US Dairy Forage Research Center, Madison, WI, ³Milk Specialties Company, Dundee, IL.

The objective of this study was to determine the influence of increasing the forage in the diet, while maintaining the energy level through supplemental fat, on production, health and reproductive efficiency of dairy cows. Forty-five Holstein cows were blocked according to expected due date and milk yield of previous lactation. Cows within blocks were assigned to 3 treatments and fed a standard diet for the first 15-20 d of lactation. The experiment lasted for 15 wk. During the experiment cows were fed either a diet containing 43% forage (CTL), 56% forage without fat supplement (FR), or 56% forage with fat supplement (1.61% of diet; FRF). Forage and fat supplement were added by replacing corn grain. Calculated energy and metabolizable protein contents of the diets were 1.57, 1.57, and 1.62 Mcal NE_L/kg and 11.7, 11.6, 11.5% of diet DM in the CTL, FR and FRF, respectively. Weekly milk samples from 2 milkings were analyzed for composition. Cows ate 25.3^{ab}, 26.1^a, and 23.1^b kg DM/d (DMI; P=0.06) and produced 36.4^b, 39.4^a, and 38.9^a kg/d of energy corrected milk (ECM) in CTL, FR and FRF, respectively (P=0.01). The DMI as a percent of BW were 3.19^a, 3.11^a, 2.83^b (P=0.06) in CTL, FR and FRF, respectively. Gross feed efficiencies (ECM/DMI) were 1.52^b, 1.59^{ab}, and 1.79^a (P=0.01) for the CTL, FR, and FRF, respectively. Milk fat and protein contents were 3.53, 3.67, 3.71% (P=0.17) and 2.88^a, 2.76^b, and 2.77^{bc} (P=0.03) in the CTL, FR and FRF, respectively. Daily fat and protein yields were 1.27^b, 1.44^a, and 1.45^a kg (P=0.001) and 1.03, 1.08, and 1.06 kg/d (P=0.44) for CTL, FR and FRF, respectively. Cows gained 37.6, 13.6, and 28.6 kg (P=0.13) during the experiment in CTL, FR and FRF, respectively. No noticeable trends were detected in health and reproductive parameters among treatments. Cows fed a diet high in forage with supplemental fat consumed less feed than cows fed high grain diet and produced the same amount of milk. Feeding high forage diets decreased protein content of the milk, however protein yield was not different. Feeding a pound of fat to cows fed high forage diets improved feed utilization efficiency while maintaining milk production.

Key Words: Cow, Forage, Fat

M170 Milk production response to increased fatty acid level in the feed. M. R. Weisbjerg* and L. Wiking, *Danish Institute of Agricultural Sciences, Tjele, Denmark.*

Milk production response to increased dietary fatty acid (FA) level was investigated using 16 Danish Holstein cows at two production levels (8 cows 32.2 kg energy corrected milk (ECM)/d, LM; 8 cows 40.0 kg ECM/d, HM) in a Latin square design. LM and HM groups were in average 158 and 74 DIM at experimental onset, respectively. Treatments were four levels of FA in ration dry matter (DM), unsupplemented (17 g FA/kg DM) and three increasing substitutions of barley with Palm Fatty Acid Distillate (PFAD) fat, resulting in 29, 40 and 52 g FA/kg DM, respectively. PFAD fat is free FA, mainly C16 and C18:1. Rations were fed as total mixed rations, 63% of ration DM was grass/clover silage. Milk production and composition were recorded the last 3 days in each of the four 3 week periods. DM intake decreased with increased FA level, resulting in a constant net energy intake. The general linear responses to increased FA level when FA level was increased with 10 g/kg DM (1% of ration DM) were 1.1 kg ECM (P<0.0001), 0.061 kg milk fat (P<0.0001), 0.012 kg milk protein (P=0.09) and 0.052 kg lactose (P=0.0002) per day, and linear responses

in milk composition were 0.39 g fat (P=0.07), -0.71 g protein (P<0.0001) and 0.05 g lactose (P=0.3) per kg milk, and in milk fat average globule diameter 0.092 μ m (P<0.0001). It was expected that the response in milk production to increased dietary FA would be almost proportional to cows' actual milk yield, however, the opposite was the case. When responses were analysed separately for the two groups of cows, response in kg ECM from lowest to highest FA level was slightly larger for the medium than for the high yielding group. Statistical analysis with likelihood ratio tests, using random regression in PROC MIXED across all cows, confirmed that the ECM response (regression coefficient) was significantly negatively correlated to the production level of the cows (intercept). A negative correlation was also found for the other milk production and concentration parameters except for milk fat concentration. However, the correlations were only significantly different from zero for kg milk, kg ECM, kg protein, kg lactose and fat concentration.

Key Words: Milk, Fatty acids, Fat globule diameter

M171 Performance of dairy cows fed Ca-salts of saturated and unsaturated fatty acids. T. R. Dhiman*¹, A. Hopkins¹, R. Thompson¹, L. R. Godfrey¹, and N. D. Luchini², ¹Utah State University, Logan, ²NutriScience Technologies Company, Fairlawn, OH.

The objective of this study was to determine the optimum combination of Ca-salts of saturated and unsaturated fatty acids in an ideal fat supplement for dairy cows. Twelve mid-lactation Holstein cows were assigned to one of four treatments. Experimental design was 4 x 4 Latin squares with three replicates and four periods. Each period was 3 wk. Measurements were made during the last week in each period. Cows in 4 treatments were fed a diet containing 50% forage and 50% grain including either 2.1% of dietary DM as Ca-salts of palm oil fatty acids (saturated fatty acids) and 0% calcium salts of unsaturated fatty acids (UF0), 1.4% saturated and 0.7% unsaturated (UF33), 0.7% saturated and 1.4% unsaturated (UF67) or 2.1% unsaturated (UF100). Diets were fed as a total mixed ration. Diets contained 1.65, 1.65, 1.66, and 1.66 NE_L Mcal/kg DM in UF0, UF33, UF67 and UF100, respectively. Diets had similar CP contents. Daily feed intake and milk yield were recorded. Milk samples were collected from 6 consecutive milkings (a.m. and p.m.) during week 3 in each period and analyzed for composition and fatty acid profile. Daily feed DM intake and energy corrected milk yield (ECM) of cows were 24.4, 24.4, 24.4, and 24.7 kg (P=0.97) and 36.8, 37.4, 36.8, and 35.1 kg (P=0.30) in UF0, UF33, UF67 and UF100, respectively. Milk protein, lactose, and urea contents were not different among treatments. Milk fat contents were 3.71^a, 3.83^a, 3.54^{ab}, and 3.41^b (P=0.05) in UF0, UF33, UF67 and UF100, respectively. Gross feed efficiencies (ECM/DMI) were 1.50, 1.55, 1.50, and 1.42 (P=0.17) in UF0, UF33, UF67 and UF100, respectively. The proportions of C18:1 trans-11 and C18:2 cis-9, trans-11 were 2.16^b, 2.31^b, 2.94^{ab}, and 3.67^a (P=0.001) and 0.64^a, 0.64^b, 0.78^{ab}, and 0.85^a % of total fatty acids in UF0, UF33, UF67 and UF100, respectively. The proportions of unsaturated fatty acids were 35.2^b, 36.1^b, 38.1^a, and 38.6^a (P=0.03) % of total fatty acids in UF0, UF33, UF67 and UF100, respectively. In the present study the best combination of Ca-salts of saturated and unsaturated fatty acids in a fat supplement was 33:67, respectively for optimum productivity and fatty acid profile of milk from dairy cows.

Key Words: Dairy, Milk, Fat

M172 Influence of method of processing and feeding level of safflower seeds on the performance of dairy cows. L. R. Godfrey and T. R. Dhiman*, *Utah State University, Logan.*

Optimum method of processing safflower seeds and level of feeding was determined in 3 experiments. In Expt 1, using the criteria of reduction in seed particle size and ease of grinding without plugging hammer mill it was found that the optimum method of processing safflower seeds was with a 50:50 mixture of corn and safflower seeds using a screen of 0.635 cm size mesh. In Expt 2, 12 cows (99±42 DIM) in a crossover design repeated 3 times over a period of 12 wk were fed a diet containing 48.4% forage and 51.6% grain supplemented with ground safflower seeds either 0% (CTG), 2.1% (SG2), or 4.2% (SG4) of diet. Safflower seeds were added to the diet by replacing linted cottonseed. In Expt 3, another group of 12 cows (85±42 DIM) were fed a diet similar to the Expt 2, except supplemented with extruded safflower seeds either 0% (CTE), 2.1% (SE2), or 4.2% (SE4) of diet. Safflower seeds were extruded dry using 50:50 mix of corn and safflower at 132°C. Diets had 1.56, 1.58, 1.60, 1.56, 1.58, and 1.60 Mcal NE_L /kg in CTG, SG2, SG4, CTE, SE2, and SE4, respectively. Diets were isonitrogenous. DM intakes of cows were 26.9, 25.7, and 26.8 (P=0.16) 26.95, 27.6, and 27.62 kg/d (P=0.27) in CTG, SG2, SG4, CTE, SE2, and SE4, respectively. Cows produced 38.3, 39.5, and 38.8 (P=0.56) 40.2, 41.2, and 38.7 kg/d (P=0.21) of energy corrected milk (ECM) in CTG, SG2, SG4, CTE, SE2, and SE4, respectively. Milk protein contents and yields were similar among treatments in Expt 2 and 3. Milk fat contents were 3.40^{ab}, 3.58^a, and 3.15^b (P=0.006) 3.58^a, 3.71^a, and 3.24^b % (P=0.04) in CTG, SG2, SG4, CTE, SE2, and SE4, respectively. Daily milk fat yields were 1.33, 1.41, and 1.28 (P=0.21) 1.47, 1.49, and 1.33 kg/d (P=0.11) in CTG, SG2, SG4, CTE, SE2, and SE4, respectively. Gross feed efficiencies (ECM/DMI) were 1.43, 1.55, and 1.45 (P=0.10) 1.48, 1.50, and 1.39 (P=0.16) in CTG, SG2, SG4, CTE, SE2, and SE4, respectively. Ground or dry extruded safflower seeds can be fed to dairy cows up to 2% of diet without negative impact on feed intake, milk yield or milk composition. Feeding processed safflower seeds at 4% of diet will result in decreased milk fat content and maybe fat yield.

Key Words: Cow, Safflower, Milk

M173 Milk production, milk composition, digestion, and feed intake of cows fed different concentrations of whole flaxseed. H. V. Petit*¹ and P. Mir², ¹*Agriculture and Agri-Food Canada, Lennoxville, QC, Canada*, ²*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*.

Thirty-two lactating multiparous Holstein cows averaging 622 kg of BW were used from week 25 to 29 of lactation to determine the effects of different concentrations of whole flaxseed in the diet on milk production, milk composition, digestion, and feed intake. Cows within groups were assigned randomly to one of four TMR: a control diet (CON) with no fat supplement or diets containing either 5, 10 or 15 % whole flaxseed (FS) on a DM basis. Feed consumption and milk yield were recorded daily. Milk samples were obtained from each cow for two consecutive milkings on the fifth week of the experiment to determine milk composition. Total collection of feces and urine was carried out on the fifth week of the experiment. Milk production averaged 25.9 kg/d and was similar among treatments. Milk concentrations of protein and lactose, and yields of protein, lactose, and fat were not affected (P > 0.10) by diet. Cows fed 10% FS had the highest milk fat concentration (4.71%). Intake of DM averaged 19.2 kg/d and was

similar (P > 0.10) among treatments. Feeding 10% FS resulted in the highest (P = 0.06) DM digestibility and tended to lead to the highest digestibility of ADF and NDF (P = 0.11 and 0.12, respectively). Digestion of N was similar (P > 0.10) among treatments. Milk concentrations of short- and medium-chain fatty acids (FA) decreased linearly and those of long-chain FA increased linearly with greater concentrations of FS in the diet. Feeding greater concentrations of FS increased linearly milk concentrations of C18:1c9, C18:1t11, C18:2t9,t12, C18:3n3, and total omega 3 FA and decreased linearly the omega 6 to omega 3 FA ratio. Although there is a linear increase in concentrations of many FA important for human health, differences in milk FA composition between cows fed 10 and 15% FS would be of little biological significance. These results suggest that 10% would be the optimal concentration of FS to feed in the diet of mid-lactating dairy cows as it generally leads to better feed digestion, and higher milk fat concentration and milk enrichment in omega 3 and long-chain FA.

Key Words: Dairy, Milk composition, Fatty acids

M174 Effect of flaxseed and flaxseed oil supplementation on milk fatty acid composition in dairy cows fed high- or low- forage diets. C. Benchaar*¹, H. V. Petit¹, T. A. McAllister², and P. Y. Chouinard³, ¹*Agriculture and Agri-Food Canada, Dairy and Swine R&D Centre, Lennoxville, QC, Canada*, ²*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*, ³*Université Laval, Quebec, QC, Canada*.

The objective of this study was to examine the effect of flaxseed (FS) and flaxseed oil (FO) supplementation (10 and 3%, respectively; DM basis) on milk fatty (FA) composition in dairy cows fed high- (H) or low- (L) forage diets (70 and 30%, respectively; DM basis). Four lactating cows (BW=647 kg; DIM=96 d) used in a 4x4 Latin square design were fed: H+FS (HFS), H+FO (HFO), L+FS (LFS), and L+FO (LFO). Orthogonal contrasts were used to test the main effects of forage level (F), flaxseed source (FLA) and their interaction (F x FLA). Significance was declared at P<0.05. Contents of C10:0 (3.04 vs. 2.49%), C12:0 (3.55 vs. 2.65%), C14:0 (12.36 vs. 10.53%), C14:1 (1.18 vs. 0.84%), C15:0 (1.38 vs. 1.10%), *cis*-11 C18:1 (1.04 vs. 0.72%), and *cis*-9, *cis*-12 C18:2 (1.83 vs. 1.49%) were higher and those of C4:0 (4.05 vs. 5.18%), C18:0 (11.3 vs. 14.5%), and *cis*-9, *trans*-11, *cis*-15 C18:3 (0.09 vs. 0.06%) were lower in milk of cows fed L than in that of cows fed H diets. Feeding L diets tended (P=0.07) to decrease milk content of *cis*-9, *cis*-12, *cis*-15 C18:3 (0.53 vs. 0.67%) as compared to H diets. Cows fed FS produced milk with lower contents of *cis*-11 C18:1 (0.77 vs. 0.99%), *cis*-15 C18:1 (0.37 vs. 0.65%), *trans*-9 C18:1 (0.26 vs. 0.49%), *trans*-11 C18:1 (1.27 vs. 2.91%), *trans*-12 C18:1 (0.69 vs. 1.10%), *cis*-9, *trans*-11 C18:2 (CLA, 1.11 vs. 0.47%), *trans*-11, *cis*-15 C18:2 (0.40 vs. 1.16%), and higher contents of C10:0 (3.03 vs. 2.50%), C12:0 (3.38 vs. 2.83%), C16:0 (25.8 vs. 22.8%), C18:0 (13.5 vs. 12.3%), and *cis*-9, *cis*-12, *cis*-15 C18:3 (0.67 vs. 0.45%) than cows fed FO. Milk fat contents of *trans*-10 C18:1 were 0.53, 0.30, 2.41, and 0.43% for HFO, HFS, LFO, and LFS, respectively (interaction of F x FLA). Feeding L diets modified the pathway of biohydrogenation, leading to the production of more *trans*-10 C18:1 in milk fat and this effect was of greater magnitude when FO was added in the diet as compared to FS. Feeding FS increased milk fat content of *cis*-9, *cis*-12, *cis*-15 C18:3, the major FA present in flaxseed, and decreased the content of *trans* intermediates of ruminal biohydrogenation as compared with FO.

Key Words: Flaxseed/flaxseed oil, Milk fatty acid, Dairy cows

M175 Bovine somatotropin and dietary fat enriched with omega-3 fatty acids in dairy cows: I. Lactation performance. M. Carriquiry*, W. J. Weber, C. R. Dahlen, G. C. Lamb, and B. A. Crooker, *University of Minnesota, St. Paul.*

Multiparous cows (n=59) were blocked by expected calving date and previous 305ME and assigned randomly to a 2x2 factorial design to determine effects of bST (POSILAC®) and dietary fat during 280 DIM. Diets (1.98 Mcal NEL_{1x}, 184 g CP, and 185 g ADF per kg DM) included whole, high-oil sunflower seeds (10% of dietary DM, SS) or a mixture of Alifet-High Energy® and Alifet-Repro® (3.4 and 1.5% of dietary DM, AF) and were provided from calving. Cows received 0 or 500 mg bST (N, Y) every 10 d from 12 to 70 DIM and at 14 d-intervals thereafter. Blood was collected weekly through 150 DIM. Means from a repeated measures analysis differed when P<0.05. Daily 4%FCM yield was 4.7 kg/d greater after 23 d of bST but was not altered by diet. Peak milk was delayed (54.9 vs 72.0 ± 3.9 DIM) and tended (P=0.07) to increase (48.9 vs 51.1 ± 1.0 kg) with bST. Milk fat, protein, and lactose yields increased with bST but did not differ between diets. Daily DMI did not differ among treatments but BCS was reduced with bST (3.30 vs 3.18 ± 0.06). Energy balance (EB) nadir (-11.2 ± 0.75 Mcal NEL/d) occurred at 15 DIM and did not differ among treatments. There was an interaction of bST and diet on EB as AF decreased the impact of bST on mean EB (2.04^a, -2.75^c, 2.00^a, 0.13^b ± 0.69 Mcal NEL/d for SSN, SSY, AFN, and AFY) and allowed AFY cows to reach positive EB earlier than SSY cows (70 for SSN, AFN, and AFY vs 105 DIM for SSY). Adjusted gross efficiency was greater for bST cows (1.10 vs 1.24 ± 0.02 kg FCM/Mcal NEL intake). Plasma NEFA and glucose were similar among treatments. The postpartum decrease in IGF-I did not differ among treatments but mean IGF-I during lactation was less for SS than AF (98.6 vs 112.2 ± 6.7 ng/mL) and for non-bST than bST (85.7 vs 126.1 ± 6.7 ng/mL) cows. Plasma IGF-I increased by 35 DIM for bST cows. Pre-calving concentrations of IGF-I were reached by 84 DIM for bST and after 168 DIM for non-bST cows. Initiation of bST at 12 DIM in cows fed AF increased FCM yield and plasma IGF-I by 35 DIM without detrimental effects on EB.

Key Words: bST, Omega-3 fatty acids, Lactation

M176 Bovine somatotropin and dietary fat enriched with omega-3 fatty acids in dairy cows: II. Milk fatty acid composition. M. Carriquiry*¹, W. J. Weber¹, C. R. Dahlen¹, G. C. Lamb¹, S. R. Sanders², L. H. Baumgard², and B. A. Crooker¹, ¹University of Minnesota, St. Paul, ²University of Arizona, Tucson.

Multiparous cows (n=32) were blocked by expected calving date and previous 305ME and assigned randomly to a 2x2 factorial design to determine effects of bST (POSILAC®) and dietary fat on milk fatty acid (FA) composition during the first 140 DIM. Isocaloric diets (1.98 Mcal NEL_{1x}) that included whole, high-oil sunflower seeds (10% of dietary DM, SS) or a mixture of Alifet-High Energy® and Alifet-Repro® (3.4 and 1.5% of dietary DM, AF) were provided from calving. Alifet-Repro® contained protected omega-3 FA (15.7% 18:3, 1.3% 20:5, and 1.3% 22:6). Cows received 0 or 500 mg bST (N,Y) every 10 d from 12 to 70 DIM and at 14 d-intervals thereafter. Milk samples from wk 2, 8, and 20 of lactation were analyzed for FA composition. Means from a repeated measures analysis differed when P<0.05. Proportions of *de novo* synthesized FA (200 vs 185 ± 6 mg/g FA) tended to decrease (P=0.06) and preformed FA (533 vs 558 ± 5 mg/g FA) increased in milk with bST. Diet did not modify the proportions of *de novo* or preformed FA but 18:3, 20:5, and 22:6 FA were greater with AF. As lactation progressed, the proportion of *de novo* and mixed origin FA increased, while preformed FA decreased.

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The saturated to unsaturated FA ratio (S/U) did not differ among treatments and increased as lactation progressed. However, the increase in *de novo* FA, the decrease in preformed FA, and the increase in S/U ratio were detected later in lactation for bST cows (wk 8 vs 20). The omega-6 to omega-3 FA ratio in milk was reduced in cows fed AF (8.80 vs 7.39 ± 0.29) and increased by bST as lactation progressed. The *cis*-9, *trans*-11 CLA tended (P = 0.07) to be reduced by AF and increased between wk 2 and 8 of lactation despite the decrease in *trans*-11 18:1. The 14:1/14:0 ratio increased with wk of lactation. Alifet-Repro® induced an increase in omega-3 FA in milk and bST prolonged the mobilization period in milk FA composition.

Key Words: bST, Omega-3 fatty acids, Milk fat

M177 The abomasal infusion of wheat starch or cottonseed oil with casein on milk yield and compositions in Sannen dairy goats.

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To determine effects of the abomasal infusion wheat starch or cottonseed oil with casein on milk production and composition of Sannen dairy goats, from three multiparous lactating Sannen dairy goats in mid-lactation were used with mean yield and DIM of 1.6 ± 0.22 and 167 ± 4 days. Goats were fed ad libitum with basal diet include, 40% hay and 60% concentrate. Treatments were abomasal infusion of 1) wheat starch (100 g/d), 2) wheat starch and casein (100 and 50 g/d respectively) and 3) cottonseed oil and casein (45 and 50 g/d respectively). The DMI was not different among treatments. Infusion of starch or cottonseed oil with casein increased milk yield, percentage and yield of total protein, total solids, casein and true protein, but percentage and yield of lactose, NPN, and whey protein were not affected by treatments. Infusion of wheat starch with casein decreased milk fat concentration. Digestibilities of DM, OM, CP, NDF, ADF and EE in total tract were not different among treatments. No effect on ruminal pH, rumen ammonia concentration and glucose, blood urea nitrogen and triglyceride of plasma were observed. In general, it is concluded using of casein with starch and oil in post-ruminal had positive effect on milk yield and milk protein.

Key Words: Casein, Starch, Cottonseed oil

M178 Effects of adding whole safflower seeds to dairy Lacaune sheep diets on CLA in milk, fatty acids profile and dairy performances.

M. A. Bouattour, R. Casals*, E. Albanell, X. Such, and G. Caja, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

A total of 24 Lacaune dairy ewes milked twice daily were used to study the effects of adding whole safflower seeds (WSF) to their concentrate, on dairy performances, milk, fatty acids (FA) profile and CLA. Ewes were allocated to two balanced groups according to number of lactation, BW and daily milk yield, and kept in two separate pens. TMR fed to ewes was a mixture of 55% forage (dehydrated fescue:alfalfa hay; 1:1), and 45% concentrate, to which the WSF was or not added. Dietary treatments were: C (control) and WSF (16.2% in the concentrate). Ether extract in the two experimental concentrates were similar (8.01%) due to the incorporation of calcium soaps of palm oil FA (6.25%) to the control concentrate. The experiment consisted of a two periods crossover design (20d each), during which the TMR was offered ad libitum in the pens (09:00 and 18:00). Addition of WSF decreased (P<0.05) DMI (2.42 vs. 2.34 kg/d), milk yield (1.58 vs. 1.48 L/d), ECM (1.47 vs. 1.34 L/d) and milk conversion rate (0.60 vs. 0.57

L/kg DM), but did not modify milk fat (6.7%), protein (5.3%), casein (4.19%) and TS (17.9%) contents. True protein content was increased (5.16 vs. 5.43%; $P < 0.0001$) and fat (108 vs. 96g) and protein (83 vs. 73) yields were decreased ($P < 0.05$) by WSF, mainly because of the milk yield depression. The WSF treatment increased ($P < 0.05$) ewes BCS (3.11 vs. 3.24) but decreased ($P < 0.05$) blood concentrations of cholesterol (96.2 vs. 84.5 mg/dL) and glucose (51.6 vs. 44.9 mg/dL). Safflower addition increased ($P < 0.0001$) LCFA (35.2 vs. 45.4%) and MUFA (24.4 vs. 27.1%), and decreased MCFA (49.3 vs. 39.9%), but no changes were observed in SCFA (12.7%), PUFA (4.1%), n3 (0.86%) and n6 (3.25%). In contrast, the addition of WSF increased ($P < 0.01$) the concentration of cis 9- trans 11 C18:2 (CLA, 0.62 vs. 0.93%), reduced ($P < 0.05$) the saturated/unsaturated ratio (2.52 vs. 2.12) and the atherogenicity index (2.75 vs. 2.2), which is positive in terms of human health.

Key Words: Safflower, Dairy ewes, CLA

M179 Milk fatty acid composition and dairy performances in Lacaune sheep fed whole linseed and linseed oil with reference to CLA. M. A. Bouattour, R. Casals*, E. Albanell, X. Such, and G. Caja, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

This study was performed to investigate the effects of feeding whole linseed (WLS) or linseed oil (LSO) to dairy ewes on lactational performances, and milk fatty acids profile and CLA content. Thirty Lacaune dairy ewes were blocked in 3 pens of 10 animals, and used in a 3×3 Latin square (20 d periods). Ewes were fed a TMR with 55% forage (alfalfa and fescue dehydrated mixture, 1:1) and 45% concentrate. Treatments were: 1) C (control); 2) WLS (8.2% of TMR, DM basis); and, 3) LSO (2.7%). Diets were isonitrogenous (18.5% CP), and had the same level of fat (5.3% EE), being a 6.3% of calcium soap of palm oil included in the control concentrate. Feed intake (C: 2.65; WLS: 2.72; LSO: 2.7 kg DM/d) was increased ($P < 0.05$) by WLS, but milk yield (1.9 L/d), ECM (1.6 L/d) and milk protein (5.23%) and casein (4.1%) contents were unaffected by treatments. In contrast, true protein content (5.2; 5.11; 4.97%) was reduced and milk fat (5.7; 5.85; 6.08%) content and yield (107; 107; 114 g/d) and total solids content (16.3; 16.6; 16.9%) were increased ($P < 0.05$) by LSO. Regarding blood metabolites, both linseed treatments increased ($P < 0.01$) triglycerides concentration (12.7; 19.2; 17.6%) but did not affect glucose (53.6 mg/dL), cholesterol (100.6 mg/dL), NEFA (0.11 mmol/L), HDL (1.78 mmol/L) or LDL (0.67 mmol/L) concentrations. Both linseed treatments increased ($P < 0.01$) SCFA and LCFA, but decreased ($P < 0.0001$) MCFA. The cis 9- trans 11 C18:2 (CLA) was only improved by LSO (0.65; 0.6; 1.23%) and no changes were observed in C18:1 (23.4%) and MUFA (24.6%), while PUFA (4.03; 4.68; 4.54) were higher ($P < 0.05$), and saturated FA (70.02; 67.6; 68.8%) and atherogenicity index (2.66; 2.31; 2.35%) lower ($P < 0.05$) in linseed treatments than in control. In conclusion, LSO was more effective than WLS to increase CLA in milk, but both linseed treatments were useful to increase PUFA and reduce atherogenicity index of milk fat.

Key Words: Dairy ewes, Linseed, CLA

M180 The long term effect of supplementing grazing dairy cows diet with fish oil and sunflower oil on milk conjugated linoleic acid. L. Holmes* and A. AbuGhazaleh, *Southern Illinois University, Carbondale.*

The objective of this study was to determine the effect of adding fish oil (FO) and sunflower oil (SFO) to grazing dairy cows diet on milk

cis-9 trans-11 conjugated linoleic acid (CLA) and other fatty acids commonly found in milk. Fourteen Holstein cows (105 ± 19 DIM) were fed a TMR (50:50) diet for 1 wk then divided into 2 groups (7 cows/treatment) and offered fat supplements for 8 wks while in pasture. Cows in group one were fed a basal diet (7.5 kg DM basis) consisting of corn, soybean meal, molasses, vitamin/mineral premix plus 500 g animal fat (CONT). Cows in the second group were fed the basal diet plus 100 g of FO and 400 g of SFO (FOSFO). Cows were milked twice a day and milk samples were collected weekly throughout the trial. Both groups grazed together on alfalfa-grass mix pasture for ad libitum and fed treatment diets after the morning and afternoon milking. Analysis of variance was conducted using the MIXED procedure of SAS for a completely randomized design with repeated measures. The model contained the effects of covariance, diet, week, and diet \times week. Milk production (30.4 and 31.4 kg/d), milk fat percentages (3.7 and 3.6), milk fat yield (1.12 and 1.12 kg/d) and milk protein yield (0.90 and 0.91 kg/d) for diet 1 and 2, respectively, were not affected ($P > 0.05$) by treatment diets. Compared with CONT, milk protein percentages (3.0 and 2.9) were lower ($P < 0.05$) with FOSFO diet. The concentrations of cis-9 trans- 11 CLA (0.78 and 1.47 g/100g fatty acid) and vaccenic acid (2.02 and 4.57 g/100g fatty acid) in milk fat were higher ($P < 0.05$) for cows fed the FOSFO over the 8 wks of oil supplementation. The concentration of cis-9 trans- 11 CLA in milk fat reached maximum (1.0 and 1.64 g/100g fatty acid for diets 1 and 2, respectively) on week 1 with both diets and remained relatively constant thereafter. In conclusion, supplementing grazing cows diet with FO and SFO enhances milk cis-9 trans- 11 CLA content without affecting cows performance and that increase remains relatively constant after the first week of oil supplementation.

Key Words: Grazing, Fish oil, CLA

M181 Effectiveness of linoleic and linolenic acid for enhancing conjugated linoleic acid in milk from dairy cows. B. Dengpan¹, J. Wang*¹, T. R. Dhiman², and L. Shijun¹, ¹*Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, P.R. China,* ²*Animal, Dairy and Veterinary Sciences Department, Utah State University, Logan, UT.*

Feeding feeds rich in linoleic acid or linolenic acid increases the conjugated linoleic acid (CLA) content of milk from dairy cows. Objective of this study was to determine the comparative effectiveness of linoleic and linolenic acid in enhancing CLA in milk when fed at the same levels to mid lactation dairy cows. Forty dairy cows producing an average of 25 kg of milk and 170 days in milk were randomly assigned to 4 treatments. Cows in four treatments were fed a basal diet containing 59% forage and 41% grain either without oil supplement (CTL), 4% soybean oil (SO), 4% flaxseed oil (FO) or 4% 50:50 mix of soybean and flaxseed oil (SFO) on DM basis. Oils were added by replacing the corn in the diet. Soybean and flaxseed oils contained 43% linoleic and 57% linolenic acid, respectively. Diets were fed as a total mixed ration 3 times a day. Diets had 1.48, 1.64, 1.64, and 1.64 Mcal NE_L/kg DM in CTL, SO, FO, and SFO, respectively. Diets were isonitrogenous and contained an average of 16.1% CP. Experimental duration was 9 wk. Measurements were made during the last 6 wk of the experiment. Data was analyzed using mixed Models procedures of SAS package 9. Cows ate 16.2, 16.2, 15.6, and 15.9 kg/d feed DM ($P = 0.10$) and produced 23.1, 24.6, 24.2, and 24.3 ($P = 0.77$) kg/d of energy corrected milk (ECM) in CTL, SO, FO, and SFO, respectively. Milk fat and protein contents were 3.49, 3.21, 3.26, and 3.30% ($P = 0.36$) 3.15, 3.20, 3.17, and 3.15% ($P = 0.95$) in CTL, SO, FO, and SFO, respectively. Milk fat yields were 0.77, 0.83, 0.81, and 0.82 kg/d

($P=0.19$) in CTL, SO, FO, and SFO, respectively. The proportions of C18:1 *trans*-11 (VA) and C18:2 *cis*-9, *trans*-11 CLA isomer were 1.48^c, 6.19^a, 3.04^b, and 4.53^{ab} ($P=0.01$) 0.64^c, 2.39^a, 1.60^b, and 1.81^b of total fatty acid methyl esters in CTL, SO, FO, and SFO, respectively. The proportions of unsaturated fatty acids were 27.9^b, 33.6^a, 36.4^a, and 33.8^a ($P=0.001$) in CTL, SO, FO and SFO, respectively. Feeding free oil rich in linoleic acid is 100 and 50% more effective in enhancing VA and CLA in milk fat, respectively, than feeding free oil rich in linolenic acid fed at the similar levels in the diet.

Key Words: Milk, Conjugated linoleic acid, Oils

M182 The effect of pH and polyunsaturated C18 fatty acid source on the production of vaccenic acid and conjugated linoleic acids in ruminal cultures incubated with docosahexaenoic acid. A. AbuGhazaleh* and B. Jacobson, *Southern Illinois University, Carbondale*.

Previously, combining docosahexaenoic acid (DHA) with linoleic acid in rumen cultures enhanced vaccenic acid (VA) and conjugated linoleic acid (CLA) accumulations. The objective of this experiment was to examine the effect of two pH levels and two polyunsaturated C18 fatty acid sources on VA and CLA accumulations in rumen cultures incubated with DHA. High pH culture treatments consisted of 10 mg DHA plus 20 mg linoleic acid (LOH), or 10 mg DHA plus 20 mg linolenic acid (LNL). Low pH culture treatments consisted of 10 mg DHA plus 20 mg linoleic acid (LOL), or 10 mg DHA plus 20 mg linolenic acid (LNL). Treatments were incubated in triplicate in 125 ml flasks containing 500 mg finely ground TMR, 10 ml strained ruminal fluid, 40 ml media, and 2 ml reducing solution. Ruminal fluid was collected from fermenters fed high forage (pH 6.7) or high grain diets (pH 5.4). A 5-ml sample of culture contents was taken at 0 and 24 h for fatty acid analysis by gas liquid chromatography. After 24 h of incubation, VA was the predominant *trans* C18:1 FA isomer in the high pH cultures and its concentration was greater ($P > 0.05$) with LOH (20.9 mg/culture) than with LNL (9.3 mg/culture). Similarly, t10 C18:1 was the predominant *trans* C18:1 FA isomer in the low pH cultures and its concentration was greater ($P > 0.05$) with LOL (12.8 mg/culture) than with LNL (4.5 mg/culture). The c9t11 CLA (0.74 mg/culture) and tt CLA (0.67 mg/culture) were the predominant CLA isomers in the LOH cultures, while t10c12 CLA (1.47 mg/culture) and tt CLA (1.27 mg/culture) were the predominant CLA isomers in the LOL cultures. Additions of linolenic acid to cultures caused a dramatic increase ($P > 0.05$) in the concentration of t11c15 C18:2 (9.84 and 8.45 mg/culture, for treatments LNL and LNL, respectively). The concentrations of VA and c9t11 CLA in rumen cultures were greatest ($P > 0.05$) when DHA was incubated with linoleic acid at high pH. In contrast, t10 C18:1 replaced VA and c9t11 CLA disappeared when linoleic and linolenic acids were incubated under the low pH condition.

Key Words: DHA, PUFA, Trans FA

M183 The relationship between the concentration in milk of c18:1 t10 and the concentration of total milk fat. P. J. Moate*¹, R. C. Boston¹, I. J. Lean², and W. Chalupa¹, ¹*University of Pennsylvania, Kennett Square*, ²*University of Sydney, Sydney, NSW, Australia*.

A model is being developed to describe how diet and cow factors influence milk fat concentration and the concentrations of individual long chain fatty acids (LCFA) in milk. Much recent research has focused on C18:1 t10 as a fatty acids that may decrease milk fat content.

In this work we collated recent data from 23 published experiments that described a total of 58 diets, did not involve administration of exogenous CLA and which reported the concentrations (g/L) in milk of total milk fat and of C18:1 t10. Unweighted univariate regressions, were performed on these data. For total milk fat concentration, the mean, standard deviation, minimum and maximum values were respectively 33.9, 5.3, 22.2 and 45.7, while for C18:1 t10, the corresponding values were 0.25, 0.16, 0.01, and 0.82. The total concentration of milk fat was significantly ($P<0.01$) negatively related to the concentration of C18:1 t10 in milk, but this only accounted for 25% of the total variation in milk fat concentration. $[\text{Milkfat}] = 40.0 \pm 1.1 - 24.8 \pm 5.7 * [\text{C18:1 t10}] R^2 = 0.25$. Most of the milk fat depressive effect of C18:1 t10 was due to a significant ($P<0.01$) effect on concentrations of de novo milk fatty acids (C4-C14); but only accounted for 19% of the variation in these concentrations. $[\text{Total de novo}] = 9.9 \pm 0.5 - 6.1 \pm 1.7 * [\text{C18:1 t10}] R^2 = 0.19$. Although TMR fed cows had higher concentrations of C18:1 t10 than did pasture fed cows, these also had lower concentrations of C18:2 t10, c12. Since C18:2 t10, c12 also can depress milk fat concentration this observation may explain why there was no significant difference in total milk fat concentration between TMR and pasture fed cows. In conclusion, factors other than C18:1 t10 must be taken into account to describe the majority of the variation that occurs in the concentration of total milk fat.

Table 1. Influence of TMR and pasture diets on milk fat composition

Parameter	TMR		Pasture		Significance
	N	Concentration (g/L)	N	Concentration (g/L)	
Milk fat	43	33.4 ± 4.9	15	35.4 ± 6.2	$P \geq 0.5$
C18:1 t10	43	0.29 ± 0.15	15	0.11 ± 0.05	$P \leq 0.01$
C18:2 t10, c12	33	0.007 ± 0.006	9	0.017 ± 0.009	$P \leq 0.03$

Key Words: Milk fat, c18:1 t10

M184 The effect of *trans*-10, *cis*-12 CLA on milk fat synthesis and cheese yield in sheep fed at two levels of energy intake. A. L. Lock*¹, R. M. Early², D. E. Bauman¹, and L. A. Sinclair², ¹*Cornell University, Ithaca, NY*, ²*Harper Adams University College, Newport, UK*.

Sheep milk is characterized by a high ratio of fat to protein but for cheese production this is a disadvantage as the excess fat is lost in the whey. *Trans*-10, *cis*-12 conjugated linoleic acid (CLA) is a potent inhibitor of milk fat synthesis in sheep and can result in increased milk and milk protein yield, particularly when energy intake is inadequate. The objectives of this study were to examine the effects of a rumen protected source of CLA at a high and low level of energy intake on milk fat synthesis and cheese yield. Sixteen multiparous ewes (59±9.0 kg) were randomly assigned to one of two restricted energy levels; High (H; 28MJ ME/d) or low (L; 21MJ ME/d), and supplemented with either Megalac (U: Volac, Royston, UK) or lipid-encapsulated CLA (S: BASF AG, Ludwigshafen, Germany) in each of 4 periods of 21 d duration in a Latin square design. Megalac and CLA supplements were fed at 25 g/ewe/d, providing 2.4 g/d of CLA to ewes on treatment S. During the final 5 d of each period milk was collected, yield and composition determined and the milk made into a cheddar type cheese. There was no effect ($P > 0.05$) of treatment on milk or cheese curd yield (Table 1). Milk fat content and yield were reduced when ewes were supplemented with CLA ($P < 0.001$) whilst milk protein yield was lower and liveweight gain higher ($P < 0.05$) when ewes were fed

the high vs. low feed level. Supplementation with CLA reduced milk fat content and yield similar to that recorded previously in dairy cows and sheep, but there was no effect on curd yield. Ewes responded to the greater level of energy intake by increasing weight gain rather than milk yield.

Table 1.

	Treatment				SEM	Significance	
	HU	HS	LU	LS		Feed level	Fat source
Milk yield g/d	1188	1225	1204	1244	40.4	0.66	0.35
Fat content, %	6.36	4.87	6.17	4.79	0.093	0.15	<0.001
Fat yield, g/d	75.2	59.1	73.8	59.9	2.12	0.89	<0.001
Protein content, %	4.69	4.52	4.80	4.73	0.049	0.003	0.02
Protein yield, g/d	54.8	55.1	57.2	58.6	1.45	0.05	0.58
Live weight change, kg/d	0.134	0.130	0.034	0.066	0.0215	<0.001	0.52
Green curd yield, kg/kg	0.164	0.156	0.151	0.162	0.0073	0.66	0.85

Key Words: CLA, Sheep, Milk fat

M185 Distribution of supplemental L-carnitine among tissues and fluids of periparturient dairy cows. D. B. Carlson^{*1}, N. B. Litherland¹, J. C. Woodworth², and J. K. Drackley¹, ¹University of Illinois, Urbana, ²Lonza, Inc., Allendale, NJ.

Our hypothesis was that supplemental L-carnitine would increase liver carnitine concentration and hepatic fatty acid oxidation. Previously, we have demonstrated that dietary L-carnitine effectively decreased liver lipid accumulation during the periparturient period. Multiparous Holstein cows (n = 56) were supplemented with four amounts of Carniking (50% L-carnitine; Lonza, Inc.), mixed with 227 g ground corn plus 227 g dried molasses, as a topdress from d 14 before expected calving until 21 days in milk. Treatments were: control (CON; 0 g L-carnitine), low (LC; 6 g L-carnitine), medium (MC; 50 g L-carnitine), and high (HC; 100 g L-carnitine). All cows were fed the same basal diet prepartum (21 d before expected calving) and same postpartum diet (calving until d 56). Liver and skeletal muscle were biopsied on d 21 before expected calving and at d 2, 10, and 28. Free, short-chain, and long-chain carnitine esters were quantified using a radioenzymatic procedure and ion exchange chromatography. Orthogonal contrasts were used to compare carnitine treatments vs. CON; LC vs. MC and HC; and MC vs. HC. Carnitine supplementation increased free carnitine and carnitine ester concentration in liver tissue ($P = 0.01$). The MC and HC treatments resulted in higher liver carnitine content than did the LC treatment ($P < 0.01$), although concentrations of free carnitine and carnitine esters did not differ between the MC and HC treatments at any point during the periparturient period ($P > 0.15$). Carnitine supplementation caused greater free carnitine and carnitine ester concentrations in liver on d 2 and 10 after calving compared with the CON treatment, but differences were diminished by d 28 after calving (treatment x time; $P < 0.01$). These results suggest that dietary L-carnitine increased liver carnitine concentration in periparturient cows, which likely contributed to the reduction in liver lipid accumulation around calving by stimulating fatty acid oxidation.

Key Words: L-Carnitine, Liver, Periparturient period

M186 Effect of feeding Ca salts of trans-octadecenoic fatty acids and linoleic acid on productive and metabolic responses of dairy cows during the transition period. S. G. Onetti¹, S. J. Bertics¹, N. D. Luchini², and R. R. Grummer^{*1}, ¹University of Wisconsin, Madison, ²Virtus Nutrition, Fairlawn, OH.

Fifty-eight multiparous Holstein cows were used in a completely randomized block design to evaluate the effects of feeding Ca salts of trans-octadecenoic fatty acids and linoleic acid on animal performance and lipid metabolism during the transition period. Three weeks before expected calving, cows were fed 1% of the diet dry matter (DM) as Ca salts of palm oil (PFA) or as Ca salts of trans-octadecenoic fatty acids and linoleic acid (TFAL). After calving and until d 28 postpartum, half of the cows from each prepartum treatment were assigned to a diet containing PFA or TFAL at 2% of dietary DM. Pre- and postpartum diets differed only in the type of supplemental fatty acids. After d 28 postpartum, all cows were fed the PFA lactation diet until d 42. Fatty acid supplementation had no effect on pre- or postpartum DM intake or milk production. Milk fat % was lower ($P < 0.01$) and milk fat yield tended to be lower ($P < 0.15$) for cows fed TFAL than for cows fed PFA prepartum (3.8 vs. 4.1%, and 1.51 vs. 1.39 kg/d, respectively). Cows fed TFAL postpartum had lower ($P < 0.03$) milk fat test than cows fed PFA (3.8 vs. 4.0%, respectively), but no effect of postpartum treatment was observed for milk fat yield. Prepartum plasma concentration of nonesterified fatty acids (NEFA) tended to be lower ($P < 0.10$) for cows fed TFAL than for cows fed PFA (369 vs. 451 $\mu\text{Eq/L}$, respectively). Cows fed TFAL prepartum tended to have lower ($P < 0.11$) plasma NEFA concentration at d 1 postpartum than cows fed PFA prepartum (792 vs. 989 $\mu\text{Eq/L}$, respectively). Postpartum treatments had no effect on plasma NEFA concentration. No effect of prepartum treatment was observed for liver triglyceride content at d 1 postpartum. Results of this study suggest that feeding Ca salts of trans-octadecenoic acids and linoleic acid during late gestation may cause milk fat depression and lower NEFA mobilization at parturition compared to feeding palm oil fatty acids.

Key Words: Trans-fatty acid, Transition period, Lipid metabolism

M187 Production, metabolic and reproductive responses of transition Holstein cows fed trans fatty acids. C. J. Rodríguez-Sallaberry*, C. Caldari-Torres, E. S. Greene, C. R. Staples, and L. Badinga, University of Florida, Gainesville.

The objective of this study was to examine the effect of feeding calcium salts of trans-octadecenoic fatty acids on performance and metabolic responses of dairy cows during the periparturient period. Eighteen multiparous and 12 primiparous Holstein cows were assigned randomly to be supplemented with a highly saturated fat (RBF, Cargill; n=15) or a Ca salt fat enriched in trans C_{18:1} fatty acids (TRANS, EnerG TR, Virtus Nutrition; n=15). Dietary treatments started at approximately 28 d prepartum and continued through 21 DIM. The diets were formulated to contain 1.50 and 1.75% of RBF and TRANS, respectively, so as to provide isolipid supplementation. Dry matter intake (12.9 ± 0.7 kg/d), body weight (618 ± 16 kg), BCS (3.09 ± 0.05) and milk (32.4 ± 1.4 kg/d) did not differ between dietary treatments. Milk composition at week 3 of lactation (fat = 3.5 ± 0.1%; true protein = 2.76 ± 0.05%; SCC = 90,700 ± 20,000) did not differ between dietary treatments. Plasma NEFA (302.4 ± 37.9 $\mu\text{Eq/L}$), BHBA (3.9 ± 0.4 mg/dL) and glucose (56.4 ± 1.14 mg/dL) concentrations were not different between dietary groups. Compared to cows fed saturated fat, cows given supplemental trans fatty acids had higher PGF_{2 α} metabolite (PGFM) concentration in plasma during the first week of lactation.

The fatty acid effect on PGFM response was minimal in first-lactation heifers. Dietary treatments had no detectable effects on follicular dynamics during the first 3 weeks of lactation. Results indicate that dietary *trans*-octadecenoic fatty acids may affect reproductive responses in early post-partum dairy cows through alteration of uterine PGF_{2α} production.

Key Words: Production, Reproduction, *Trans* fatty acids

M188 Lactation response of cows to intravenous infusion of conjugated linolenic acids. R. Gervais* and P. Y. Chouinard, *Université Laval, Québec, Québec, Canada.*

It has been previously established that supplementation of *trans*-10, *cis*-12 conjugated linoleic acid reduces milk fat content and fat deposition in a number of species. Recently, a mixture of isomers of conjugated linolenic acid (*cis*-9, *trans*-11, *cis*-13 C18:3 and *cis*-9, *trans*-13, *cis*-15 C18:3) has been shown to affect lipid metabolism in mice (Plourde et al. 2005, 96th AOCS An. Mtg. Exp.). The objective of this study was to evaluate the effects of an intravenous administration of conjugated linolenic acid on milk yield and composition with special emphasis on milk fat content in lactating dairy cows. Three multiparous Holstein dairy cows (DIM = 200 ± 35; BW = 648 ± 56 kg; SD), fitted with indwelling jugular catheter, were randomly assigned to a 3 × 3 Latin square design. For the first 5 d of each 14-d period, cows were infused intravenously with a 15% lipid emulsion providing: LNA) 10 g/d of *cis*-9, *cis*-12, *cis*-15 C18:3 + 1.3 g/d of *cis*-9, *cis*-12 C18:2 as control, CLA) 10 g/d of *cis*-9, *cis*-12, *cis*-15 C18:3 + 1.3 g/d of *trans*-10, *cis*-12 C18:2 as positive control, and CLNA) 10 g/d of an equal mixture of *cis*-9, *trans*-11, *cis*-15 C18:3 and *cis*-9, *trans*-13, *cis*-15 C18:3 + 1.3 g/d of *trans*-10, *cis*-12 C18:2. CLA treatment reduced milk fat concentration by 6% ($P < 0.05$) compared to LNA treatment (4.23 vs. 4.52 ± 0.50%; SEM; $P < 0.05$), whereas CLNA treatment had no effect on milk fat concentration (4.17%; $P > 0.10$) beyond that attributable to its *trans*-10, *cis*-12 C18:2 content. Milk lactose content was increased ($P < 0.05$) when CLA treatment was infused (4.61 ± 0.11%) compared to LNA treatment (4.51%) and CLNA treatment (4.50%). Milk yield (27.4 ± 2.9 kg/d), milk fat yield (1148 ± 37 g/d), milk protein content (3.69 ± 0.32%) and yield (992 ± 36 g/d), as well as dry matter intake (20.3 ± 0.5 kg/d) were unaffected by treatments ($P > 0.10$). The intravenous infusion of an equal mixture of *cis*-9, *trans*-11, *cis*-15 C18:3 and *cis*-9, *trans*-13, *cis*-15 C18:3 did not affect milk fat concentration and yield suggesting that these isomers of conjugated linolenic acid have no effect on milk fat synthesis in lactating dairy cows.

Key Words: CLNA, CLA, Milk fat

M189 Effect of diets rich in oleic acid (cis or trans), linoleic and linolenic acids on plasma bST, IGF-I, and PGFM of Holstein cows. B. C. do Amaral*, C. R. Staples, L. Badinga, S. A. Sennikov, and W. W. Thatcher, *University of Florida, Gainesville.*

The objective was to evaluate how dietary fat sources of oleic, trans-octadecenoic, linoleic, or linolenic acids affected bST, IGF-1, and PGF metabolite (PGFM) concentrations in plasma of Holstein heifers (n = 22) and cows (n = 32) during the summer season. Fat supplements were the following: 1) sunflower oil (SFO; Trisun, Humko Oil, 80% C18:1), 2) Ca salt of trans-octadecenoic acids (TRANS; EnerG TR, Virtus Nutrition, 57% trans 6-12 C18:1), 3) Ca salt of vegetable oils (MEGR; Megalac-R, Church & Dwight Co, 30% C18:2), and

4) linseed oil (LSO- Archer Daniels Midland, 56% C18:3 and 16% C18:2). Supplemental fats were fed at 1.35% of dietary DM beginning at 29 d prior to expected calving date. After calving, fats were fed at 1.5% (oils) and 1.75% (Ca salts) of dietary DM for 15 wk. Blood samples were taken thrice weekly during 7 wk for measurement of IGF-1 and bST and for the first 14 DIM for PGFM. Mean concentrations of plasma IGF-1 tended to be greater ($P = 0.08$) in heifers compared to cows (135 vs. 124 ng/ml) but did not differ among treatment groups (122, 135, 124, and 137 ng/ml for diets 1, 2, 3, and 4 respectively). Concentrations of IGF-1 increased at a faster rate for animals fed polyunsaturated fats compared to those fed monounsaturated fats. Mean concentrations of bST were not different among treatments. Plasma concentrations of bST decreased from 7.0 to 4.1 ng/ml over DIM for primiparous cows except those fed MEGR, which increased from 7.3 to 8.3 ng/ml. For multiparous cows, bST concentrations also decreased over time but those fed MEGR decreased at a faster rate (treatment by parity by DIM interaction). Cows fed TRANS had a higher initial plasma concentration of PGFM (4065 vs. 2408 ng/ml) and decreased at a faster rate than cows fed SFO but both reached baseline by 9 DIM. The PGFM concentrations of cows fed MEGR decreased at a slower rate compared to cows fed LSO, reaching baseline 2 d later. Dietary fatty acids alter hormonal status of lactating dairy cows.

Key Words: Fat, Hormones, Periparturient cow

M190 Effect of diets enriched in oleic (cis or trans), linoleic or linolenic acids on concentration of blood and liver fatty acids of Holstein cows. B. C. do Amaral*, C. R. Staples, S. C. Kim, L. Badinga, and W. W. Thatcher, *University of Florida, Gainesville.*

The objective was to evaluate how dietary fat sources enriched with oleic, trans-octadecenoic, linoleic, or linolenic acids affected the plasma and liver fatty acid profiles of Holstein heifers (n = 22) and cows (n = 32) during the summer season. Fat supplements were the following: 1) sunflower oil (SFO - Trisun, Humko Oil, 80% C18:1), 2) Ca salt of trans-octadecenoic acids (TRANS- EnerG TR, Virtus Nutrition, 57% trans 6-12), 3) Ca salt of vegetable oils (MEGR- Megalac-R, Church & Dwight Co, 30% C18:2), and 4) linseed oil (LSO- Archer Daniels Midland, 56% C18:3 and 16% C18:2). Supplemental fats were fed at 1.35% of dietary DM beginning at 29 d prior to expected calving date. After calving, fats were fed at 1.5% (oils) and 1.75% (Ca salts) of dietary DM for 15 wk. Three blood samples collected on a Monday-Wednesday-Friday schedule between 21 and 28 DIM were analyzed for fatty acids using gas chromatography. Liver samples were taken via biopsy on 2, 14±2, and 28±2 DIM, immediately frozen in liquid nitrogen and kept at -80°C for fatty acid analysis. Feeding high oleic sunflower oil did not affect the C18:1 concentrations of plasma (12.35%) or liver (21.8%). Cows fed TRANS fats had greater concentrations of plasma C18:1 trans isomers in liver tissue (1.0, 1.4, 1.0, and 1.0% for diets 1, 2, 3, and 4, respectively). Concentrations of C18:2 were greater in cows fed MEGR (44.4%) compared to cows fed LSO (41.8%) but were not different from that of cows fed SFO (43.4%) or TRANS (45.2%). *Cis*-9, *trans*-11 CLA was greater in plasma (0.13, 0.13, 0.16, and 0.14%) and liver (0.41, 0.43, 0.50, and 0.47%) of cows fed MEGR compared to those fed SFO or TRANS. Cows fed LSO had greater concentrations of C18:3 (2.4, 2.5, 2.3, and 4.9%; 0.9, 0.9, 1.0, and 1.4%) and C20:5 (0.5, 0.5, 0.5, and 0.7%; 0.6, 0.6, 0.5, and 0.9%) in plasma and liver, respectively. Feeding dietary fats enriched with particular fatty acids resulted in increased concentrations of those fatty acids in the plasma and liver.

Key Words: Fat, Blood, Liver

M191 Effects of abomasal infusion of tallow or linseed oil on responses to glucose and insulin challenges of Holstein cows. J. A. A. Pires*, A. E. Kulick, N. Silva del Rio, and R. R. Grummer, *University of Wisconsin, Madison.*

The objective was to test whether abomasal infusion of linseed oil, rich in C18:3, enhances the response to glucose and insulin challenges in Holstein cows when compared to tallow. Eight non-lactating, non-gestating cows were assigned to a cross-over design, fed to meet maintenance requirements and supplemented with abomasal infusions of either linseed oil (L) or tallow (T) at a rate of 0.54 g/kg of BW per d for 5.5 d. This dose is equivalent to a 735-kg cow eating a diet containing 2.7% TG (DM basis) at 2% of BW. Feed and treatments were provided in equal doses every 8 h during the first 3 d of each period, and every 4 h thereafter. Five d after initiation of treatments, glucose tolerance tests (GTT) were performed (0.25g dextrose i.v. bolus/kg BW), followed by insulin challenges (IC; 0.1 IU insulin i.v. bolus/kg BW) 12 h later. Before GTT, plasma glucose concentration was greater for L (66 vs. 63 mg/dl; $P < 0.05$) and there was no difference in serum insulin (29 vs. 28 μ IU/ml; $P = 0.81$), nor plasma NEFA (113 vs. 106 μ Eq/L; $P = 0.41$) for L and T, respectively. There was no difference in glucose clearance parameters after GTT, but insulin concentrations were lower for L during the first 40 minutes after GTT. Accordingly, the insulin response area under the curve to GTT was lower for L than T (9810 vs. 12589 μ IU/ml/180 min; $P < 0.01$). NEFA was higher for L during GTT (108 vs. 89 μ Eq/L; $P < 0.001$), possibly due to the lower insulin response to GTT observed with L. Before IC, glucose was similar between treatments (68 vs. 66 mg/dl; $P = 0.13$), but NEFA was higher for L (151 vs. 90 μ Eq/L; $P < 0.05$). Glucose was similar across treatments during the 30 min of sampling period after IC, suggesting that treatments did not affect maximum responsiveness to insulin. NEFA was reduced to same extent by 30 min after IC (20% vs. 17% for L and T; $P = 0.71$). L had an insulin sensitizing effect compared to T, because lower insulin concentrations caused similar glucose clearance during GTT.

Key Words: Linseed oil, Glucose and insulin tolerance tests, Bovine

M192 Effect of feeding whole soybeans on thermal balance and fatty acid profiles on early lactation cows during heat stress. J. D. Sampson, D. E. Spiers, and J. N. Spain*, *University of Missouri, Columbia.*

Elevated air temperatures during summer months cause a change in thermal balance of lactating cows. Skin secretions of heat stressed cows contain a high proportion of 18:2n6. Feeding fat has been used to increase energy intake while decreasing heat increment of the diet. This study was conducted to investigate the effects of cracked soybeans (SB) on thermal balance and plasma fatty acids of lactating dairy cows during heat stress (HS). Twenty four cows were paired based on calving date and parity and randomly assigned to one of two experimental diets (Control or SB). SB diet provided the cows with 2.5 kg raw, cracked soybean/d. Diets were fed ad libitum via Calan gates as a TMR beginning on the first day after calving. Daily DMI was recorded. On day 42 of lactation, cows were moved to the Brody Climate Lab. Cows were housed under thermoneutral conditions (19°C) for 2 wks before exposure to HS (cycling daily temperature; min. ~24°C, max. ~32°C). Blood samples were collected on day 7 and 14 during both TN and HS periods. Data were analyzed by PROC MIXED of SAS. There were no differences due to diet in thermal balance as assessed by respiration rate and rectal temperature ($P > 0.10$). Heat stress caused decreases in milk production and DMI, but there were no differences between diets ($P > 0.10$). Diet altered fatty acid profile

of the cows during periods of heat stress. Feeding soybeans caused trends for increasing levels of plasma fatty acids with 16:0, 18:0, 18:1, and 18:2 higher in cows fed SB versus control (16:0, 76.0 vs. 141.0; $P = 0.09$), (18:0, 101.5 vs. 193.9; $P = 0.08$), (18:1, 40.5 vs. 86.4; $P = 0.08$), and (18:2; 339.2 vs. 538.9; $P = 0.14$). Cows fed control diet had a significant 40% increase in NEFA immediately following heat stress ($P = 0.06$ diet*time interaction). The addition of fat from soybeans did not alter production or thermal balance, but did increase the concentration of fatty acids in the plasma of heat stressed cows. The impact of altered fatty acid balance during heat stress on immune function and reproductive performance warrant additional study.

Key Words: Heat stress, Soybeans, Plasma fatty acids

M193 A comparison of the fatty acid profiles of red deer and sheep adipose tissues. G. A. Romero-Perez¹, R. W. Mayes¹, and J. R. Scaife², ¹*The Macaulay Institute, Aberdeen, UK*, ²*Writtle College, Essex, UK.*

The fatty acid (FA) composition of adipose tissues from grazing red deer and sheep were compared in order to examine possible implications to human health of consuming fat from these animals. For nine weeks, 12 yearling female red deer (*Cervus elaphus scoticus* L.) grazing high quality mixed grass pasture were supplemented with 60 g/d sunflower oil mixed with 135 g/d DM barley-based concentrate. Similarly, a group of 12 grazing Scottish Blackface female sheep were fed 30 g/d sunflower oil with 90 g/d DM concentrate. Separate control groups of 12 red deer and 12 sheep were fed concentrate with no oil. The statistical analysis of data was carried out using ANOVA (Genstat for Windows, release 8.1). In fat depots, the ratio saturated fatty acid (SFA):unsaturated fatty acid (UFA), was higher in deer ($\approx 2:1$) than in sheep ($\approx 1.2:1$). Total concentrations of SFA and UFA in adipose tissue in control deer were 267.35 \pm 43.004 and 119.70 \pm 20.114 mg/g, respectively and in control sheep were 341.18 \pm 14.290 and 288.30 \pm 26.762 mg/g, respectively. Oil-supplementation did not significantly affect UFA and SFA in either species (deer: 316.86 \pm 33.010 and 152.87 \pm 16.447 mg/g, respectively; sheep: 366.38 \pm 7.329 and 282.23 \pm 14.624 mg/g, respectively). The total concentrations of major FA in control deer were stearic acid (SA) (133.31 \pm 20.253 mg/g), palmitic acid (PA) (103.13 \pm 18.185 mg/g) and oleic acid (OA) (60.73 \pm 9.998 mg/g). FA concentrations in control sheep were OA (216.93 \pm 18.124 mg/g), SA (173.90 \pm 10.243 mg/g) and PA (132.16 \pm 5.185). Conjugated linoleic acid (CLA) concentration in the adipose tissues of control and oil-supplemented deer (3.22 \pm 0.669 and 4.16 \pm 0.670 mg/g respectively) was not significantly different. Although higher than in deer, CLA concentration in sheep fat depots was similarly not significantly affected by oil supplementation. The consumption by humans of fat from sheep adipose tissue may be less unhealthy than that from red deer due to deer fat having a higher SFA:UFA ratio and proportion of PA.

Key Words: Red deer, Stearic acid, CLA

M194 Differences in expression and activity of β , β -carotene-15, 15'-oxygenase between yellow and white bovine fat carcasses. A. Morales¹, A. González¹, A. Varela-Echavarría², A. Shimada¹, and O. Mora¹, ¹*Facultad de Estudios Superiores Cuautitlán, UNAM, Querétaro, Querétaro, México*, ²*Instituto de Neurobiología, UNAM, Querétaro, Querétaro, México.*

Pasture-fed cattle show yellow pigmentation of their fat due to β -carotene stored in the tissues. β , β -carotene-15,15'-oxygenase (β CO) is an enzyme expressed in different tissues, and it cleaves

β -carotene into retinal. We compared the expression and activity of β CO in duodenum and liver of cattle with pigmented or non-pigmented fat. In the duodenum, *in situ* hybridizations showed expression of β CO in epithelial cells and crypts of the mucosa that was similar in pigmented and non-pigmented animals; liver showed diffuse signal at lobules, but pigmented animals showed higher signal near the portal space. Analyses by real time RT-PCR also showed amplification of mRNA for β CO, with no difference between pigmented or non-pigmented animals. Enzyme activity was similar in the duodenum, but pigmented animals had higher enzyme activity ($P=0.004$) in liver. Cattle with pigmented fat had higher expression and activity of β CO in liver, but its level was not high enough to prevent the storage of β -carotene in adipose tissue.

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Key Words: Cattle, Yellow-pigmentation, β -carotene

M195 Evaluation of fat tissue deposition and Leptin hormone measurement in early Angus-Nellore cattle treated with recombinant bovine somatotropin (rbST). C. L. Martins, R. D. C. Cervieri, M. D. B. Arrigoni, A. C. Silveira, C. A. de Oliveira, E. C. G. Felipe, H. N.s Oliveira, L. A. L. Chardulo, D. D. Millen*, and R. D. L. Pacheco, *FMVZ/UNESP, Botucatu, Sao Paulo, Brazil.*

The objective was to study the response of rbST on fat tissue deposition and leptin plasmatic concentration in early Angus-Nellore cattle. It was used 40 male calves with 20 days old supplemented with creep feeding until weaning and divided in two groups ($n=20$, 0.10mg/hd/day, every 14 days; $n=20$, not treated). The animals were weaned with 210 days old and fed in feedlot, when they were housed and divided in four treatments keeping the same dose every 14 days until 100 days prior slaughter ($n=10$, treated with rbST before and after weaning; $n=10$, treated with rbST until weaning; $n=10$, treated with rbST after weaning; $n=10$, not treated with rbST). The diet used in the feedlot had 20% of forage. Rib eye area (by ultrasound), weight gain and plasmatic concentration of leptin were measured every 28 days. The animals were slaughtered with 450kg and 13 months old. The leptin hormone was measured by RIA kit leptin multi-species (XL-85K). In the creep feeding period the calves treated with rbST had greater ($P<0.05$) average daily gain (1.10 vs. 1.02 kilos), total weight gain (170.8 vs. 158.1 kilos) and final weight (247.6 vs. 234.9 kilos) than calves not treated with rbST. For leptin, had no significant effect of the treatments and theirs interactions ($P>0.05$), showing a constant concentration during the experimental period in the calves. But, the leptin concentration increased from the beginning to the end of the experiment ($P<0.05$), independent of treatments (3.098 vs. 7.996 ng/mL), as well the fat tissue amount ($P<0.05$), from 18.7% (creep feeding period) to 30.4% (feedlot period). The animals not treated with rbST in both periods had smaller rib eye area (69.19 vs. 74.58 cm²) and lighter final weight (469.6 vs. 519.6 kilos) and hot carcass weight (257.3 vs. 286.5 kilos) than treated animals. Leptin showed to be a good metabolic indicator of animal adiposity, being able to be utilized to predict body condition score. The rbST used before weaning presents advantage for increasing the weaning weight and decrease the feedlot period, without altering the fat tissue deposition in carcasses.

Key Words: Leptin, rbST, Young cattle

M196 Effects of feeding soybean oil and high-corn silage diets on feedlot performance of beef cattle. C. K. Reynolds*, F. L. Fluharty, and S. C. Loerch, *The Ohio State University, Wooster.*

The objective was to determine the effect of feeding soybean oil (SO) and high corn silage (CS) diets on feedlot performance and carcass characteristics in beef steers. Angus based-steers ($n = 168$; BW = 287 kg) were allotted to 24 pens (7 steers each) and assigned to one of 6 treatments (4 pens each) based on 3 forage regimens with or without SO supplementation in a 3 X 2 arrangement of treatments. Forage regimens (8 pens each) were low CS diets for the entire finishing period (LO) or high CS diets for 126 (HILO) or 210 (HI) d, followed by LO until slaughter. Within each forage regimen 4 pens were fed SO (5 % of diet DM) for the entire study. There were no implants or ionophores used. Steers were harvested when s.c. back fat depth by ultrasound (pen mean) was 1 cm. Final BW (Table) increased ($P < 0.01$) with greater CS and SO. Increasing CS decreased ADG ($P < 0.01$). Feeding SO tended to decrease ADG for HI-LO and HI, but not LO ($P < 0.08$). DMI was greater for LO ($P < 0.01$) compared to HI-LO and HI, was reduced by SO ($P < 0.01$), and the reduction was less for LO ($P < 0.04$). Gain/kg feed DM was decreased ($P < 0.01$) with increased CS and increased ($P < 0.01$) by SO. Dressing % (61.3) and marbling score (569) were not affected by treatments, but kidney, heart and pelvic fat % was reduced ($P < 0.02$) by SO (2.43 vs. 2.10). In conclusion, feeding high CS diets increased total carcass yield without reducing quality, but increased time on feed and decreased ADG. Feeding SO increased gain/feed ratio, but increased feed costs and reduced ADG for the high CS diets.

Table 1. Feedlot performance of beef steers fed varying amounts of corn silage and soybean oil

Item	LO	LO-SO	HILO	HILO-SO	HI	HI-SO	SEM
Final BW, kg	488	509	548	552	583	586	13
Days fed	146	149	200	218	246	260	6
DMI, kg/d	9.19	8.77	8.46	7.58	8.79	7.76	0.22
ADG, kg/d	1.46	1.49	1.30	1.22	1.21	1.15	0.02
Gain/feed, kg/kg	0.159	0.169	0.154	0.161	0.137	0.149	0.004

Key Words: Beef, Forage, Oil

M197 Effects of adding sunflower or soybean seeds on heifers feedlot performance. J. A. Navarro*, F. J. Santini, G. J. Depetris, E. L. Villarreal, and D. H. Rearte, *EEA INTA Balcarce, Fac. Cs. Agrarias, UNMdP, Balcarce, Buenos Aires, Argentina.*

The objective of this trial was to evaluate dietary effects on heifers performance fed with different proportions of sunflower or whole raw soybean seed. One hundred and five Angus heifers (147±19 kg) were used in a randomized complete block design. The lipid supplementation treatments, applied for 125 d., were: no oilseeds (CON), sunflower seed at 4% (LSF), at 6% (MSF), and at 8% (HSF), soybean seed at 15% (LSB), at 20% (MSB), and at 25% (HSB) on a dry matter basis. Diets were formulated to be isonitrogenous (15% CP) and isocaloric (2.5 ME Mcal/kg). All diets consisted of corn silage, whole corn, sunflower meal and urea. Feed intake (DMI) was recorded daily and animals were weighed at the start and end of the trial and at two week intervals to obtain live weight gain (LWG). Ultrasound backfat (SBF) was measured to estimate fat deposition rate (FDR). The results of the least square means comparisons are shown on the table. Control had higher ($P<0.05$) DMI, LWG and FDR than sunflower and soybean treatments, and higher ($P<0.05$) FE than soybean treatments, but not

different than sunflower treatments. Sunflower treatments had higher ($P < 0.05$) DMI and LWG than soybean treatments; FE was better ($P < 0.05$) for soybean treatments, and there were no difference in FDR between oilseeds. Increasing the proportion of sunflower in the diet caused a linear decrease in the DMI ($P = 0.02$) and a quadratic effect for LWG ($P = 0.05$), but no response in the FE and FDR. The soybean showed a linear effect for FE ($P = 0.03$) only.

Table 1.

Item	CON	LSF	MSF	HSF	LSB	MSB	HSB	SEM
DMI, kg/d	5.79 ^a	5.22 ^b	5.21 ^b	4.85 ^{bc}	4.75 ^{bcd}	4.39 ^{cd}	4.28 ^d	0.12
Initial BW, kg	148	148	149	149	148	145	149	2
Final BW, kg	260 ^a	250 ^{ab}	250 ^{ab}	244 ^{ab}	241 ^{ab}	237 ^b	246 ^{ab}	4
LWG, kg/d	0.933 ^a	0.831 ^{ab}	0.867 ^{ab}	0.772 ^b	0.787 ^b	0.746 ^b	0.811 ^{ab}	0.026
LWG, kg/d	0.933 ^a	0.831 ^{ab}	0.867 ^{ab}	0.772 ^b	0.787 ^b	0.746 ^b	0.811 ^{ab}	0.026
LWG, kg/d	0.933 ^a	0.831 ^{ab}	0.867 ^{ab}	0.772 ^b	0.787 ^b	0.746 ^b	0.811 ^{ab}	0.026
LWG, kg/d	0.933 ^a	0.831 ^{ab}	0.867 ^{ab}	0.772 ^b	0.787 ^b	0.746 ^b	0.811 ^{ab}	0.026
FE, feed/gain	6.18 ^a	6.27 ^a	6.01 ^a	6.27 ^a	6.02 ^a	6.02 ^a	5.26 ^b	0.16
Initial SBF, mm	2.44	2.58	2.60	2.49	2.58	2.22	2.40	0.10

^{abcd}Means within a row with unlike superscripts differ ($P < 0.05$).

Key Words: Sunflower and soybean seeds, Beef heifers, Feedlot performance

M198 Effects of rumen-protected Ca salts of conjugated linoleic acid (CLA) and previous rate of gain on growth performance, immune function, and carcass characteristics of feedlot cattle. H. Flórez-Díaz^{*1}, E. B. Kegley¹, G. F. Erf¹, D. L. Kreider¹, K. P. Coffey¹, J. K. Apple¹, and N. D. Luchini², ¹Department of Animal Science, Division of Agriculture, University of Arkansas, Fayetteville, ²NutriScience Technologies, Inc., Fairlawn, OH.

Crossbred beef steers ($n = 35$; initial BW = 402 kg), that had been on a 56-d growing study and fed diets with Ca salts of palm oil (PO) or Ca salts of CLA and formulated for a low (L; 0.68 kg/d) or a high rate of gain (H; 1.36 kg/d), were used on this finishing study to evaluate the effects of previous growth rate and growing and finishing fat source on growth performance, immune function, and carcass characteristics. Steers remained on the same fat source and were transitioned to 2 ad libitum finishing treatments consisting of a basal, corn-soybean meal based, diet with either 4% Ca salts of PO or CLA. Steers were fed to an average slaughter weight of 564 kg and data were analyzed using the GLM and MIXED procedures of SAS for a 2×2 factorial arrangement of treatments with pen ($n = 12$) as the experimental unit. Steers fed CLA had lower ($P = 0.05$) ADG, ADFI, final BW, HCW, dressing percent, proliferation of mononuclear cells stimulated with phytohemagglutinin and pokeweed mitogen, percentage of $\gamma\delta$ -TCR⁺CD8⁻ cells, and tended to have decreased total monocytes ($P = 0.07$) compared to steers fed PO. At harvest, steers fed CLA tended to have a lower ($P = 0.10$) percentage of CD4⁺CD8⁺ blood cells and a greater ($P = 0.09$) percentage of CD4⁺CD8⁺ cells in jejunal lymph nodes. Feeding CLA increased the jejunal CD4⁺/CD8⁺ ratio ($P = 0.01$) in H but not in L steers. Compared to H steers, L steers had greater ($P = 0.04$) ADG and NEFA, and a lower ($P = 0.03$) percentage of $\gamma\delta$ -TCR⁺CD8⁻ cells, and tended to have a higher ($P = 0.10$) G:F ratio, better ($P = 0.07$) yield grades, and lower blood CD4⁺CD8⁻/CD4⁺CD8⁺ ($P = 0.07$) and CD4⁺/CD8⁺ ($P = 0.08$) ratios. In conclusion, feeding CLA affected immunity, growth, and carcass traits of feedlot steers; however, previous rate of gain may interact with these responses in finishing cattle.

Key Words: CLA, Immune function, Cattle

M199 Influence of rate of growth and rumen-protected Ca salts of conjugated linoleic acid (CLA) on growth performance, immune function, and lipid metabolism of growing cattle. H. Flórez-Díaz^{*1}, E. B. Kegley¹, G. F. Erf¹, D. L. Kreider¹, K. P. Coffey¹, N. D. Luchini², and S. L. Krumpelman¹, ¹University of Arkansas, Fayetteville, ²NutriScience Technologies, Inc., Fairlawn, OH.

Forty-eight crossbred beef calves (initial BW = 350 kg) were used to determine the effects of rate of growth and CLA on immunity, lipid metabolism, and growth performance. Calves were blocked by weight, stratified by gender, and assigned to 16 pens. Pens within each block were assigned randomly to 1 of 4 diets arranged as a 2×2 factorial. Main effects were rate of gain (diets formulated to gain 0.68 [L] or 1.36 [H] kg/d), and fatty acid source (4% Ca salts of palm oil [PO] or 4% Ca salts of CLA). Data were analyzed using GLM and MIXED procedures of SAS with pen as the experimental unit. Feeding CLA tended to increase ($P = 0.07$) ADG and G:F in cattle fed L but not H diets, and tended to decrease the percentage of monocytes ($P = 0.09$) and eosinophils ($P = 0.06$) in H but not in L diets during the 56 d trial. Total white blood cell ($P = 0.02$) and lymphocyte concentrations ($P = 0.05$) were greater in L vs. H diets. Feeding CLA decreased the proliferation of cells stimulated with phytohemagglutinin (PHA; $P = 0.04$) or concanavalin A ($P = 0.03$) in H but not in L diets. Responses of cells to PHA were lower ($P = 0.003$) in L than in H diets. On d 56, CLA tended to decrease ($P = 0.08$) the percentage of CD4⁺CD8⁺ T cells, and to increase the percentage of $\gamma\delta$ -TCR⁺CD8⁻ T cells ($P = 0.08$), the CD4⁺CD8⁻/CD4⁺CD8⁺ ratio ($P = 0.07$), and the CD4⁺/CD8⁺ ratio ($P = 0.08$). Lower ($P < 0.05$) CD4⁺CD8⁻/CD4⁺CD8⁺ and CD4⁺/CD8⁺ ratios were observed in L vs. H diets. Feeding CLA decreased ($P = 0.05$) NEFA on d 28 and 56 in L but not in H diets. Lower insulin concentrations were observed on d 28 ($P = 0.01$) and 56 ($P = 0.002$) in L-CLA but not in L-PO. In conclusion, CLA may increase growth performance, modulate immunity, and affect lipid metabolism in growing cattle but responses depend on time and rate of growth.

Key Words: Cattle, Immune function, CLA

M200 Maternal nutrition effects on lipogenic enzyme messenger RNA in adipose tissue of suckling calves. C. M. Murrieta^{*1}, S. L. Lake², E. J. Scholljegerdes³, B. W. Hess¹, and D. C. Rule¹, ¹University of Wyoming, Laramie, ²Purdue University, West Lafayette, IN, ³USDA ARS, Mandan, ND.

Milk fatty acid composition can be altered through maternal dietary manipulation. We hypothesized that changes in milk fatty acid composition could affect adipose tissue development in the suckling calf. Our objective was to determine the effects of maternal prepartum energy balance and postpartum lipid supplementation on mRNA transcripts of four lipogenic enzymes in adipose tissue of suckling calves. Three-year-old Angus \times Gelbvieh beef cows nutritionally managed to achieve a BCS of 4 ± 0.07 (BW = 479.3 \pm 36.3 kg) or 6 ± 0.07 (BW 579.6 \pm 53.1 kg) at parturition were used in a 2-yr experiment ($n = 36$ /yr). Beginning 3 d postpartum, cows within each BCS were assigned randomly to be fed hay and a low-fat control supplement or supplements with either high-linoleate cracked safflower seeds or high-oleate cracked safflower seeds until d 60 of lactation. Diets fed to cows were formulated to be isonitrogenous and isocaloric, with 5% of DMI as fat. After 61 d of suckling these cows, calf adipose tissue biopsies were taken from the tail head region for determination of mRNA abundance. Maternal BCS did not influence mRNA abundance for lipoprotein lipase (LPL; $P = 0.90$), acetyl-CoA carboxylase (ACC; $P = 0.96$), stearoyl-CoA desaturase (SCD; $P = 0.97$), or fatty acid synthase (FAS; $P = 0.25$). Likewise, mRNA abundance of LPL (P

= 0.94), ACC ($P = 0.93$), SCD ($P = 0.98$), and FAS ($P = 0.86$) did not differ in adipose tissue of calves suckling cows fed the various dietary treatments. We conclude that neither maternal BCS nor milk fat compositional changes occurring from 5% of DMI as fat from oil

seeds during the first 60 d of lactation in beef cows was great enough to impact lipogenic enzyme mRNA abundance in adipose tissue of their suckling calves.

Key Words: Lipid supplementation, Beef cattle, Milk

Ruminant Nutrition: Metabolism and Immunology

M201 Is OmniGen-AF capable of augmenting markers of immune health when blended into a nutritional block? N. Forsberg*, Y. Wang, and S. Puntenney, *Oregon State University, Corvallis.*

Previous studies have shown that addition of OmniGen-AF to diets of ruminant livestock and laboratory animals increases expression of markers of innate immune health. Markers which respond to the presence of OmniGen-AF have included neutrophil L-selectin, interleukin-1-beta (IL1B) and interleukin 8-receptor. The goal of this study was to evaluate whether similar responses in immunity were detected when OmniGen-AF was mixed into a nutritional block. The rationale for completing this experiment was that block formation requires high temperature processing and we were concerned that heat may thereby inactivate the product. Fourteen growing sheep were assigned to two treatments: control block and Omnigen-AF-supplemented block. Concentration of the OmniGen product in the block was 9% which was expected to deliver an approximate daily intake of 4g OmniGen/animal/d. All animals on the study were immunosuppressed via twice daily injection of Azium (0.1 mg/kg twice/day). Duration of the study was 28 d. On day 28, blood samples were taken via the jugular and neutrophils were isolated. The RNA was prepared from neutrophils using Trizol. Concentrations of L-selectin mRNA and beta-actin mRNA were then determined using selectin- and actin-specific primers and quantitative RT-PCR. Animals on the 2 treatments gained similar weight during the study ($P > 0.05$). Control-fed sheep gained 0.17 kg/d and OmniGen-AF-fed sheep gained 0.19 kg/d. Quantitative RT-PCR revealed that feeding OmniGen-AF increased expression of L-selectin in neutrophils of immunosuppressed sheep by 3.75-fold ($P < 0.05$). This increase is similar to effects of OmniGen-AF on L-selectin expression when provided outside of a nutritional block formulation. Therefore, the high temperatures associated with nutritional block formulation do not inactivate OmniGen-AF. OmniGen-AF is capable of enhancing expression of immune genes in immunosuppressed sheep when included in a nutritional block.

Key Words: OmniGen-AF, Immunity, L-selectin

M202 Effect of feeding blends of feedstuffs naturally contaminated with Fusarium mycotoxins on performance, metabolism and immunological parameters of dairy cattle. S. Korosteleva* and T. Smith, *University of Guelph, Guelph, Ontario, Canada.*

There is little known about the effect of Fusarium mycotoxins on performance, metabolism and immunity of dairy cattle. A blend of naturally contaminated feedstuffs was fed to 18 mid-lactation Holstein cows with average milk production of 30-35 kg/day. Diets included: (1) control (2) contaminated and (3) contaminated + 0.2% glucomannan mycotoxin adsorbent (GMA) for a period of 56 days. Wheat, corn and hay were the contaminated feedstuffs. Deoxynivalenol (DON) was the major contaminant and was found in TMR at up to 3.6 ppm dry matter. Body weight, body condition score, milk production, milk composition, SCC, blood serum chemistry, hematology, total Ig count and coagulation profile were measured. Data were analyzed by analysis of covariance using the mixed model of SAS as a completely

randomized design with repeated measures ($P < 0.05$). Zero point (before experiment) measurements were used as a covariate. Multiple comparisons at each time point were performed. Experimental groups were compared to control. Milk production, milk composition and SCC were not affected by diet ($P > 0.05$). Globulin ($P = 0.0016$) and total protein ($P = 0.0130$) levels increased significantly in cows fed contaminated TMR compared to controls after 42 days, while albumin:globulin ratio decreased ($P = 0.0074$). Serum urea concentrations were significantly elevated ($P = 0.0121$) throughout the experiment when cows fed the contaminated diet were compared to controls. Serum IgA concentrations decreased significantly in cows fed contaminated TMR after 36 days of feeding ($P = 0.0095$). The feeding of GMA prevented these effects ($P > 0.05$). It was concluded that feed naturally contaminated with Fusarium mycotoxins, even in low concentrations, can affect metabolic parameters and immunity of dairy cows and GMA can prevent some of these effects.

Key Words: Dairy cows, Fusarium mycotoxins, Deoxynivalenol

M203 Effect of feeding whole soybeans on hepatic gene expression in lactating dairy cows. J. D. Sampson*¹, R. P. Rhoads¹, R. J. Tempelman², S. S. Sipkovsky², P. M. Coussens², M. C. Lucy¹, J. N. Spain¹, and D. E. Spiers¹, ¹University of Missouri, Columbia, ²Michigan State University, East Lansing.

The purpose of this study was to determine hepatic gene expression in the dairy cow supplemented with whole soybeans during adaptation to chronic heat stress (HS) using microarray analysis. Twenty-four Holstein dairy cows were randomly assigned to either control diet (LC) or a whole soybean (LSB) diet and acclimated to thermoneutral conditions (TN; 19°C) for 2 weeks prior to exposure to HS conditions (cycling daily temperature; minimum ~24°C, maximum ~32°C). During the study, individual feed intake (FI) and milk production (MP) were measured on a daily basis. Rectal temperature (Tre) and respiration rate (RR) were measured at four hour intervals and milk components were analyzed weekly. Liver biopsies were obtained after one week of TN conditions and again after two weeks of HS exposure. Hepatic total RNA was reverse transcribed to cDNA. LC and LSB paired samples were sequentially labeled with Cy3 or Cy5 prior to hybridization to an 18,263 member NBFGC microarray. Gene expression data were normalized and analyzed using a two-stage mixed effects model in SAS. During HS, the profile of Tre and RR mirrored the cycling temperature, reaching daily maximums of 41°C and 95 breaths per minute, respectively. FI and MY steadily declined and reached stable reductions of 25% and 20%, respectively, for both dietary treatment groups by day 5 of HS. Microarray analysis revealed no diet by temperature interactions. However, there were 11 differentially expressed genes ($P \leq 0.001$) due to diet with an approximately equal number of up and down-regulated genes. In conclusion, feeding whole soybeans alters hepatic gene expression.

Key Words: Liver, Microarray, Whole soybeans

M204 Effects of feeding Tasco® *Ascophyllum nodosum* to large and small dairy cows during summer months in central Arkansas. D. W. Kellogg^{*1}, J. A. Pennington², Z. B. Johnson¹, K. S. Anschutz¹, D. P. Colling³, and A. B. Johnson⁴, ¹University of Arkansas, Fayetteville, ²University of Arkansas, Little Rock, ³Acadian Agritech, Dartmouth, Nova Scotia, Canada, ⁴Bio-Ingenuity, LLC, Chanhassen, MN.

A trial was conducted in central Arkansas from July 1 to September 30 (2005) to evaluate the effects of feeding Tasco® *Ascophyllum nodosum* to lactating dairy cows during hot weather. The 540 cows were divided in 4 free-stall barns to achieve 2 similar groups of large cows and small cows. Milk yield of cows averaged 28.8 kg/d for control and treatment groups during June, the preliminary period. All cows received a total mixed ration containing either 0 or 0.25% Tasco. Respirations were counted on 60 cows weekly. Cow fed Tasco had fewer respirations per minute on August 3 (77.3 compared to 88.5 for control cows; $P < 0.05$), on August 10 (80.0 compared to 91.4 for control cows; $P < 0.01$), on August 31 (66.6 compared to 71.5 for control cows; $P < 0.05$), and on September 7 (60.6 compared to 68.1 for control cows; $P < 0.01$). Cows fed Tasco produced more ($P < 0.01$) milk during July, August, and September; however, there was a significant interaction with size of cows during August ($P < 0.01$) and September ($P < 0.05$) caused by 2.3-kg/d more milk for the larger cows fed Tasco compared to similar yield for smaller cows. Cows were bred, but the number of pregnancies from the larger breeds was very low (3 of 50) for control cows. With Tasco in the diet, the pregnancy rate was enhanced ($P < 0.01$) dramatically (20 of 55). The number of inseminations per conception and the days open before first service did not vary ($P > 0.05$) among treatment groups. With Tasco in the diet, respiration rates were reduced for both large and small cows, although the effect appeared dependent upon time. Tasco reduced the steep decline in milk yield of the larger cows and dramatically enhanced the pregnancy rate of the larger cows, but smaller cows were not affected.

Key Words: Heat stress, Respiration rate, Conception rate

M205 Effects of feeding adsorbents on lactating dairy cows hematology and milk yield during summer. F. Abeni, L. Migliorati, F. Calza, and G. Pirlo*, *CRA Istituto Sperimentale per la Zootecnia, Cremona, Italy.*

The objective of this study was to evaluate the effects of a 12-wk inclusion of adsorbents (ADS) in the diet on hematology and milk yield of lactating dairy cows. In June 2005, 28 Italian Friesian cows were randomly assigned by parity, DIM, and previous milk yield to either be supplemented with 160 g/d per cow of adsorbents (80% clinoptilolite + 20% sepiolite) or to consume only the basal lactation diet (CON). Cows were milked in an automatic milking system that allowed daily milk recording. Blood samples were taken before TMR distribution (0730 h) before the trial start, and at 2, 4, 6, 8, 10, and 12 weeks of trial, to be analyzed for hematological parameters. Statistical analysis was performed by a randomized block design, with adsorbent supplementation (ADS vs. CON), milk yield level (high vs. low), and week of trial as main factors, with cow repeated in time. Cows fed ADS yield more milk than cows fed CON (27.6 vs. 25.1 kg/d respectively; $P = 0.02$). Adsorbents *per se* did not affect erythrocytes count, hemoglobin concentration (HGB), hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration, whereas week of trial did ($P < 0.001$). There were no interactions between adsorbents and productive level ($P > 0.05$) on erythrocyte features. There was interaction between adsorbents and week of trial for MCV ($P < 0.05$), MCH ($P < 0.05$), and also a trend was evidenced for HGB ($P < 0.10$). The increase of MCV and HGB observed at the 2 final samplings in cows

fed CON, and not observed in ADS cows, suggest a relative reduction in erythrocyte function. Considering the selectivity of the adsorbents used, a decreased availability of Fe or other micronutrients can be hypothesized. Our results can not be exhaustive concerning long term response of cow hematology to adsorbent inclusion in the diet; further research on micronutrients involved in erythrocyte functions (Fe and Cu) will be necessary.

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Key Words: Adsorbents, Dairy cow, Hematology

M206 Effects of dietary antioxidant plant extracts on udder health and milk quality. T. Doriana*, G. Sara, M. Marina, and B. Valerio, *University of Milan, Milan, Italy.*

Increasing evidence presents a relationship between dietary antioxidants and udder health and resistance to infection. Aim of this trial was to evaluate the effects of plant extracts with antioxidant properties on milk quality and udder health parameters. Twenty Holstein cows selected according to parity, milk production (33.7±2.21 kg/d), DIM (112±29) and SCC (<100,000), were divided into two groups. The treated group received a 10 g/d of a natural extracts mixture (*Lonicera* spp, *Vitis* spp., Indena S.p.A.) by oral drench for 15 d. Milk production was recorded and samples aseptically collected on 0, 7, 14, 21 and 28d after the start of the treatment. Composition (protein, fat, lactose and urea), bacteriological analysis (FIL-IDF methods), and SCC (fluoro-optical-electronic counter) were assessed on milk samples. Phagocytic activity evaluation was performed on PMNs by chemiluminescence luminol enhanced assay while macrophages activity was read by Lucigenin enhancement both vs Zymosan as stimulus, properly opsonized with homologous serum. Nitric Oxide was assessed with a Griess modified assay. Statistical analysis was performed using PROC MIXED of SAS. Treatment didn't affect milk production and composition. A decrease in milk yield was found both in control and treated group due to the physiological descending phase in the lactation curve. SCC was unaffected by treatment. The treated animals showed a reduction in mammary gland infections. The percentage of quarters infected over the entire trial was 53.5 in the control group and 39.5 in the treated group. Pathogens isolated most frequently were coagulase-negative staphylococci and coliforms. Treatment didn't affect the phagocytic activity of macrophages and PMNs. Nitric oxide in milk was also unaffected by treatment. In conclusion treatment with this natural mixture does not affect milk production and composition, but can reduce mammary infection.

Key Words: Antioxidant plant extract, Udder health, Milk quality

M207 A simulation model to integrate ruminal volatile fatty acids (VFA) and blood glucose metabolism in transition dairy cows under steady state conditions. X. Markantonatos^{*1}, Y. Aharoni³, T. Cassidy¹, R. K. McGuffey², L. F. Richardson², and G. A. Varga¹, ¹The Pennsylvania State University, ²Elanco Animal Health, ³Newe Ya'ar Research Center, Israel.

Eight multiparous transition Holstein cows in a completely randomized design were used to evaluate the effects of monensin (M) on ruminal VFA and plasma glucose (Glu) metabolism. Cows received the same diet consisting of 58:42 or of 51:49 (forage:concentrate) prepartum (Pre) or postpartum (Post), respectively. Diets were supplemented with 300 mg/d of M or without M. VFA isotopic tracers [Na-1-¹³C-acetate (Ac), -propionate (Pr), or -butyrate (Bu)] were used as markers to

describe VFA kinetics in the rumen. U-¹³C-Glu was injected into the jugular vein for Glu kinetic determination. WinSAAM was used to develop a steady state VFA and blood Glu model. A 14-compartment model was used to describe ruminal VFA and blood Glu metabolism. The main VFA compartments consisted of Ac, Pr, and Bu. Interconversions between Ac and Bu were estimated by assigning virtual compartments which accumulate carbons from the donor compartment, e.g. Ac, before they are delivered to the recipient compartment, e.g., Bu. Plasma Glu was comprised of two compartments; the compartment into which U-¹³C-Glu was infused, and a virtual compartment-acceptor of Pr originated Glu. The model described VFA and plasma Glu kinetics. The model estimated lower Bu and Ac interconversions with M, Pre (Bu to Ac; 14% vs 12%; $P=0.04$, and Ac to Bu; 32% vs 25%; $P=0.11$). Glu input from other sources than Pr decreased with M, Post (2.26 g/min vs 1.09 g/min). Gluconeogenesis, expressed as Pr contribution to plasma Glu pool was higher ($P=0.06$; 22% vs 31%), but the Glu disposal rate decreased in M cows ($P=0.001$; 1.67 g/min vs 0.92 g/min). The proposed model described and integrated ruminal VFA and blood Glu kinetics, resulting in quantification of VFA and Glu metabolism. Results suggest that M affects interconversions of ruminal VFA, increases Pr originated gluconeogenesis, and reduces Glu disposal rate in transition cows.

Key Words: Simulation model, VFA Interconversions, Gluconeogenesis

M208 Splanchnic metabolism of [U-13C]glucose in lactating dairy cows. N. B. Kristensen*, B. M. L. Raun, and B. A. Røjen, *Danish Institute of Agricultural Sciences, Tjele, Denmark.*

Three lactating Holstein cows (20 ± 1 kg milk/d; 315 ± 13 DIM) implanted with permanent indwelling catheters in the mesenteric artery, hepatic portal vein, hepatic vein and mesenteric vein were used to investigate splanchnic glucose metabolism with two levels of starch intake. Two diets were formulated to supply different amounts of starch from corn silage (4% of DM, LS; 16% of DM, HS). Artificially dried hay was substituted for corn silage with the LS treatment. Supplement was based on sugar beet pulp and rape seed cake to ensure minimal starch supply from supplement. Treatment periods were 14 days with sampling on the last day of each period. Continuous infusion of pAH (32 ± 2 mmol/h) into the mesenteric vein and primed continuous infusion of [U-13C]glucose (0.95 ± 0.05 mmol/h) into the jugular vein were initiated 1 h before first blood sampling. Ten sets of blood samples were obtained simultaneously from the artery, portal vein, and hepatic vein during the 12-h collection period. Data was analyzed as a split-plot design using Proc Mixed in SAS. Dry matter intake was numerically higher with HS (16 ± 2 kg/d) compared with LS (12 ± 2 kg/d). The net hepatic flux of glucose increased ($P < 0.01$) with HS compared with LS (544 and 432 ± 6 mmol/h, respectively) and the irreversible loss rate of glucose increased ($P < 0.05$) with HS compared with LS (438 and 352 ± 10 mmol/h). The net portal flux of glucose (-50 ± 5 mmol/h) and portal-drained visceral extraction of arterial [U-13C]glucose (1.6 ± 0.2 %) were not affected ($P > 0.10$) by treatment. Glucose extraction in the liver was not different from zero ($P > 0.10$) and did not differ between treatments (0.08 ± 0.2 %). Glucose absorption to the portal blood corrected for portal-drained visceral extraction of arterial [U-13C]glucose was not affected by treatment ($P > 0.10$) and not different from zero ($P > 0.10$; 4.6 ± 9.7 mmol/h). Data show that increased intake of starch from corn silage was not followed by any detectable increase in glucose absorption to the portal blood or changes in the portal-drained visceral metabolism of glucose.

Key Words: Glucose, Metabolism, Stable isotope

M209 Feeding a high energy diet on a restricted basis during the dry period does not negatively affect postpartum milk yield or dry matter intake. L. A. Winkelman* and C. K. Reynolds, *The Ohio State University, Columbus.*

Meeting the energy demands of the transition dairy cow is challenging. Cows often decrease DMI before calving, causing negative energy balance (EB). Limit feeding dry cows a high energy diet may enable adequate DM and energy intake and reduce the extent of negative EB at calving. Multiparous Holstein cows ($n = 18$), dried off 45 d before expected calving and paired by expected calving date, parity, and previous milk yield, were randomly assigned to dry period diets formulated to meet nutrient requirements at ad libitum (AL) or restricted (R) DMI. All cows had ad libitum access to the same diet after calving. Blood samples were taken weekly from the coccygeal vein. Data were statistically analyzed as repeated measures within cows. Prepartum DMI for R cows was 9.4 kg/d, vs. 13.7 kg/d for AL cows ($P < 0.01$). Prepartum EB (0.02 vs. 6.37 Mcal/d, $P < 0.01$) and BW (756 vs. 773 kg, $P < 0.10$) were higher for AL cows, but BCS did not differ (3.58, $P = 0.56$). For 4 wk after calving, prepartum diet did not affect DMI (19.4 kg/d, $P = 0.36$), BW (678 kg, $P = 0.77$), BCS (3.21, $P = 0.40$), milk yield (41.5 kg/d, $P = 0.75$), milk protein concentration (3.26 %, $P = 0.42$) or milk lactose concentration (4.55 %, $P = 0.24$). Cows fed R had higher EB during week 1 after calving (-10.9 vs. -17.7 Mcal/d, $P < 0.10$). Milk fat concentration and yield were greater in the first week after calving for AL vs. R (6.63 vs. 4.39 %; 1.22 vs. 1.90 kg/day), but were lower for AL during wk 2 and 3 after calving ($P < 0.01$). Prepartum plasma glucose was lower ($P = 0.08$) for R vs. AL (3.5 vs. 3.7 mM), but prepartum insulin (0.22 nM) did not differ by treatment ($P = 0.38$). After calving, both insulin and glucose concentrations decreased ($P < 0.01$) and glucose was lower ($P = 0.03$) for R vs. AL (2.5 vs. 2.9). Postpartum insulin (0.08) did not differ by dry-period diet ($P = 0.55$). In conclusion, restricted intake of a high energy diet during a 45 d dry period does not adversely affect the milk production or intake of the postpartum dairy cow.

Key Words: Transition, Restricted intake, Production

M210 Systemic metabolic and endocrine changes and net portal flux in dairy cows fed a fat-based diet (FBD) compared to a starch-based diet (SBD). H. M. Hammon*¹, C. C. Metges¹, F. Becker¹, O. Bellmann¹, F. Schneider¹, P. Junghans¹, P. Dubreuil², M. C. Thivierge³, and H. Lapiere⁴, ¹Research Institute for the Biology of Farm Animals (FBN), Dummerstorf, Germany, ²University of Montreal, St-Hyacinthe, QC, Canada, ³Département des sciences animales, Université Laval, Québec, QC, Canada, ⁴Dairy and Swine Research and Development Centre, Lennoxville, QC, Canada.

Feeding rumen-protected fat (RPF) is an alternative to increase energy density of the diet and therefore energy intake in dairy cows. To investigate metabolic and endocrine changes in dairy cows fed either FBD or SBD, 3 Holstein cows (83 ± 1 DIM) were fitted with catheters in the portal vein, a mesenteric artery (A) and two mesenteric veins (MV). Cows were fed SBD and FBD (17.2% CP; 7.2 MJ NEL) for 3 wks, resp. In FBD, corn starch (92 g/kg DM) was replaced by 50 g/kg DM RPF (mainly C16:0 and C18:1). At d 18 of each period, blood was taken to measure concentrations of glucose (GLU), lactate, short-chain fatty acids, NEFA, triglycerides, insulin, and glucagon. Concomitantly, para-aminohippurate was infused into MV for measurement of portal plasma flow and estimation of net portal fluxes. Plasma A GLU enrichment was measured during the last 2h of a 4h infusion of D-[U-¹³C₆]GLU to calculate whole body GLU irreversible loss rate (ILR). Diet effects were tested using the Mixed Model of SAS. Intakes of

CP and NEL were not affected by diets. Milk and lactose yields were higher ($P < 0.05$) in FBD than SBD. GLU A concentrations were lower ($P < 0.01$) in FBD than SBD. Net portal utilization of GLU and whole body ILR were not affected by diets. NEFA and triglyceride A concentrations were higher ($P < 0.05$) in FBD. Portal absorption of propionate tended to be higher ($P < 0.1$) in FBD than SBD. Glucagon concentrations and glucagon to insulin ratios were higher ($P < 0.05$) in FBD. Greater milk yield in FBD were linked to lower GLU plasma concentrations, an elevated lipid status, and higher glucagon concentrations, but were not associated with differences in whole body GLU ILR or GLU net portal flux. Lower glucose concentrations, but a greater lactose output indicates a glucose saving effect after RPF feeding.

Key Words: Dairy cow, Glucose metabolism, Portal-drained viscera

M211 Effects of postpartum drenching on acute and chronic responses of blood metabolites in primiparous Holstein cows.

J. W. McFadden*, R. L. Wallace, and J. K. Drackley, *University of Illinois, Urbana.*

We evaluated the effects of large-volume drenches with propylene glycol or a drinkable drench product on acute and chronic responses of blood metabolites. Primiparous Holstein dairy cows ($n=30$) were utilized in a completely randomized design with three drench treatments: 37.85 L of water (control), 37.85 L of water plus 355 ml of propylene glycol (PG), and 37.85 L of water plus 900 g of a commercial drinkable drench product (DDP). The PG and DDP treatments provided similar amounts of glucose precursors. Drenches were administered 9 to 11 h after parturition. All cows were fed the same postpartum diet from parturition until d 10. Blood was sampled at 0, 2, 4, 6, 8, and 10 h after drench administration to determine acute responses and once daily from d 1 until 10 d postpartum to determine chronic responses to the single drench administration. Treatments did not affect postpartum dry matter intake (18.4, 18.5, and 19.6 for control, PG, and DDP, respectively; SEM = 1.6). Treatment did not affect serum glucose concentrations during the acute response period; however, a trend for a treatment by time interaction ($P=0.10$) showed that both PG and DPP tended to maintain higher serum glucose after treatment relative to controls. Both PG and DDP treatments significantly decreased acute serum nonesterified fatty acid (NEFA; $P<0.05$) and β -hydroxybutyrate (BHBA; $P<0.01$) concentrations compared to controls. Serum glucose, NEFA, and BHBA concentrations were not affected during the first 10 d following postpartum administration of PG or DDP ($P>0.34$). We conclude that administration of DDP or PG immediately after parturition were equally effective in decreasing serum NEFA and BHBA concentrations and increasing serum glucose concentrations within hours after drenching; however, the effects were not maintained during the first 10 d postpartum. (Experiment partially supported by MSC Co., Dundee, IL).

Key Words: Primiparous cow, Propylene glycol, Transition cow

M212 Plasma aflatoxin concentrations over time in bolus fed lactating dairy cows. M. Moschini¹, F. Mosoero¹, D. E. Diaz², A. Gallo¹, A. Pietri¹, and G. Piva^{*1}, ¹*Catholic University of Piacenza, Piacenza, Italy*, ²*Utah State University, Logan, UT*.

The aflatoxins (AF) are a group of mycotoxin produced primarily by *Aspergillus flavus* and *A. parasiticus*. Aflatoxin B1 (AFB1), the most frequently occurring and most studied of the AF is a Group 1 carcinogen and a potent hepatotoxin. Aflatoxin M1, a direct metabolite of AFB1,

appears in milk of lactating dairy cows soon after consumption of AFB1 contaminated diets. The objective of this experiment was to monitor plasma levels of aflatoxin B1 (AFB1) aflatoxin B2 (AFB2), aflatoxin G1 (AFG1), aflatoxin G2 (AFG2) and aflatoxin M1 (AFM1) in lactating dairy cows consuming AF. Seven lactating Holstein cows were given a bolus of a naturally contaminated corn meal (97.9±1.41 ppm AFB1, 20.2±0.5 ppm AFB2, 212.6±0.6 ppm AFG1, 17.7±0.3 ppm AFG2) for a total of 4.9 mg AFB1, 1.01 mg AFB2, 10.63 mg AFG1 and 0.89 mg AFG2. Vitamin A, at 1,000,000 IU, was added as a biomarker of intestinal absorption. Blood samples were collected at 0, 15, 30, 60, 120, 180, 270 and 330 min after bolus consumption. Plasma was analyzed by HPLC for AFB1, AFB2, AFG1, AFG2 and AFM1 concentration. Within the considered time points, peak plasma AFB1 concentration was obtained at 15 min. Plasma AFM1 concentrations were significant as soon as the first collection (15 min) and peaked at 270 min indicating both a rapid absorption of AFB1 through the rumen wall and a rapid metabolization into AFM1. The palmitate plasma level suggests the intestinal contribution to the aflatoxin plasma level begins after 120 min. Results suggest a rapid absorption of AF possibly through a passive transport through the rumen wall (Funded by AFLARID).

Table 1.

Item	Time (min)							
	0	15	30	60	120	180	270	360
AFB1, ng/L	n.d.	49.5±20.6	42.2±28.5	37.8±26.7	33.0±25.5	19.2±10.3	17.4±5.3	27.2±31.7
AFB2, ng/L	n.d.	9.0±6.5	8.0±7.5	6.8±4.5	9.2±8.3	5.5±3.1	4.4±2.9	7.2±7.6
AFG1, ng/L	n.d.	24.2±16.6	20.2±13.6	24.1±20.8	48.0±82.0	14.6±9.5	12.5±6.8	43.8±83.9
AFG2, ng/L	n.d.	3.6±2.8	3.2±2.6	3.6±1.9	8.5±9.8	2.8±1.7	2.7±1.7	7.8±10.0
AFM1, ng/L	n.d.	45.1±13.0	35.3±18.5	51.0±14.9	53.2±11.0	55.1±9.3	58.7±21.5	58.7±11.9
Retinol palmitate, μ L	n.d.	n.d.	n.d.	12.4±2.2	23.8±6.1	43.9±6.6	86.8±49.1	109.3±60.6

n.d. = not detected

Key Words: Mycotoxins, Aflatoxin, Milk

M213 Milk production as a function of nutrient supply follows a Michaelis-Menten relationship. J. J. O. Pimentel^{*1,3}, R. P. Lana^{1,2}, B. Zamperline¹, M. F. Paulino^{1,2}, S. C. Valadares Filho^{1,2}, R. M. A. Teixeira^{1,3}, and D. C. Abreu^{1,2}, ¹*Universidade Federal de Viçosa, Viçosa, MG, Brazil*, ²*CNPq, Brasilia, DF, Brazil*, ³*FAPEMIG, Belo Horizonte, MG, Brazil*.

Two experiments aimed to evaluate the effects of supplement type and amount on milk production in Brazil. In each experiment, eight Holstein cows (517±40 kg) were allotted in two 4 x 4 Latin squares, in four periods of 14 days. The Exp. 1 was conducted on pasture of Elephant grass (*Pennisetum purpureum*, Schum) in the rainy season, and the treatments included a control (mineral mixture - MM) and supplements with 24% CP in dry matter at levels of 1.25, 2.5, and 5.0 kg/animal/day, based on corn meal, soybean meal, urea and MM. The Exp. 2 happened in the dry season, in which the cows received 40 kg/day of chopped sugarcane plus 0.25% urea as fed basis and the treatments consisted of a control (MM) and supplement levels of 1.25, 2.5, and 5.0 kg/animal/day, based on MM (12.5, 5.7, and 2.9%, respectively), urea (11.6, 5.9, and 2.9%, respectively), corn meal and soybean meal, in which the protein sources were used to reach 12.2% CP in the total diet. The experiments were analyzed as Latin square design including effects of treatments, Latin square, animal within Latin square and period. There was no treatment effect ($P>.05$) on both experiments due to high coefficient of variation. In spite of that, the milk responses to supplementation were curvilinear in both experiments, following a Michaelis-Menten relationship of enzymatic systems and were explained by equations of Lineweaver-Burk as seen below:

Exp. 1: $1/\text{Milk} = 0.0125*(1/\text{Suppl}) + 0.0826 r^2 = 1.00$

Exp. 2: $1/\text{Milk} = 0.0199*(1/\text{Suppl}) + 0.1032 r^2 = 0.96$

The theoretical maximum milk production (1/a) were 12.1 and 9.7 kg/animal/day, respectively, and the half maximum milk production (b/a) was verified with 5.2% of the supplementation necessary to reach 95% maximum response. Therefore, the marginal increase in milk production reduces with increasing supplementation, different of the 2001 dairy NRC that consider linear responses for both energy and protein supplies.

Key Words: Dairy cattle, Lineweaver-Burk, Supplement

M214 Physiological responses to heat stress in steers following ruminal administration of ground endophyte-infected tall fescue seed. L. E. Wax*, G. Rottinghaus, and D. E. Spiers, *University of Missouri, Columbia*.

Cattle from Southeast to Midwest regions of the US often experience fescue toxicosis during summer months following intake of tall fescue infected with the endophyte *Neotyphodium coenophialum* (E+). Recent studies in our lab have attempted to enhance this condition by feeding cattle a diet containing ground E+ seed under heat stress conditions, which resulted in a large reduction in feed intake. The objectives of the present study were to separate out the oral effect of ground E+ seed by using ruminal administration, and determine a dose-response to ergovaline (i.e., a primary toxin found in E+ seed). Steers (n=6, 350kg avg. BW) were housed in the Brody Environmental Center at the University of Missouri and used in four trials over a 5 month period to ultimately expose each animal to each of the four treatments. All animals were originally housed at 19C for seven days and received endophyte-free ground seed (E-; Miller Seed Company, MO) in the diet. This was followed by 11 days of cycling heat stress (i.e., 26 to 36C). After this time, steers either continued on the E- supplementation or switched to E+ seed (Seed Research of Oregon, OR) at 5, 10 or 20µg ergovaline/kg BW for five days. Respiration rate, skin, and rectal temperatures were taken six times daily, along with daily measurement of feed intake. Fescue seed was mixed directly into the rumen four times daily to ensure the animal received the entire dose. Results were analyzed using ANOVA. Only the highest dose resulted in a significant change in performance. Treatment at this level resulted in a 30% rapid reduction in feed intake (P=0.02) below E- level. In contrast, hyperthermia associated with the highest dose developed gradually over four days of treatment to peak at 0.85C above E- level (P=0.01).

Feed intake is more responsive to fescue toxicosis than indicators of thermal stress, which develop gradually. These results also suggest that the reduction in feed intake is not a taste issue, since bypassing the mouth still results in decreased intake.

Key Words: Cattle, Heat stress, Endophyte

M215 Assessment of blended sorbitol and mannitol as a prepartum glucogenic supplement for periparturient dairy cows. J. W. McFadden*¹, S. S. Block², and J. K. Drackley¹, ¹*University of Illinois, Urbana*, ²*ADM Alliance Nutrition, Inc., Decatur, IN*.

We evaluated the effects of prepartum sugar alcohol supplementation on metabolic status and milk production in a commercial herd setting. Primiparous (n=66) and multiparous (n=101) Holstein dairy cows were utilized in a completely randomized design with two prepartum treatments: control (unsupplemented) or 100 g/d of sorbitol-mannitol blend (SMB) incorporated into the total mixed ration. Treatments were initiated 3 wk before expected calving and terminated at parturition. Cows were housed in group pens corresponding to treatment during the prepartum period then released into the herd after parturition. Milk production and composition was determined until 98 DIM. Blood metabolite response was measured at 1 d and 7 d postpartum. A single liver biopsy was obtained between 5 d and 8 d postpartum. Body condition score was documented prior to treatment and at parturition. Frequency of health disorders was recorded. Data was analyzed using the PROC MIXED procedure of SAS with repeated measures. Treatment with SMB tended to increase milk yield (P=0.10) in multiparous cows (44.3 and 46.3 kg/d for the control and SMB, respectively; SEM = 0.9). Milk yield in primiparous cows was not affected by SMB. Milk protein content was significantly lower (P=0.03) for the SMB treatment, however milk protein yield was not affected. Milk fat content and yield, SCC, and MUN concentrations were not affected by treatment. Serum glucose, β-hydroxybutyrate, and nonesterified fatty acid concentrations were not affected by prepartum supplementation of SMB. Hepatic concentrations of total lipid, triacylglycerol, and glycogen were not affected by treatment. Neither body condition score nor frequency of health disorders was affected by treatment. We conclude that prepartum supplementation of SMB may increase milk yield in multiparous Holstein dairy cows, but did not alter metabolic characteristics during the periparturient period. (Experiment supported by ADM Alliance Nutrition, Inc., Decatur, IN).

Key Words: Milk yield, Sorbitol, Transition cow

Ruminant Nutrition: Nitrogen Metabolism/Amino Acids - Dairy

M216 Effects of the isopropylester of the hydroxylated analogue of methionine (HMBi) on production performance of dairy cows in early lactation. S. Jurjanz*¹, J. C. Robert², and F. Laurent¹, ¹*INRA-ENSAA, Laboratoire de Sciences Animales, Vandoeuvre, France*, ²*Adisseo France SAS, Commeny, France*.

Thirty six Holstein cows (26 multiparous, 10 primiparous) were assigned to one of two treatments 17 to 24 days after calving. A basal diet consisting of (DM basis) 61.5 % corn silage, 6.7% wheat straw, 14.9% cracked wheat, 15.6% soybean meal, 1.3 % minerals was fed for 17 weeks as a control diet (treatment 1: T1), or was supplemented with 0.12 % of diet DM with HMBi (treatment 2: T2). The control diet contained an estimated (per kg DM) 1.61 Mcal Net Energy, 100g metabolizable protein (MP), 46g digestible undegraded protein

(PDIA from PDI system), 6.91 metabolizable lysine (%MP) and 1.78 metabolizable methionine (%MP). Treatment 2 contained 2.25 metabolizable methionine (%MP), HMBi supplying 0.47 metabolizable methionine (%MP). Results were analysed through an ANOVA using the mixed procedure of SAS with the repeated time option. The covariance structure between the different weekly averages was defined as compound symmetric. No significant differences were observed between treatment groups for DMI, milk yield, milk fat (content and yield) and body weight variations. Milk protein content was higher for T2 vs T1 (%3.36 vs 3.24, p<0.10) and lactose content increased significantly for T2 vs T1 (% 5.13 vs 5.02, p<0.01). Total nitrogen content in milk did not vary significantly (g/L, 5.37 and 5.20 respectively for T2 and T1). Protein nitrogen and casein nitrogen

increased significantly for T2 vs T1: respectively (g/L) 5.10 vs 4.91 (p<0.10) and 4.33 vs 4.12 (p<0.05). Non protein nitrogen content and proportion in total nitrogen decreased significantly for T2 vs T1: respectively (mg/L) 274 vs 293 and (%) 5.12 vs 5.68. HMBi supplementation improved N use by partitioning a greater proportion of absorbed N into milk protein N. Moreover, N losses in non-valorised form as NPN were reduced. This result is in agreement with metabolizable methionine optimization of the ration through HMBi supply.

Key Words: Dairy cow, Methionine, Milk protein

M217 Evaluation of rumen-protected methionine (RP-Met) sources and period length on performance of lactating dairy cows within Latin squares. B. C. Benefield*¹, R. A. Patton², M. J. Stevenson³, and T. R. Overton¹, ¹Cornell University, Ithaca, NY, ²Nittany Dairy Nutrition, Inc., Mifflinburg, PA, ³Degussa Corporation, Kennesaw, GA.

A previous study showed carryover effects on production parameters in Latin square designs assessing RP-Met sources. Multiparous Holstein cows (n=16) were used in a replicated (n=4) Latin square design to determine effects of different sources of RP-Met on performance. Squares were balanced to enable determination of carryover effects. The basal TMR was predicted to supply Met at 1.75% of metabolizable protein (MP) supply (NRC, 2001). Treatments consisted of 0 g/d RP-Met (control; C), 6 g/d RP-Met as Mepron (M6), 12 g/d RP-Met as Mepron (M12), and 12 g/d RP-Met as Smartamine M (S). The daily treatment for each cow was mixed into 0.45 kg of wheat middlings and combined with the basal TMR at the mixer. Cows were fed treatments for 2-wk periods and data were collected on the last 2 d of each week. Statistical analysis (GLM of SAS) was conducted separately for data collected during wk 1 and 2 of each period. RP-Met resulted in varying positive effects on DMI and content of milk fat and true protein during wk 1; however, these differences were not significant after 2 wk of treatment. Carryover effects were not significant. Predicted Met supplies (g/d) were in excess of predicted requirements for all treatments. Increasing Met supply (% MP) through use of RP-Met resulted in small increases in milk true protein content. Results suggest that length of study period can affect productive variables of cows fed RP-Met sources.

Table 1.

Treatment	DMI, kg/d		DMI, kg/d		Milk, kg/d		Milk kg/d	
	Fat, %	Fat, %	Fat, %	Fat, %	Protein, %	Protein, %	Protein, %	Protein, %
	wk 1	wk 2	wk 1	wk 2	wk 1	wk 2	wk 1	wk 2
C	28.4 ^a	28.4	38.4	37.0	3.16 ^a	3.26	2.90 ^a	2.97
M6	28.6 ^a	28.2	36.8	35.9	3.36 ^b	3.24	3.02 ^b	2.99
M12	28.8 ^a	28.0	37.3	36.2	3.39 ^b	3.31	3.02 ^b	3.03
S	29.2 ^b	28.7	37.5	37.0	3.37 ^b	3.29	2.98 ^{ab}	3.04
SE	0.2	0.2	0.6	0.5	0.06	0.05	0.04	0.02

Values within columns with different superscripts differ, P < 0.05

Key Words: Amino acids, Methionine, Milk protein

M218 The effect of various rumen protected methionine sources on milk yield, milk composition and nitrogen efficiency of cows in mid-lactation. J. A. Strzetelski¹, J. Kowalczyk², and W. Heimbeck*³, ¹National Research Institute of Animal Production, Balice, Poland, ²The Kielanowski Institute of Animal Physiology and Nutrition, Jablonna, Poland, ³Degussa AG, Hanau, Germany.

The objective of this experiment was (1) to assess the effect of rumen protected methionine sources (RP-Met) on N efficiency, DMI and lactational performance of mid-lactation cows and (2) to compare N efficiency and milk protein % as measures of RP-Met response. The experiment used 4 Black-and-White cows in mid lactation (8-16 weeks) in a Latin square design. The basal diet (kg DM/d) consisted of corn silage (8.22), meadow hay (3.47) and concentrate (9.20) and contained 1.85% methionine as a percent of metabolizable protein (NRC, 2001). Treatments consisted of the basal diet (C) plus one of 3 supplements added daily: 10.5 g Mepron[®] (M), 10.5 g Smartamine[™] M (S) or 21 g MetaSmart[™] (H), estimated to increase Met to 2.14 as % of MP. Cows were first adapted to control diet for 3 weeks followed by four 21-day treatment periods. A 14-day preliminary period was followed by 7 days of collection. Statistical analysis was performed with Proc GLM of SAS. There were no significant differences among diets for N efficiency, N or DM intake or milk yield. Milk protein % was affected by RP-Met supplementation as was lactose % (P<.06). Results suggest that under conditions of this experiment, added RP-Met had little effect on animal performance. N-efficiency appears to be a less sensitive measure of Met status in milking cows than milk protein %.

Table 1.

Diets	DMI	Milk	Fat	Protein	Lactose	Casein	N Intake	Milk N	MNE*
	kg/d	kg/d	%	%	%	%	g/d	g/d	%
C	19.9	25.6	4.01	3.43 ^a	4.70 ^{ab}	2.84	500	137	27.5
H	19.9	25.6	3.93	3.42 ^a	4.72 ^b	2.84	499	136	27.4
M	19.8	24.7	4.36	3.60 ^b	4.60 ^a	2.96	496	138	27.7
S	19.6	25.3	3.98	3.46 ^{ab}	4.71 ^b	2.86	497	136	27.5
SE	0.16	0.58	0.19	0.05	0.04	0.04	2.1	3.6	0.79

*Milk Nitrogen Efficiency = Milk N/N intake*100. Different superscripts within columns differ significantly (P<.06)

Key Words: RP-Met, N-efficiency, Milk protein

M219 Milk composition as technique to evaluate the relative bio-availability of rumen protected methionine sources. Z. Bester, L. J. Erasmus*, and R. J. Coertze, University of Pretoria, Pretoria, South Africa.

To determine the bio-availability of any rumen protected amino acid, the resistance to ruminal degradation and intestinal availability need to be measured. This requires multi-cannulated animals. When various prototypes are evaluated, simpler techniques are needed to screen the prototypes for relative bio-availability. The objective of this study was to evaluate the use of milk composition as a simple technique to evaluate the relative bio-availability of an experimental liquid rumen protected methionine (LRPM). Using a randomized block design, forty mid-lactation Holstein cows were used to compare a methionine (met) deficient diet (MP lys:met of 4.23:1) to the same diet supplemented with either LRPM, DL-met or Smartamine M. Supplementation with the rumen protected sources resulted in a MP lys:met ratio of 7.2:2.4, which is considered optimal. After an adaptation phase of one week (period 1), cows were fed the met deficient diet for three weeks (period

2) and thereafter fed either the met deficient diet or one of the three supplemented diets (period 3). Dry matter intake and milk production did not differ ($P > 0.10$). Supplementation with Smartamine M increased ($P < 0.05$) milk protein from 3.22 to 3.46% when compared to the met deficient diet; the other supplements had no effect. When the change in milk fat and protein % between the last week of period 2 and period 3 respectively are compared, the magnitude of change was higher ($P < 0.05$) for cows receiving Smartamine M, when compared to the other treatments. Results suggest milk composition to be a simple method to evaluate the relative bio-availability of rumen protected methionine sources.

Key Words: Rumen protected methionine, Milk composition, Smartamine M

M220 Supplemental rumen-protected choline and methionine for lactating dairy cows. M. L. Eastridge*, J. Engel, and C. V. D. M. Ribeiro, *The Ohio State University, Columbus.*

In experiment one, 3 rumen protected choline (RPC) sources [Reashure® (REA), Balchem Encapsulates, New Hampton, NY; BPC, Robt Morgan, Inc., Paris, IL; and Pro-Choline™40 (PC), Probiotech, Inc., St-Eustache, QC, Canada] were incubated in situ using 2 rumen cannulated cows. Dacron bags containing the samples were suspended in the rumen and removed at 0, 2, 4, 6, 12, 24, and 48 h, with 2 samples per time point per cow. Rate of DM disappearance was lower for REA (0.015 /h) than for BPC (0.187 /h) and PC (0.215 /h). Rate of disappearance of choline also was lower for REA (0.003 /h) than for BPC (0.558 /h) and PC (0.254 /h). Although REA and BPC had similar DM residue after 48 h of incubation (31%), the choline remaining was only 2% for BPC but 85% for REA. In situ DM disappearance is inadequate for assessing choline protection, and REA provided greater choline protection compared to the other 2 sources. In experiment two, initially 56 lactating cows were fed one of 4 diets beginning at parturition: 1) control (duodenal flow of lysine:methionine (lys:met) 3.8, NRC 2001), 2) 0.26% RPC (REA; targeted at 60 g/d to provide 15 g/d of choline; lys:met 3.8; REA-L), 3) 0.52% RPC (REA, 120 g/d to provide 30 g/d of choline; lys:met 3.8; REA-H), or 4) 0.096% rumen protected methionine (Smartamine M™, Adisseo, Antony Cedex, France; lys:met 3.0; MET). Diets were fed as TMR for 13 weeks and consisted of 52% forage (76% corn silage and 24% alfalfa hay), 9% whole linted cottonseed, and 39% concentrates. Diets contained 16.8% CP, 39.2% NDF, and 20% forage NDF. Forty-eight of the cows (31 Holstein and 17 Jersey) completed the trial. The DMI (20.6 kg/d), milk yield (36.5 kg/d), milk fat (4.35%), and milk protein (3.14%) were not different among diets. The MUN was highest for REA-H (19.1 mg/dl) and intermediate for MET (18.1 mg/dl). Milk choline was higher for MET, but plasma choline and nonesterified fatty acids were similar among diets. Plasma glucose was higher for control and MET than for either level of REA. Milk choline was a better indicator of choline status than plasma choline, and MET resulted in higher milk choline concentration than the feeding of RPC.

Key Words: Choline, Methionine, Rumen protect

M221 Milk production and carry-over effects of methionine supplements in lactating dairy cows. H. F. Bucholtz*¹, R. A. Patton², J. S. Liesman¹, P. N. Naasz³, and M. J. Stevenson⁴, ¹Michigan State University, East Lansing, ²Nittany Dairy Nutrition, Inc., Mifflinburg, PA, ³Michigan State University Upper Peninsula Experiment Station, Chatham, ⁴Degussa Corporation, Kennesaw, GA.

Amino acid requirements of dairy cattle and efficacy of rumen protected amino acids are often assessed using Latin square experiments with 2 week periods. Carry-over effects between periods may affect estimates of both. Objectives were to measure (1) the effects on milk production and composition and (2) carry-over effects of commercially available methionine supplements (RP-Met). A basal TMR, with 1.87% Met as % of MP was fed to all cows. Dietary treatments consisted of 0 g of RP-Met (C), 12 g of Smartamine (S), 6 g of Mepron (M6) and 12 g of Mepron (M12) to the TMR. Four squares of 4 cows were utilized. Periods were 12 days for diet adaptation and 2 days for data collection. Milk aliquots were taken to determine composition, reported as the average of 2 days. Statistical analysis was by proc GLM of SAS. Addition of RP-Met had no effect on any variable measured, but methionine flow was in excess as calculated by CPM and AminoCow models. Carry-over effects were observed only for S. For a treatment following S compared to following C, milk and lactose production were 2.49 and 0.14 kg less respectively ($P < 0.05$). We conclude that carry-over effects may occur when using experiments with 2-week periods to evaluate RP-Met sources and that these carry-over effects need to be accounted for when evaluating experiments with RP-Met sources.

Table 1.

Variable	Treatments				SE	P<
	C	S	M6	M12		
Milk kg	33.5	33.6	34.0	33.7	0.47	0.85
Fat %	4.09	4.17	4.12	4.25	0.05	0.15
Fat kg	1.36	1.40	1.41	1.43	0.03	0.38
4FCM kg	33.8	34.4	34.8	34.9	0.57	0.54
Protein %	3.25	3.31	3.25	3.29	0.02	0.14
Protein kg	1.07	1.11	1.10	1.10	0.02	0.52

Key Words: Amino acids, Methionine, Milk protein

M222 Plasma lysine irreversible loss rate to determine the effect of treatment of soybean meal on lysine availability in dairy cattle. S. I. Borucki Castro*^{1,2}, H. Lapierre², L. E. Phillip¹, P. Jardon³, and R. Berthiaume², ¹McGill University, Ste Anne de Bellevue QC, Canada, ²Agriculture and Agri-Food Canada, Dairy and Swine R&D Centre, Lennoxville QC, Canada, ³West Central, Ralston IA.

In an attempt to develop a non-invasive, accurate technique to determine the effect of treatment of soybean meal (SBM) on lysine (Lys) availability, the increment in plasma Lys irreversible loss rate (ILR) was compared with the increment in Lys intestinal flow and apparent digestibility. Four multiparous Holstein cows (173 DIM) with ruminal and duodenal cannulas were used in a 4 x 4 Latin square with 14-d periods. They were fed either solvent extracted SBM (SE), expeller SBM (EP) or lignosulfonate treated SBM (LS) as 23% of the diet. The fourth treatment (SE20) consisted in a 20 mmol/h omasal infusion of Lys to cows fed the SE diet. On the last day of each period, a pulse dose of [2-¹⁵N] Lys was given in the jugular vein and jugular

plasma samples were collected at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, 16, 19, 25 and 31 min after the injection. Chromic oxide was included as an indigestible marker to assess DM flow and 8 separated digesta samples were collected on d 13 and 14 and pooled by period. The decay curve of ¹⁵N Lys enrichment was explained by a two exponential equation. The plasma Lys ILR was not different ($P > 0.10$) between the different SBM (84, 89 and 80 ± 3.9 mmol/h for SE, EP and LS, respectively). However, the SE20 treatment increased ($P < 0.04$) Lys ILR to 104 mmol/h, i.e. exactly 20 mmol/h above the SE treatment. No differences were observed on duodenal Lys flow (213, 203 and 213 ± 11.9 g/d) or apparent intestinal digestion (79, 75 and 77 ± 1.8 %) between the SBM diets. Plasma Lys ILR was an accurate technique to estimate the increment of Lys availability, as it responded quantitatively to Lys infusion. Although the treatment of SBM should have increased Lys availability (NRC 2001), differences were too small or too variable to be detected. Further studies should be performed to test the sensitivity of this method, increasing the power of detection with larger amount of animals.

Key Words: Lysine, Irreversible loss rate, Soybean meal

M223 Effect of post-ruminal supplementation of amino acids on production performance of lactating dairy cows. T. Whyte^{*1}, A. Hayirli¹, H. Lapierre², and L. Doepel¹, ¹University of Alberta, Edmonton, AB, Canada, ²Agriculture and Agri-Food Canada, Dairy and Swine Research and Development Centre, Lennoxville, QC, Canada.

Amino acids (AA) are classified as essential (EAA) or nonessential (NEAA), based on the ability of the animal to synthesize them or not. Despite this confusing nomenclature both types of AA are needed to synthesize milk protein. The objective of this experiment was to determine if *de novo* synthesis of NEAA limits milk and milk protein yields. Eight lactating cows (61 ± 4 DIM), 4 primiparous and 4 multiparous, were used in a replicated 4x4 Latin square balanced for residual effects. Samples were collected from the last 7 days of each 14-d period. The diet provided 87% of the net energy requirement and 75% of the metabolizable protein requirement (NRC, 2001). The effects of abomasal infusions of EAA and NEAA were tested in a factorial arrangement. The four treatments were 1) Ctl (water), 2) EAA (359 g/d), 3) NEAA (356 g/d) and 4) TAA (EAA + NEAA, 715 g/d), with the casein profile. Milk, protein and lactose yields and DMI were affected ($P < 0.05$) by parity, with all parameters being lower in the primiparous than in the multiparous cows. Since there was no parity by treatment interaction the responses were averaged over the parities. Milk fat concentration and yield were not affected by treatment. Milk production and milk protein concentration and yield were increased by EAA infusions. Milk lactose content was lowest for the EAA treatments whereas lactose yield was highest. There were no effects of NEAA on the response variables monitored, nor was there an interaction between EAA and NEAA. These results indicate that NEAA supplementation is not beneficial, at least on a 14-d period, suggesting that NEAA synthesis does not limit milk and milk protein yields.

Table 1.

	Trt					P (Contrasts)		
	Ctl	EAA	NEAA	TAA	SEM	EAA	NEAA	EAAxNEAA
DMI, kg/d	16.6	16.9	16.6	16.7	0.6	0.26	0.85	0.40
Milk, kg/d	34.0	37.1	34.4	37.9	1.3	<0.01	0.37	0.74
Fat, %	2.96	2.90	3.00	2.64	0.23	0.07	0.33	0.18
Fat, g/d	989	1072	1013	995	78	0.38	0.49	0.18
Protein, %	2.83	2.97	2.81	3.03	0.05	<0.01	0.55	0.16
Protein, g/d	967	1104	966	1150	32	<0.01	0.34	0.31
Lactose, %	4.65	4.55	4.69	4.60	0.06	<0.01	0.14	0.87
Lactose, g/d	1583	1691	1609	1744	51	<0.01	0.18	0.63

Key Words: Amino acid supplementation, Milk production

M224 Metabolizable essential amino acids in mature ewes fed limited amounts of beet pulp. B. W. Hess^{*1}, P. W. Nathanielsz², and S. P. Ford¹, ¹University of Wyoming, Laramie, ²University of Texas Health Sciences Center, San Antonio.

Eleven mature Western white-face ewes fitted with ruminal, duodenal, and ileal cannulae were used to determine the effects of OM intake on supply of metabolizable essential AA and concentrations of plasma AA and urea-N. Ewes were assigned randomly to be fed beet pulp OM at various levels of NE_m requirements (OM intake ranged from 200 to 844 g/d). Titanium dioxide was dosed intraruminally twice daily. After a 14-d adaptation to diets, intestinal digesta was collected in a manner which represented every 2 h in a theoretical 24-h timeframe. Simple linear regression was used to assess responses to amount of OM intake. Apparent ruminal OM digestibility ($51.9 \pm 11.3\%$) was not affected ($P = 0.60$) by amount of OM consumed. Except for phenylalanine ($P = 0.03$) and tryptophan ($P = 0.02$), profile of essential AA disappearing from the small intestine did not differ ($P = 0.14$ to 0.97) among various amounts of OM intake. Intestinal disappearance of arginine ($P = 0.36$), histidine ($P = 0.88$), lysine ($P = 0.74$), and tryptophan ($P = 0.77$) was not a simple function of OM intake, whereas OM intake could be used to predict ($P < 0.001$) intestinal disappearance of methionine, threonine, valine, isoleucine, leucine, and phenylalanine. Intestinal disappearance of total essential AA could be predicted ($P < 0.001$) using OM intake as the dependent variable, where metabolizable essential AA, g/d = 0.0365 g/d OM intake + 1.941 g/d ($r^2 = 0.87$). Plasma AA concentrations did not differ ($P = 0.09$ to 0.99) across level of OM intake, but increased ($P < 0.006$) plasma urea-N as amount of OM intake decreased indicated that tissue AA were used to maintain plasma AA concentrations. A simple linear regression equation can be used to predict metabolizable essential AA supply in mature ewes fed limited amounts of OM.

Key Words: Amino acids, Intake, Sheep

M225 Metabolizable essential amino acids in mature ewes fed limited amounts of beet pulp and supplementary ruminally undegradable protein. B. W. Hess^{*1}, P. W. Nathanielsz², and S. P. Ford¹, ¹University of Wyoming, Laramie, ²University of Texas Health Sciences Center, San Antonio, TX.

Seven mature Western white-face ewes fitted with ruminal, duodenal, and ileal cannulae were used in a randomized incomplete block designed experiment to determine if supplemental ruminally undegradable intake protein could be used to maintain supply of metabolizable essential AA when mature sheep consume limited amounts of OM.

Ewes were stratified by BW and assigned randomly to be fed beet pulp OM at either 50 or 100% of NE_m requirements. Ewes assigned to 50% of NE_m requirements were fed a protein supplement (6.8% porcine blood meal, 24.5% hydrolyzed feather meal, and 68.7% menhaden fish meal; DM basis) designed to provide quantities of metabolizable essential AA equal to that of ewes fed 100% of NE_m requirements. Amount of supplement was formulated using tabular estimates of metabolizable AA or adjusted for more extensive ruminal degradation in ruminants consuming limited amounts of OM. Titanium dioxide was dosed intraruminally twice daily. After a 14-d adaptation to diets, intestinal digesta was collected in a manner which represented every 2 h in a theoretical 24-h timeframe. Although flow of isoleucine ($P = 0.09$) and methionine ($P = 0.10$) to the duodenum tended to be less in ewes fed beet pulp at 50% of NE_m and supplementary protein, duodenal flow of total essential AA did not differ ($P = 0.23$) among dietary treatments. Likewise, intestinal disappearance of individual ($P = 0.19$ to 0.89) and total ($P = 0.74$) essential AA did not differ among dietary treatments. Although ewes fed beet pulp at 100% of NE_m requirements tended to have greater ($P = 0.06$) amounts of CP reaching the duodenum, supply of metabolizable amino acids ($P = 0.40$) and protein ($P = 0.26$) did not differ among dietary treatments. Therefore, provision of supplementary ruminally undegradable protein can be used to maintain supply of metabolizable AA in mature ewes fed limited amounts of OM.

Key Words: Amino acids, Intake, Sheep

M226 An *in-silico* comparison of nitrogen fraction parameter estimates derived from data in the 1996 Beef NRC and 2001 Dairy NRC feed libraries. M. Barry*, *AgModels, LLC, Tully, NY.*

Nitrogen fractionation and kinetic behavior of 25 feedstuffs common to the 1996 Beef and 2001 Dairy NRC feed libraries were compared. There was a close agreement between feed libraries for gross nitrogen (crude protein) content ($r = 0.997$; concordance coefficient = 0.997). However, a lower agreement was found for calculated rumen-degradable protein (RDP) and rumen-undegradable protein (RUP) values using respective library parameters at a standardized passage rate of 0.040 h⁻¹ ($r = 0.767$; concordance coefficient = 0.708). Both systems use a first-order competition between passage and degradation to estimate extent of ruminal digestion, but they differ in the number of nitrogenous fractions included. The 3-pool (A, B and C) model used by the Dairy NRC is simpler to parameterize, but changes in chemical composition are not reflected in pool sizes. In contrast, the 5-pool model (A, B1, B2, B3 and C) used by the Beef NRC attempts to relate each fraction to specific analytical entities, but it is more difficult to estimate kinetic parameters using this model. A simulation representing the simultaneous competition between ruminal passage and degradation of nitrogenous fractions was constructed for each model across a range of physiologically likely passage rates. A least squares approach using the standard solver function of Microsoft Excel 2003 was then applied to fit parameters for the 3-pool model to match the response curves of the 5-pool model across the various passage rates for that feed. For all feeds, a solution was obtained and parameter values thus estimated for the 3-pool model that yield the same RDP/RUP values as the original 5-pool model ($r > 0.999$; concordance coefficient > 0.999). A 5-pool model provided no better sensitivity with respect to variable passage rates than did a fitted 3-pool model when estimating RDP/RUP. However, the 5-pool model does allow for field adjustments due to variation in chemical composition. This approach permits more direct animal model comparisons to be made by providing a method to reduce inherent bias present between the two feed libraries.

Key Words: Protein, Kinetics, Parameterization

M227 Milk odd and branched chain fatty acids in relation to rumen protein digestion. T. Van Nespen¹, W. van Straalen², and V. Fievez*¹, ¹*Laboratory for Animal Nutrition and Animal Product Quality, Ghent University, Melle, Belgium,* ²*Schothorst Feed Research, Lelystad, The Netherlands.*

In this study we investigated changes in rumen fermentation characteristics and milk odd and branched chain fatty acids (OBCFA, expressed relative to their sum) and their mutual correlation by feeding early lactation cows varying proportions of quickly fermentable carbohydrates with or without buffer supplementation. The experiment was according to 4 x 4 Latin square design with four rumen fistulated cows, but results reported here were limited to three diets, consisting of 12 kg DM grass:maize silage (50:50 on DM basis) and 5.5 kg DM of concentrates. The concentrate of the control diet (C) contained 100 g starch/kg DM, the glucogenic diet (G) 333 g starch/kg DM and the glucogenic diet with buffer (B) 333 g starch/kg DM and a daily dose of 250 g of NaHCO₃. Rumen (2, 4, 6, 8, 10 and 12h after morning feeding) and pooled morning and evening milk samples were taken after two weeks of adaptation on three sampling days of the experimental week. Rumen concentrations of total and dominant volatile fatty acids or rumen pH showed no significant differences according to the diets fed. Feeding glucogenic diets significantly reduced rumen NH₃ concentrations [83.1 (C) vs. 59.9 (G) and 64.9 (B); mg NH₃-N/l]. The diet with buffer showed higher rumen concentrations (mmol/l) of valeric [2.16 (B) vs. 1.79 (C) and 1.81 (G)] and isovaleric acid [1.51 (B) vs. 1.14 (C)]. Milk fat of cows fed the glucogenic diets (either G or B) showed higher values of iso C17:0 and lower values of iso C14:0, anteiso C15:0 and anteiso C17:0. The glucogenic diet with buffer induced significantly higher amounts of iso C13:0 and anteiso C13:0 in the milk. Iso C14:0 was negatively and anteiso C17:0 positively correlated with the rumen NH₃-N concentration (rPearson: -0.475 and 0.433, respectively, $n = 36$; $P < 0.05$). These findings might be related to a more asynchronous protein feeding by diet C, confirming earlier hypotheses, which suggests that milk OBCFA can indicate irregularities in the rumen digestion.

Key Words: Dairy nutrition, Odd and branched chain fatty acids, Synchronization

M228 Effects of reducing ruminally degradable protein in the diets of lactating dairy cows. J. Cyriac*, A. G. Rius, M. L. McGilliard, and M. D. Hanigan, *Virginia Polytechnic Institute and State University, Blacksburg.*

This study was conducted to determine the effect of reducing ruminally degradable protein (RDP) with constant ruminally undegradable protein in mid-lactation dairy cow diets on feed intake, milk production, milk composition, feed efficiency and body condition score. Forty mid-lactation Holstein (36) and Jersey by Holstein cross-bred (4) cows were randomly assigned to one of four dietary treatments. Diets were fed as total mixed rations. A common diet of 18.4% crude protein (CP) was fed from day 1 to 28. From day 29 through 47, cows were fed diets with formulated CP contents of 18, 16.8, 15.7, or 14.5% with formulated RDP contents of 11.3, 10.4, 8.5 and 7.6% of dry matter, respectively. Cows were transitioned to lower CP diets over a period of 3 d. Feed intake, milk yield and body weight were measured daily. Milk composition was measured for 3 d in each of weeks 3 and 7. Body condition was scored by two individuals at the end of the 3rd and 7th weeks. Blood was collected from the coccygeal vessel on two days in weeks 3 and 7 for metabolite analyses. Individual forage samples, grain mixtures and total mixed rations were sampled weekly. The Proc Mixed procedure of SAS was used to analyze the data using a repeated

measures model. Second period milk yields were observed to be 41.2, 42.1, 40.3, and 36.6 kg/d as dietary CP decreased from 18 to 14.5% with the lowest CP diet trending towards significance. No treatment effects were observed for body weight or milk fat, protein, or lactose content. Milk urea nitrogen decreased linearly as the CP content of the diets declined averaging 20.2, 17.6, 14.3, and 12.4 mg/dl, respectively, for diets of 18 to 14.5% CP. These results suggest that mid-lactation dairy cows can be fed diets with RDP contents as low as 8.5% of dry matter, which is less than that recommended by NRC (2001). This indicates that current NRC RDP requirements may be overstated.

Key Words: Dairy cow, Ruminally degradable protein, Milk production

M229 Evaluation of Biuret as a slowly degradable non-protein nitrogen source for lactating dairy cows. K. J. Daniels, P. H. Doane*, N. A. Pyatt, and M. J. Cecava, *ADM Animal Nutrition Research, Decatur, IN.*

Our objective was to examine if Biuret (ADM Alliance Nutrition, Inc., Quincy, IL) is a suitable replacement for ruminally degradable true protein in dairy lactation diets. Lactating Holstein cows (n=237) were divided into three groups balanced based upon parity, stage of lactation (DIM), and mean milk production measured one week before the co-variant adjustment period. The standard lactation ration served as the control ration (CT). A 2-week co-variant adjustment period in which CT was fed was followed by a 28-day test period during which cows received diets containing 0, 45 (LO), or 77 (HI) g/cow/day of Biuret. Biuret replaced an equivalent amount of soybean meal-nitrogen in the diet. Urea and total crude protein of diets were similar among diets. Estimated bypass protein content of diets decreased and non-fiber carbohydrate increased with addition of Biuret. Data was analyzed using the Proc Mixed procedure of SAS for a repeated measures, completely randomized design. Milk yield and components were co-variant adjusted using data collected in the pre-test period. Substitution of Biuret for ruminally degradable true protein did not affect milk yield (P>0.10). Dry matter intake linearly decreased (P<0.05) with Biuret feeding. Efficiency of milk yield (milk/feed DMI) improved when Biuret was fed. The HI treatment decreased (P<0.05) daily milk fat yield (1371, 1374, 1305 g for CT, LO and HI, respectively) and decreased (P<0.05) milk lactose percentage (4.86%, 4.85%, 4.82% for CT, LO and HI, respectively). Data were parsed into high and low production groups based on pre-study median performance to examine treatment effects of Biuret on milk yield and composition. Milk composition of lower-producing cows was affected by Biuret whereas milk yield was more responsive to Biuret in higher-producing cows. For all cows, MUN levels increased with Biuret feeding. Milk urea nitrogen may be an appropriate tracking variable to evaluate efficiency of nitrogen use when slowly degradable NPN sources, such as Biuret, are fed to lactating dairy cows. In lactating cow diets balanced for RDP and RUP, Biuret was an effective substitute for ruminally degradable true protein.

Key Words: Biuret, NPN, RDP

M230 Effect of RDP source on ruminal digestion in lactating dairy cows. S. M. Reynal*, G. A. Broderick, and J. Leibovich, *US Dairy Forage Research Center, Madison, WI.*

Eight lactating dairy cows fitted with ruminal cannulas and averaging 116 DIM were assigned to two 4 x 4 Latin squares to determine the effect of feeding diets differing in the proportions of RDP coming from

urea and non-urea sources on apparent ruminal digestion of nutrients. Diets contained (DM basis) 15% alfalfa silage, 40% corn silage, 29 to 27% high-moisture corn, and 16 to 18% concentrate mix. The RDP from soybean meal (SSBM) was replaced with RDP from urea by changing the proportions of concentrates (DM basis) in diets A to D in equal increments as follows: ground shelled corn, from 0 to 6.3%; SSBM, from 14 to 0%; lignosulfonate-treated SBM, from 0 to 8.0%, and urea, from 0 to 1.2%. Diets contained on a DM basis 16.1% CP, 10.5% RDP, 5.6%RUP, 26% NDF, and 1.58 Mcal of NEI/kg. Data were analyzed using the Proc Mixed procedure of SAS. Omasal flows of N decreased linearly while rumen ammonia concentrations increased linearly with increasing addition of urea to the diets, suggesting a lesser utilization of dietary urea-N by microbes. Replacing RDP from SSBM with RDP from urea depressed OM intake and N flows from the rumen in lactating dairy cows.

Table 1.

Diets	A	B	C	D	SE	Linear	Quadratic
Urea, % of DM	0	0.4	0.8	1.2			
OM Intake, kg/d	21.0	19.7	20.4	19.2	0.6	0.02	0.84
Digestibility, %	40.4	41.5	40.4	41.1	2.2	0.90	0.90
NDF Intake, kg/d	5.54	5.52	5.95	5.46	0.22	0.80	0.12
Digestibility, %	32.5	40.6	36.0	35.4	2.8	0.72	0.09
ADF Intake, kg/d	3.18	3.12	3.36	2.97	0.14	0.40	0.09
Digestibility, %	36.5	43.7	40.9	39.6	2.9	0.57	0.10
Total N Intake, g/d	569	545	561	534	18	0.09	0.90
Flow, g/d	603	559	573	508	27	<0.01	0.52
Rumen NH ₃ -N, mg/dl	8.2	9.3	10.3	10.8	0.86	<0.01	0.52

Key Words: Rumens-degraded protein, Urea, Digestibility

M231 Effects of replacement of animal protein with soy protein in lactating Holstein cows. A. Garcia*¹, P. W. Jardon², and R. A. Patton³, ¹*Instituto Tecnológico y de Estudios Superiores de Monterrey, Queretaro, Mexico,* ²*West Central, Ralston, IA,* ³*Nittany Dairy Nutrition, Inc., Mifflinburg, PA.*

Animal proteins are regarded as superior amino acid sources for dairy cattle. However, soy protein has an amino acid composition more like rumen bacteria and thus may be equal or superior to animal protein. To test this, we fed diets supplemented with either fishmeal plus commercial animal protein blends (AP) or soy protein as SoyPLUS® (SP). Diets were formulated to be 16.8% CP with high RUP (~39% of CP) to force greater dependence on amino acids from RUP. Diets were equal in amount of metabolizable protein by NRC model. Eighty cows (39 multiparous and 41 primiparous) were divided by production, days in milk and parity into two groups in a switch over design of two 3-week periods. Lactational performance was assessed on the last two days of each period. Statistical inference was by Proc Mixed of SAS and the model included terms for diet, parity, stage of lactation and period. There were no statistical differences due to dietary treatment. First lactation cows produced more milk than older cows but neither period nor stage had a significant effect on performance. In early lactation, when protein was at a premium, MUN was significantly higher (P<0.01) compared to mid or late lactation (20.8, 15.6 and 12.3 mg-dl-1, respectively.) We conclude that soy protein may be substituted for animal protein without loss of production and that this substitution should be made solely on the basis of ingredient cost.

Table 1.

Variable	AP	SP	SE	P<
Milk kg	38.8	39.0	1.00	0.73
Fat %	3.38	3.26	0.09	0.18
Fat kg	1.29	1.27	0.04	0.43
Protein %	3.12	3.06	0.04	0.27
Protein kg	1.21	1.19	0.03	0.48
Lactose %	4.81	4.75	0.05	0.37
Lactose kg	1.87	1.86	0.05	0.71
MUN mg/dl	16.1	16.4	0.71	0.41

Key Words: RUP, Amino acids

M232 Effect of dietary protein levels on milk production and nitrogen efficiency in dairy cattle. M. Baik*¹, J. R. Aschenbach², M. J. VandeHaar³, and J. S. Liesman³, ¹Chonnam National University, Gwangju, South Korea, ²Institute of Veterinary Physiology Leipzig University, Leipzig, Germany, ³Michigan State University, East Lansing.

Efficiency of nitrogen use in lactating dairy cows is 25 to 30%, and much of the waste nitrogen is converted to ammonia, an emerging environmental hazard. Twelve lactating multiparous cows between 100 and 200 days postpartum were randomly assigned to a treatment sequence in four - 3x3 Latin Squares balanced for carryover effects and with 10 d periods. Treatments were 3 rations with crude protein (CP) levels at 19%, 15% and 11%. Rations were fed ad libitum and contained corn and alfalfa silage, with CP being adjusted by varying soybean meal and corn grain. Milk production, milk components, and DMI were recorded the last 3 days of a period. Approximately 200 mg of liver and mammary tissues were biopsied on the last day of each period; gene expression is being examined in these tissues. Statistical analysis was by proc GLM of SAS. Results for treatments are below. There were no significant carryover effects. Feeding 11% CP for 10 d reduced milk yield 15%, and, as expected, dramatically increased the gross efficiency of feed N use. This may not have been a sustainable metabolic adaptation but should result in some measurable changes in the expression of genes involved in metabolism and metabolic regulation.

Table 1.

Items	11% CP	15% CP	19% CP	SE	P Linear	P Quadratic
Milk (kg/d)	34.1	40.1	40.6	0.8	0.0001	0.016
Fat (kg/d)	1.29	1.46	1.53	0.04	0.0002	0.28
Protein (kg/d)	0.99	1.20	1.24	0.02	0.0001	0.0026
Fat%	3.83	3.66	3.80	0.06	0.75	0.087
Protein%	2.93	3.02	3.07	0.03	0.011	0.73
DMI (kg/d)	48.6	52.4	51.2	0.9	0.068	0.052
Milk N/Feed N (%)	40.4	33.1	27.4	0.7	0.0001	0.35
MUN (mg/dL)	6.3	10.7	18.4	0.4	0.0001	0.012

Key Words: Protein levels, Nitrogen efficiency, Dairy cattle

M233 Optimal nutrient intake and digestion for ruminal microbial protein and milk yields in lactating dairy cows. S. M. Reynal* and G. A. Broderick, *US Dairy Forage Research Center, Madison, WI.*

Individual-cow data from six in-vivo experiments (248 observations) conducted in our laboratory were used to study the response of

microbial nonammonia nitrogen flow (MNAN) from the rumen and milk yield (MY) of lactating dairy cows to several dietary and digestion factors. Diets were based on high-moisture corn, corn silage, and legume silage (mainly alfalfa) and ranged from 13.5 to 20.3% CP (mean = 17.4%), from 43 to 55% NFC (mean = 49%), and from 22 to 30% NDF (mean = 25%). Urea, heated and unheated soybean meal, corn gluten meal, blood meal, canola meal, and cottonseed meal were used as protein supplements. Cows averaged 113 days in milk, consumed between 14 and 34 kg of DMI/d (mean = 23 kg/d), and produced between 14 and 55 kg milk/d (mean = 36 kg/d). Digestion variables were measured in vivo using the omasal sampling technique and total purines (1 study) and ¹⁵N (5 studies) as microbial markers. Data were analyzed using ProcMixed in SAS following the meta-analysis approach of St. Pierre et al. (J. Dairy Sci. 84:741) with study considered as random in the models. Response variables evaluated were OM truly digested in the rumen (OMTDR), rumen-degraded (RDP) and rumen-undegraded (RUP) protein, DM intake (DMI), N intake, dietary CP content, and ruminal fiber digestibility. MNAN was evaluated as a response variable for MY. The equation for MNAN was:

$$\text{MNAN, g/d} = 36 (\text{SE}=82; \text{P}=0.68) + 32 \text{ RDP (\% of DM; SE}=12; \text{P}<0.01) - 0.8 \text{ RDP}^2 (\text{\% of DM; SE}=0.43; \text{P}=0.06) + 0.57 \text{ OMTDR}^2 (\text{kg/d; SE}=0.06; \text{P}<0.01)$$

The equation for MY was:

$$\text{MY, kg/d} = -8.3 (\text{SE}=7.8; \text{P}=0.34) + 1.18 \text{ RUP (\% of DM; SE}=0.26; \text{P}<0.01) + 0.29 \text{ DMI (kg/d; SE}=0.13; \text{P}<0.05) + 0.115 \text{ MNAN (g/d; SE}=0.030; \text{P}<0.01) - 0.0001 \text{ MNAN}^2 (\text{g/d; SE}=0.00004; \text{P}<0.01)$$

Quadratic maxima for MY was at 573 g of MNAN. Milk yield responses to RUP supplementation (slope = 1.18) were substantially smaller than those predicted by the NRC (2001; slope = 1.85). For this data set, maximum MNAN was achieved at a dietary RDP level (20% of DM) that may result in inefficient N utilization and high N losses to the environment.

Key Words: Meta-analysis, Microbial protein, Milk yield

M234 Effect of dietary energy and protein level on dry matter intake, body weight changes and milk yield of Holstein cows in transition period. R. Lopez*¹, D. Gomez-Perez¹, J. G. Garcia-Muniz¹, G. D. Mendoza², and A. Lara³, ¹Universidad Autonoma Chapingo, Chapingo, Estado de Mexico, Mexico, ²Colegio de Postgraduados, Montecillo, Texcoco, Edo. de Mexico, Mexico, ³Cooperativa Agropecuaria y Forestal Chapingo S. C. de R. L., Chapingo, Edo. de México, Mexico.

The objective was to study the effect of increasing dietary NEL (Mcal/d) and CP (%) levels on BW (kg), DMI (kg), and ADG (kg/d) in the dry-off period, and its influence on BW, DMI, NEL intake, milk yield (MY, kg), MY efficiency and reproductive traits during 105 DIM. Thirty Holstein cows (BW = 703.4 plusmn; 16.4 kg; eight weeks before expected calving) were stratified by BW and randomly assigned to one of three treatments. During the dry-off period, cows were individually fed with one of three diets containing 1.46 and 16.9, 1.58 and 18.7, or 1.83 and 19.3 Mcal/kg and % CP, respectively, for the low, medium and high diets. After calving, cows were fed 1.46 and 16.9, 1.77 and 1.92, or 2.10 and 19.5 Mcal/kg and % CP, respectively, for the low, medium and high diets. Results were analyzed using mixed procedures for repeated measures. The model included treatment, week and the interaction of treatment x week. Reproductive traits were analyzed using mixed procedures in a CRD with treatment as a main effect. No differences on BW were observed during the dry period, except cows fed high and low diets showed higher ADG than those fed

medium diets. Cows had similar ($P > 0.05$) DMI from week -7 through week -4 before calving; conversely, DMI from week -3 through calving was higher for cows on the high diet. Postpartum cows fed high and medium diets were heavier than those fed low diets, whereas no treatment effect ($P > 0.05$) was observed for ADG. Cows on the high level diet had higher DMI than the medium and low diet cows. A interaction treatment x week ($P < 0.05$) indicates differences in MY among treatments; on average, MY of cows fed the high diet was

7.0 and 15.3 kg higher than those fed on the medium or low diets, respectively. In contrast, calves BW at birth, days to first estrous, days open and service per conception were similar among treatments groups. In conclusion, increasing dietary levels of ENL and CP during the dry period increased DMI, BW, and ADG. Likewise, in postpartum period, increasing the levels of ENL and CP were associated with increased DMI, BW changes, and MY.

Key Words: Energy, Protein, Transition cow

Ruminant Nutrition: Non-fibrous Carbohydrate and By-Product Feedstuffs

M235 Altering structural to non-structural carbohydrate ratio in the diet of transition dairy cows grazing pasture did not affect subsequent health or production. J. R. Roche*, *Dexcel, Hamilton, New Zealand.*

Due to increasing glucose requirements precalving, it was hypothesized that altering the dietary structural to non-structural carbohydrate content to increase gluconeogenesis would reduce precalving mobilization of body tissue and improve subsequent milk production. Sixty-eight multiparous dairy cows were randomly allocated to one of two diets for 36 ± 8.7 d precalving. All cows were fed pasture and pasture-silage precalving, with one group also receiving 3kg DM/d of a barley-maize concentrate (30% DMI). Precalving diets were iso-energetic (114 MJ ME/cow/d). At calving, cows in both precalving feeding treatments were allocated in a completely randomized design to two dietary treatments for 35 d in a 2x2 factorial arrangement. Postcalving, all cows received pasture and pasture silage with one group also receiving 5.0 kg DM/d of a barley-maize concentrate (35% DMI). Postcalving diets were also iso-energetic (179 MJ ME/cow/d). Daily FCM (26.0 kg/cow/d) was not affected by either pre- or postcalving concentrate supplementation, although protein to fat ratio was higher in cows supplemented postcalving. Similarly, concentrate supplementation pre- or postcalving did not affect either BW or BCS change before or after calving. Cows receiving concentrates precalving had slightly higher ($P < 0.001$) plasma NEFA concentrations, but otherwise were not different to those receiving an equivalent energy intake from pasture and pasture silage. Postcalving concentrate supplementation increased ($P < 0.01$) plasma glucose and NEFA, decreased ($P < 0.001$) plasma BHBA. Results suggest little effect on milk production by replacing energy from structural carbohydrates in high quality pasture with energy from non-structural carbohydrate during the transition period.

Table 1.

Variable	Precalving		Postcalving		SED	P- value	
	Past	Conc	Past	Conc		Pre	Post
FCM, kg/d	26.2	25.8	26.3	25.6	0.75	0.68	0.39
Fat, %	4.67	4.72	4.99	4.40	0.091	0.57	<0.001
Protein, %	3.48	3.53	3.48	3.53	0.048	0.31	0.30
BCS change precalving	0.02	0.06			0.043	0.39	
BCS change postcalving	-0.11	-0.11	-0.09	-0.13	0.029	0.99	0.20

Key Words: Structural to nonstructural carbohydrate ratio, Pasture, Transition dairy cow

M236 The feeding value of corn distillers solubles for lactating dairy cows. A. K. Sasikala-Appukuttan*¹, D. J. Schingoethe¹, A. R. Hippen¹, K. F. Kalscheur¹, K. Karges², and M. L. Gibson², ¹South Dakota State University, Brookings, ²Dakota Gold Research Association, Sioux Falls, SD.

Fifteen Holstein cows (10 multiparous and 5 primiparous) in midlactation (79.3 ± 9.2 , DIM) were used in a replicated 5 x 5 Latin square design with 4-wk periods to evaluate and compare the use of condensed corn distillers solubles (CCDS) and dried distillers grains with solubles (DDGS) in the total mixed ration. The forage portion of the diets was kept constant at 27.5% corn silage and 27.5% alfalfa hay (DM basis). Diets were: 1) 0% distillers grains products (control), 2) 18.5% DDGS, 3) 10% CCDS, and 4) 20% CCDS, and 5) 18.5% DDGS with 10% CCDS. Diets 2 and 3 contained 2% added fat while diet 4 and 5 contained 4% added fat from the distillers byproducts. The diets were balanced to provide 17% CP. Mixed model procedure of SAS was performed and the statistical model was $y = \text{treatment} + \text{parity} + \text{period}$ with cow (parity) being random. Milk yield tended ($P < 0.10$) to be greater for diets 2 to 5 than for diet 1. Fat and protein concentration and yields were similar ($P > 0.10$) for all diets. Dry matter intake, energy-corrected milk and feed efficiency, defined as ECM/DMI, were similar ($P > 0.10$) across diets. Milk urea nitrogen was greatest ($P < 0.01$) for cows fed diet 1. Ruminal acetate decreased ($P < 0.01$) and propionate increased ($P < 0.01$) when fed CCDS and DDGS. The results showed that CCDS is as effective as DDGS in replacing soybean meal and corn grain in the total mixed ration.

Table 1.

Item	Diet					SEM
	1	2	3	4	5	
DMI, kg/d	21.4	22.0	20.9	21.3	21.9	1.53
Milk, kg/d	33.8	36.2	35.5	36.0	36.0	1.86
ECM, kg/d	31.0	32.4	32.3	32.8	32.7	1.67
Fat, %	2.96	2.84	2.93	2.93	2.86	0.09
Fat, kg/d	1.00	1.01	1.03	1.05	1.04	0.06
TP, %	2.92	2.88	2.87	2.88	2.90	0.05
TP, kg/d	0.99	1.03	1.01	1.03	1.04	0.05
FE	1.55	1.60	1.62	1.59	1.55	0.12
MUN, mg/dL	15.0	10.9	11.1	11.0	11.4	1.31
Ruminal VFA						
-Acetic, %	65.6	64.6	62.6	61.1	61.4	0.97
-Propionate, %	19.9	22.0	22.1	22.3	22.6	0.95

Key Words: Condensed corn distillers solubles, Dried distillers grains with solubles, Dairy cattle

M237 Effect of feeding wet pressed beet pulp on milk yield of dairy cows. J. C. Dalton^{*1}, N. Rimbey¹, B. Shafi², W. J. Price², M. A. McGuire², D. Costesso³, and J. Stewart⁴, ¹University of Idaho, Caldwell, ²University of Idaho, Moscow, ³Amalgamated Sugar, LLC, Ogden, UT, ⁴Stewart Farms, Inc., Nampa, ID.

Beet pulp is the solid residue remaining after sugar is extracted from sugar beets. Typically, the pulp is mechanically pressed to 25% DM content and then artificially dried for storage and feeding. Wet pressed beet pulp (WBP) is an inexpensive alternative that would expend less fossil fuel during processing. The objective of this study was to determine the effect of feeding WBP (24.3% DM, 11.1% crude protein, 28.4% ADF, 46% NDF) on milk yield of dairy cows. Dairy cows (n = 379) greater than 30 days in milk were randomly allotted to receive a diet that contained WBP or a control diet (CON) for 11 weeks. On a dry basis, the WBP ration contained 1.35 kg of wet pressed beet pulp, 6.2 kg earlage, and .95 kg corn silage, whereas the CON ration contained 7.2 kg earlage and 1.2 kg corn silage. All other feedstuffs and amounts fed (dry basis) were the same for the treatment and control groups. Samples of the WBP TMR averaged 54.8% DM; 16.2% crude protein; 21.4% ADF; 32.8% NDF. Samples of the CON TMR averaged 58.3% DM; 16.9% crude protein; 20.3% ADF; 30.9% NDF. All cows were milked 3x, and milk yield data was collected electronically at each milking. Seven day average milk yield was analyzed as repeated measures ANOVA, using the Mixed Procedures of SAS. Separate analyses were carried out for cows between 30 to 135 days in milk (DIM) and 136 to 305 DIM. Milk yield did not differ between the WBP and CON groups (48.2 ± .71 kg/d vs. 48.7 ± .78 kg/d, mean ± SEM, respectively) for cows between 30 to 135 DIM. For cows between 136 and 305 DIM, milk yield differed (P<.05) between the WBP and CON groups (45.7 ± .87 kg/d vs. 41.7 ± 1.07 kg/d, mean ± SEM, respectively). Results from this study suggest that the inclusion of WBP in the diet of lactating dairy cows increased the milk yield of cows between 136 and 305 DIM, but not cows between 30 to 135 DIM.

Key Words: Dairy cows, Milk yield, Beet pulp

M238 The interaction of barley composition, processing method, and exogenous enzyme addition on dry matter and neutral detergent fiber disappearance. T. L. Benson^{*}, J. J. Michal, R. L. Kincaid, C. T. Gaskins, and K. A. Johnson, *Washington State University, Pullman.*

To examine the interaction of the chemical composition of barley, processing method and exogenous enzyme addition, 8 varieties of barley of differing chemical composition (hullless, malt, feed, 2-row and 6-row) were processed using 4 methods; whole (W), steam-rolled (SR), dry rolled (DR), and temper-rolled (TR) and incubated in the rumen for 24h. Processed barleys were treated with water (H₂O), b-glucanase (5.4 U/mg, BG), or one of two xylanases (0.64 U/mg, X1; and 32.1 U/mg, X2) Enzymes were applied at the rate of 1U/gm to the processed barleys 2h prior to incubation in nylon bags in the rumens of two fistulated steers fed at maintenance a diet consisting of bluegrass straw and corn silage. After incubation, bags were removed, rinsed, and analyzed for dry matter (DMD) and neutral detergent fiber disappearance (NDFD). There was no effect of steer on DMD or NDFD. Barley variety impacted DMD disappearance (P<.001). DMD ranged from 65.1± 0.42 to 53.9± 0.42 with the hullless barley having the greatest DMD and the barley variety with the highest fiber content having the lowest. Processing method significantly (P<0.001) affected DMD (W 4.2± 0.3, DR 80.4± 0.3, SR 64.5± 0.3, TR 79.8± 0.3) and NDFD (W 14.1± 0.60, DR 36.1± 0.60, SR 21.0± 0.60, TR 34.1± 0.60).

Enzyme addition impacted DMD and NDFD (p<0.001) with H₂O having no effect and X1 having the greatest effect on NDFD (H₂O 24.3± 0.6, BG 27.3± 0.6, X1 28.1± 0.6, X2 25.5± 0.6). There was no interaction of enzyme with barley variety or enzyme with processing method but there was a significant interaction (P<0.001) of barley variety by processing method on DMD and NDFD. The hullless variety had the greatest DM and NDFD with all processing methods. TR was the method of processing of barley that is high in fiber, that yielded the highest DM and NDF disappearance.

Key Words: Barley, Processing, Enzymes

M239 Effect of extent of barley grain processing on productivity of lactating dairy cows varying in milk yield and days in milk. G. McGregor¹, M. Dehghan-banadaky¹, R. Corbett², and M. Oba^{*1}, ¹University of Alberta, Edmonton, Alberta, Canada, ²Alberta Agriculture Food and Rural Development, Edmonton, Alberta, Canada.

The objectives were to evaluate the effect of finely (FN) or coarsely (CR) steam-rolled barley on productivity of lactating dairy cows, and how the response to FN relative to CR differs for cows varying in physiological state. Sixty Holstein cows (191 ± 82.1 DIM; 643 ± 83.2kg BW), 20 primiparous and 40 multiparous, were used in a cross-over design with 14d per period. The volume-weight of barley grain was 68.3 kg/hL before processing. The experimental diets contained either FN or CR (density after processing expressed as a percentage of density before processing = 68.7 ± 0.69% and 82.5 ± 1.51% respectively) at 38.4% of dietary DM. Both diets were formulated for dietary concentrations of NDF, CP and starch of 37.3, 18.4 and 32.4% respectively. All cows were fed a common diet for 14d immediately prior to the experiment to collect pre-trial production data independent of treatment. Neither dry matter intake, milk yield nor 4% fat corrected milk yield differed between the two treatments. Milk fat yield tended to be greater for FN compared to CR (1.14 vs. 1.11 kg/d; P < 0.10), although milk fat concentration was not affected by treatment. Milk urea nitrogen concentration was higher (14.0 vs. 13.6 mg/dL; P < 0.005), and lactose concentration was lower (4.55 vs. 4.58%; P < 0.001) for cows fed FN compared to CR. The response to FN relative to CR in milk fat concentration was not related to pre-trial milk yield, body weight, or body condition score, but positively related to days in milk (linear effect, P < 0.01), indicating that FN treatment decreased milk fat concentration for cows at early stages of lactation but increased for cows at later stages of lactation. Although significant statistical differences were observed for some response variables, the differences were too small to provide practical implications. The extent of processing did not have remarkable effects on productivity of lactating dairy cows for the barley grain used in this study.

Key Words: Barley processing, Production level, Dairy cows

M240 Effect of dietary wheat on dairy cow performance is not influenced by the addition of rumen buffers. L. Doepel^{*} and A. Cox, *University of Alberta, Edmonton, Alberta, Canada.*

In a previous study, we demonstrated that wheat grain fed to lactating dairy cows at up to 20% of diet DM in conjunction with sodium bicarbonate at 0.5% of diet DM had no adverse effects on rumen pH or milk and milk component yields relative to that obtained on a barley-based diet. The current study was conducted to determine if a diet containing 20% wheat could safely be fed to dairy cows without the addition of rumen buffers. Twelve 2nd lactation Holstein cows averaging 165 DIM at the beginning of the study were utilized in a

replicated crossover with 21 d periods, the last 7 d being used for sample collection. Cows were fed a TMR twice daily consisting of 35% barley silage, 15% alfalfa hay and 50% concentrate on a DM basis. The concentrate contained 40% rolled hard red spring wheat with (SB) or without (Ctl) sodium bicarbonate at 0.5% of total diet DM. Dry matter intake, cow body weight, and milk and milk component yields were unaffected by treatment. Milk composition also was not influenced by treatment. Rumen pH, measured in 6 cows, was not different between the Ctl and SB treated cows. These results suggest that up to 20% wheat can be included in the diet of lactating cows without a need for rumen buffers.

Table 1.

	Ctl	SB	SEM	P
Rumen pH	6.26	6.22	0.03	0.5
DMI, kg/d	21.3	20.7	0.4	0.3
Milk, kg/d	31.4	30.2	1.9	0.6
FCM, kg/d ¹	30.2	29.1	1.7	0.7
Fat, %	3.76	3.78	0.11	0.9
Fat, g/d	1175	1134	70	0.7
Protein, %	3.31	3.30	0.07	0.9
Protein, g/d	1031	983	48	0.5
Lactose, %	4.53	4.52	0.06	0.9
Lactose, g/d	1430	1372	97	0.7
BW, kg	612	608	4	0.4
BCS	2.40	2.58	0.08	0.13

¹FCM = fat-corrected milk yield (4% FCM, kg = 0.4 x milk yield, kg + 15 X (milk yield, kg x fat, %))

Key Words: Wheat supplementation, Rumen buffers, Dairy cow performance

M241 Effect of wheat supplementation on rumen pH and lactation performance in dairy cows. L. Doepel*, A. Cox, and A. Hayirli, *University of Alberta, Edmonton, Alberta, Canada.*

Wheat grain is seldom fed to dairy cows because of the concern that it will contribute to the development of subacute rumen acidosis, with subsequent negative effects on cow productivity. The objective of this experiment was to examine the effect of increasing levels of dietary wheat supplementation on rumen pH and lactation performance. Twelve 2nd lactation Holstein cows averaging 96 DIM at the beginning of the study were utilized in a replicated 3 x 3 Latin square design with 21 d periods. Six of the cows were ruminally cannulated. Cows were fed a TMR twice daily consisting of barley silage (35%), alfalfa hay (15%) and concentrate (50%) containing 0, 20, and 40% rolled hard red spring wheat, so that the final diets contained 0, 10, and 20% wheat on a DM basis. All diets contained sodium bicarbonate at 0.5% of diet DM. In the two wheat diets, wheat directly replaced rolled barley. Data collection took place over the last 7 d of each period except for rumen pH. Rumen fluid was obtained from the cannulated cows by a suction strainer 18 times over the last 24 h of each period. Data were reduced to means before being analyzed by the mixed procedure of SAS using a model that contained square, period and treatment as fixed effects and cow(sq) as a random effect. Rumen pH was reduced by wheat inclusion in the diet (P=.001). Milk and milk component yields were not different between the treatments, but milk protein content was lower in the wheat-fed cows than in the barley-fed cows (P=0.03). Our results indicate that replacing rolled barley with readily fermentable

carbohydrate in the form of rolled wheat has minimal effects on lactation performance and that up to 20% wheat can be included in the diet without causing milk fat depression.

Table 1.

	Wheat, % diet DM			SEM	W	P ¹	
	0	10	20			L	Q
Rumen pH	6.44	6.34	6.37	0.02	0.001	0.004	0.002
DMI, kg/d	21.4	20.5	20.8	0.7	0.2	0.4	0.2
Milk, kg/d	35.9	36.0	36.4	1.5	0.8	0.7	0.9
FCM, kg/d	33.3	32.9	33.3	1.4	0.8	0.9	0.6
Fat, %	3.51	3.44	3.43	0.10	0.3	0.4	0.6
Fat, g/d	1261	1231	1246	60	0.5	0.7	0.5
Protein, %	3.09	2.98	3.06	0.06	0.03	0.3	0.01
Protein, g/d	1106	1074	1110	46	0.7	0.9	0.3
Lactose, %	4.56	4.61	4.65	0.06	0.1	0.08	0.8
Lactose, g/d	1645	1668	1695	79	0.6	0.5	0.9
BW, kg	599	597	598	4	0.3	0.5	0.4
BCS	2.61	2.62	2.56	0.04	0.6	0.3	0.4

¹W = contrast 0 vs. mean of 10 & 20% wheat; L & Q = linear and quadratic treatment effects

Key Words: Wheat supplementation, Milk production, Rumen buffer

M242 Performance and blood metabolites of growing hairy sheep fed sorghum diets with urea and dried citrus pulp. H. Morales-Treviño, J. González-Rodríguez, E. Gutiérrez-Ornelas*, H. Bernal-Barragán, and J. Colín-Negrete, *Facultad de Agronomía, Universidad Autónoma de Nuevo León, Carretera Zuazua-Marín Km 17.5, Marín, Nuevo León, México.*

Twenty-eight weaned hairy sheep lambs, initial body weight of 14.9 ± 2.2 kg, were fed sorghum diets with two urea (0.5 and 1%) and two dried citrus pulp (DCP, 0 and 10%) levels throughout a 56 d trial in order to evaluate their growth performance and changes in blood urea N (BUN), glucose and phosphorus. Body weight was recorded and blood samples were taken from the jugular vein every 14 d. Seven lambs were used as replicates in a randomized complete block design experiment with a factorial 2X2 arrangement of treatments. There was no treatment effect (P>0.05) on overall dry matter intake (DMI) and ADG; however, lambs that did not receive DCP the last 14 d of the trial reduced (P< 0.05) their ADG by 11.5% when urea was increased from 0.5 to 1%. An interaction (P<0.05) DCP X urea was found for feed conversion rate (FCR=DMI/ADG). Lambs fed diets containing either 0% DCP + 0.5% urea (FCR=3.28) or 10% DCP + 1% urea (FCR=3.33) had better FCR (P<0.05) than those fed diets containing either 0% DCP + 1% urea (FCR=3.47) or 10% DCP + 0.5% urea (FCR=3.58). BUN increased from 13.0 and 10.3 mg/dL on day 14th to 22.5 and 25.3 mg/dL on day 56th in lambs fed with 0.5 and 1% of urea, respectively. Blood glucose and phosphorus were not affected (P>0.05) by treatments. It is concluded that it is possible to substitute sorghum grain up to 10% with DCP on weaned hairy sheep diets if they are supplemented with 1% urea. Increased levels of BUN can be used for monitoring either excess of urea or crude protein content in hairy sheep diets.

Key Words: Dried citrus pulp, Blood metabolites, Hairy sheep

M243 Effect of partial replacement of forage NDF with byproduct NDF in close-up diets of dairy cattle on periparturient metabolism and performance. H. M. Dann^{*1}, R. J. Grant¹, C. S. Ballard¹, M. P. Carter¹, K. W. Cotanch¹, H. M. Wolford¹, J. W. Darrah¹, S. A. Flis¹, C. T. Hill¹, and T. Takano², ¹*William H. Miner Agricultural Research Institute, Chazy, NY*, ²*Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan*.

The objective of the study was to determine the effect of partial replacement of forage NDF with byproduct NDF in close-up diets of dairy cattle on periparturient metabolism and performance. Holstein cows (n = 45) and heifers (n = 19) were fed diets containing either 1) 30% oat hay (1.6 Mcal NE_L/kg, 12.8% CP, 42.4% NDF) or 2) 15% oat hay and 15% beet pulp (1.6 Mcal NE_L/kg, 13.2% CP, 40.5% NDF) from -21 d relative to expected parturition until parturition. After parturition, animals received a lactation diet (1.7 Mcal NE_L/kg, 17.1% CP, 35.0% NDF). Animals were group-fed from -21 to -10 d relative to expected parturition and individually fed from -10 d relative to expected parturition until 14 DIM. Animals were required to have at least 5 d of prepartum intake data to remain on the study. Body weight and BCS were determined weekly. Blood was collected and serum from the start of study and -5, -3, -1, 1, 3, 5, 7, 9, 11, and 13 d relative to actual parturition was analyzed for content of NEFA and BHBA. Milk yield was measured. Data were analyzed as a randomized design and subjected to analysis of variance using the MIXED procedure of SAS. Close-up diet did not affect ($P > 0.10$) DMI (1.48% BW), energy balance (116%), or serum content of NEFA (381 μ Eq/L) and BHBA (6.0 mg/dL) during the last 5 d prepartum. Prepartum BW (776 kg) and BCS (3.56) were similar ($P > 0.10$) between treatments. There was no carryover effect ($P > 0.10$) of close-up diet on DMI (2.20% BW), energy balance (69%), milk yield (34.7 kg), BW (691 kg), BCS (3.32), or serum content of NEFA (723 μ Eq/L) and BHBA (12.6 mg/dL) during the first 14 DIM. Partial replacement of forage NDF (oat hay) with byproduct NDF (beet pulp) did not affect periparturient metabolism or performance. Further investigation of replacement level is needed.

Key Words: Transition cow, NDF, Beet pulp

M244 Effect of soybean hull supplementation frequency on the performance of steers grazing fall cool-season pastures with clover. R. L. Mills^{*1}, J. C. Waller¹, and C. J. Richards², ¹*The University of Tennessee, Knoxville*, ²*Oklahoma State University, Stillwater*.

In two years, eighty Angus and Gelbvieh steers (313 \pm 32 kg) were used in a randomized block design to examine performance when supplemented with digestible fiber at three frequencies while grazing fall growth of cool-season pastures, predominantly endophyte-infected tall fescue with clover. Steers were randomly allotted to sixteen 2-ha paddocks which were randomly assigned to four treatments: 1) unsupplemented control; 2) supplemented with soybean hulls (0.5% BW; DM basis) daily; 3) supplemented with soybean hulls (1.0% BW; DM basis) every second day; 4) supplemented with soybean hulls (1.5% BW; DM basis) every third day. Steers had free choice access to water and a loose vitamin/mineral mix. Steers were weighed on d 0, 1, 28, 55, and 56. Initial and final weights were an average of the two beginning and ending weights, respectively. Data were analyzed using

the MIXED procedure of SAS. Variables analyzed were initial, d 28, and final weights, and ADG (period 1 = d 1 to 28; period 2 = d 29 to 56; total = d 1 to 56). Contrasts were performed to compare control to supplemented and linear and quadratic effects of supplementation frequency. There were no differences in initial, d 28, and final body weights ($P > 0.10$). No difference ($P > 0.10$) was detected in period 1 ADG. Period 2 ADG was 29.4% greater ($P < 0.01$) for supplemented than control with frequency resulting in a linear response with daily being the greatest at 0.87 kg/d and every second day and every third day reducing ADG by 3.7 and 15.9%, respectively. Total ADG was 14.3% greater ($P < 0.01$) for supplemented than control with frequency resulting in a linear ($P < 0.01$) response with daily being the greatest at 0.90 kg/d and every second and every third day reducing ADG by 6.6 and 2.0%, respectively. This research shows that digestible fiber supplementation increases weight gain of calves grazing fall cool-season pastures with clover and less frequent feeding slightly reduces performance compared to daily supplementation.

Key Words: Cattle, Supplementation, Soybean hulls

M245 Application of advanced Synchrotron-based analytical technique (SR-FTIR) to feed science and ruminant nutrition. P. Yu^{*}, *University of Saskatchewan, Saskatoon, Canada*.

Traditional wet chemical analysis methods cannot detect intrinsic structural chemistry of a biological tissue. This is because the chemical structures and molecular characteristics of intrinsic structures of a tissue are destructed during the processing for analysis. Synchrotron-based Fourier transform infrared microspectroscopy (SR-FTIR), taking advantages of synchrotron light brightness (which is 100-1,000 brighter than sunlight), can explore molecular chemical features of the microstructure of biological samples. However, the applications of this synchrotron-based analytical technique to feed science and animal nutrition are rare. This presentation shows several applications of the SR-FTIR technique as a novel approach in feed science and ruminant nutrition research. Application 1 showed that using SR-FTIR technique, intensities and distribution of the biological components in the micro-structure of feed tissue within cellular dimension could be imaged. Application 2 showed with SR_FTIR technique, chemical differences in the ultrastructural matrix of endosperm tissue between Harrington (malting-type) and Valier (feed-type) barley in relation to rumen degradation characteristics were identified. The results indicated that the greater association of the protein matrix with the starch granules in the endosperm tissue of Valier barley may limit access of ruminal microorganisms to the starch granules and thus reduce the rate and extent of ruminal degradation relative to that of Harrington barley. It is the first time that micro-structural matrix in endosperm of barley could be revealed by using SR-FTIR technique, which makes it possible to link feed intrinsic structures to nutrient utilization and digestive behavior in ruminants. Application 3 showed with SR-FTIR technique, feed protein amide I molecular structural-chemical features affected by processing could be quantified with multi-component fitting program (Lorentzian and Gaussian function).

Key Words: Synchrotron infrared microspectroscopy, Feed molecular chemistry, Ruminant nutrition

Ruminant Nutrition: Ruminal Fermentation

M246 Effect of T-2 toxin on growth of ruminal bacteria in batch culture. D. Srichana^{*1,2}, G. E. Rottinghaus¹, P. Srichana^{1,3}, J. H. Porter¹, M. S. Kerley¹, and J. N. Spain¹, ¹University of Missouri, Columbia, ²Thammasat University, Phatumthani, Thailand, ³Charoen Pokphand Group Co., Ltd., Bangkok, Thailand.

T-2 toxin (T), a type-A trichothecene is a mycotoxin that has been found to contaminate feeds fed to dairy cattle. The effect of T-2 toxin on ruminal bacterial growth and fermentation was measured in a batch culture experiment. Feeds were incubated (39°C) in fermenters with buffer and ruminal fluid containing 0, 100, 200, 400 and 800 ppm T. Culture optical density (OD) was measured to estimate microbial populations. The cultures were sampled at 0, 6, 12 and 24 h to measure fermentation end products, pH and OD. The experimental treatments were arranged as a completely randomized design and analyzed with Proc MIXED procedures of SAS. Differences were identified at $P < 0.05$. Optical density increased over time with no differences among treatments. Culture pH decreased over time and was significantly higher at 12 and 24 h for the cultures with T at 800 ppm compared to all other treatments. The pH at 24 h was 6.08b, 6.10b, 6.09b, 6.10b and 6.18a for 0, 100, 200, 400 and 800 ppm T, respectively. Total concentration of VFA increased overtime with differences at 12 h, but VFA concentration was similar after 24 h ($P > 0.05$). Propionic acid increased over time with feed containing no T having lower propionic concentration than other treatments at 24 h (19.8b, 24.8a, 24.9a, 24.4a and 24.7a mM for 0, 100, 200, 400 and 800 ppm T). Feed containing no T supported higher concentration of butyric acid at all time points, including 24 h (19.6a, 17.3b, 17.8b, 17.9b, 17.8b mM) and ammonia at 24 h (31.5a, 29.2b, 27.0c, 28.2b, 26.9c mM) versus other treatments at 100, 200, 400 and 800 ppm. The results indicate that T-2 toxin altered ruminal microbial fermentation. The effect of these changes in rumen fermentation on animal performance should be investigated.

Key Words: T-2 Toxin, Ruminal bacteria, Batch culture

M247 *Lactobacillus acidophilus* isolated from cattle with potential to improve starch utilization. L. D. Early^{*}, J. A. Nangle, and S. E. Gilliland, Oklahoma State University, Stillwater.

Starch is the major energy component of grains and is therefore a primary energy source in many diets. From enrichment cultures in which starch was the only source of carbohydrate, a total of 19 different strains of species of *Lactobacillus* were isolated from four samples of cattle fecal matter. These strains were compared for relative abilities to hydrolyze soluble starch. Of the 19, six were selected for testing on raw starch. The six cultures also were examined for bile tolerance. There were variations among the cultures with respect to both starch hydrolysis activity and bile tolerance. All six cultures hydrolyzed raw starch and were bile tolerant; but the culture that showed the best starch hydrolysis activity with regard to soluble starch has been identified as *Lactobacillus acidophilus* S893-3. Two strains *L. acidophilus* S893-1 and S893-3 were significantly better than the others for hydrolysis of raw starch. However, there was no significant difference between the two strains in either test. *Lactobacillus acidophilus* S893-3 was significantly more bile tolerant than *L. acidophilus* S893-1. Thus this strain appears to offer the best possibility for use as a direct fed microbial to enhance starch utilization in cattle. The data were analyzed as randomized blocks with repetitions being blocks and cultures being treatments. Least significant differences were used to separate means. Differences having $P < 0.05$ were considered significant.

Key Words: *Lactobacillus*, Starch, Probiotic

M248 Evaluation of rumen microbial fluctuations in response to sub acute rumen acidosis using 16S rDNA profiles. H. Purvis II^{*1}, S. Fernando¹, K. Rutz¹, F. Najjar², B. Roe², and U. DeSilva¹, ¹Oklahoma State University, Stillwater, ²University of Oklahoma, Norman.

Rumen acidosis is considered to be one of the most important nutritional disorders in the feedlot and dairy industries today. Additionally, the economic impact of the losses due to subacute rumen acidosis is estimated to be in the billions of dollars for both the beef and dairy industries. We evaluated the corresponding fluctuations in rumen microbial population dynamics as animals contracted subacute ruminal acidosis (SARA) in an experimental setting. Eight multi-cannulated beef steers (510 ± 20 kg) were utilized in a crossover design and randomly assigned to two treatment groups (n=4/trt); Control (2.5 % BW prairie hay,) and Concentrate (2.5% BW, 3.0 Mcal of ME/Kg of DM). Following adaptation to diets two animals on Concentrate were challenged with 1.2g/Kg body weight of ground corn to experimentally induce SARA. Rumen samples were collected every two h for 24 h period following the morning feeding (0800). A 800bp fragment of the microbial 16S rRNA gene was PCR amplified and the microbial population structure and diversity were assessed using Terminal Restriction Length Polymorphism (T-RFLP) and was analyzed using the Phylogenetic Analysis Tool (PAT) software. To identify the major contributors of sub acute rumen acidosis, 16S rDNA libraries were constructed from both animals with induced SARA and control animals on high energy diet during critical stages of pH change and were sequenced. The sequence analysis shows significant increases in Proteobacteria (0.8% to 23.1%) and Actinobacteria (0.3% to 7.3%) populations, and significant decreases in Firmicutes (36.1% to 21.9), Spirochaetes (4.4% to 0.0) Bacteroidetes (44.3% to 31.0%) populations. Overall, changes in rumen populations can be evaluated using T-RFLP and microbial populations are altered greatly by SARA.

Key Words: Subacute rumen acidosis, 16s rDNA, Beef cattle

M249 The negative effects of one cycle of eight hours at suboptimal pH on rumen fermentation are not reduced by splitting it into various cycles. M. Cerrato, S. Calsamiglia^{*}, and A. Ferret, Universitat Autònoma de Barcelona, Bellaterra, Spain.

Previous studies indicate that the total amount of time (h) that ruminal pH is suboptimal may be more critical for ruminal fermentation than mean daily pH. We hypothesized that ruminal bacteria may resist short periods of low pH if pH is above 6.0 long enough to permit their regrowth. However, the negative effects of prolonged periods (12 h) of suboptimal pH were not reduced by splitting it into various cycles. Eight 1325-ml dual flow continuous culture fermenters were used in two consecutive periods to examine if the negative effects of 8 h at pH 5.5 on rumen fermentation can be reduced by splitting it in 2 periods of 4 h at pH 5.5. Temperature (39°C), diet (97 g/d of a 60 to 40 forage to concentrate diet; 16.6% CP, 30.0% NDF) and solid (5%/h) and liquid (10%/h) dilution rates were similar. Treatments were a constant pH 6.4 (CTR); 1 period of 4 h at pH 5.5 (P4); 1 period of 8 h at pH 5.5 (P8); 2 periods of 4 h at pH 5.5 (P2x4). Data were analyzed using PROC GLM of SAS (1996) and differences declared at $P < 0.05$. Treatment P8 reduced DM (52.7 vs 61.9 %), NDF (20.5 vs 31.8 %) and CP (38.1 vs 52.8%) degradation, ammonia N concentration (5.7 vs 10.4 mg/dL) and acetate to propionate ratio (2.2 vs 3.8) compared with CTR. There were no differences in these estimates between P8, P4 and P2x4. The ADF digestion (33.5 vs 38.7 and 40.7%) and branch-chained volatile fatty acids proportion (1.0 vs 1.75 and 2.8 mol/100mol) were lower

in P8 compared with P4 and CTR, respectively, but there were no differences in these estimates between P4 and CTR. There were no differences between the treatments in OM digestion (47.9%), total VFA concentration (95.3 mM), the flow of total (3.20 g/d), bacterial (1.17 g/d) and nonammonia (3.00 g/d) N and in the efficiency of microbial protein synthesis (44.8 gN/kg OM truly digested). Results suggest that the negative effects of pH 5.5 are dependent of the total time that ruminal pH is suboptimal and are not reduced by splitting it into two cycles.

Key Words: pH, Acidosis, Rumen fermentation

M250 Effect of the magnitude of the decrease of rumen pH and its fluctuations on rumen microbial fermentation. M. Cerrato, S. Calsamiglia*, and A. Ferret, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Ruminal pH below 6.0 has negative effects on rumen microbial fermentation. However, previous studies indicate that ruminal bacteria may resist short periods (4h) of pH below 6.0. It is not clear if the magnitude of the decrease is important. Eight 1325-ml dual flow continuous culture fermenters were used in two consecutive periods with similar temperature (39°C), diet (97 g/d of a 60 to 40 forage to concentrate diet; 19.2% CP, 30.0% NDF) and solid (5%/h) and liquid (10%/h) dilution rates to determine the effect of the magnitude of the decrease of rumen pH and its fluctuations on rumen bacterial fermentation. Treatments were a constant pH 6.4 (CTR); 1 period of 4 h at pH 5.6 (L); 1 period of 4 h at pH 5.1 (VL); 1 period of 2 h at pH 5.1 and 2 h at 7.1 (HL). Data were analyzed using PROC GLM of SAS (1996) and differences declared at $P < 0.05$. Dry matter (62.5% vs 75.1%) and NDF (20.8% vs 33.8%) digestion were lower in VL compared with CTR, but there were no differences compared with HL or between CTR and L. Treatment VL reduced acetate proportion (54.0 vs 60.8 and 60.4 mol/100 mol), and increased propionate proportion (31.5 vs 20.9 and 17.7 mol/100 mol) and ammonia N concentration (9.6 vs 11.6 and 13.3 mg/100 mL) compared with L and CTR, respectively. There were no differences in these estimates between VL vs HL, and between CTR vs L. The branch-chained volatile fatty acids proportion (mol/100 mol) was lower in VL (1.06) compared to L (2.86) and CTR (4.19), but there were no differences compared with HL. There were no differences between treatments in the flow of total (3.38 g/d), bacterial (1.20 g/d) and nonammonia (3.06 g/d) N, and in the efficiency of microbial protein synthesis (27.4 gN/kg OM truly digested). Dietary N flow was higher (2.04 vs 1.66 g/d) and CP degradation lower (25.1 vs 38.9 %) in VL compared with CTR. Results indicate that bacteria are able to resist short periods (4 h) at suboptimal (5.6) pH, but the effects were negative if pH fell at 5,1 for 2 or 4h.

Key Words: pH, Acidosis, Rumen fermentation

M251 Conservation of fermentation energy and control of the VFA profile in the rumen. E. M. Ungerfeld* and R. A. Kohn, *University of Maryland, College Park.*

The objective of this analysis was to compare energy conservation as ATP in the different volatile fatty acid (VFA) pathways of ruminal fermentation and relate it to the VFA profile produced. It is well understood through stoichiometrical calculations and empirical evidence that a decrease in the acetate to propionate ratio results in less methane (CH_4) being produced per unit of fermented hexose. Because

CH_4 is not an energy source for ruminants, a decrease in the acetate to propionate ratio results in an improvement of energy conservation in end products of fermentation utilizable by the host animal. However, there is uncertainty as to how VFA pathways compare regarding capture of fermentation energy in high-energy phosphate bonds, which are necessary for the production of microbial protein. The present analysis uses basic knowledge of biochemical pathways and thermodynamics to examine the utilization of free energy in the main VFA pathways, and identifies steps where research is needed for a more complete characterization of energetic efficiency. Theoretical lower and upper limits for moles of ATP generated per mole of hexose fermented could be 4.5 to 6 for acetate, 0.3 to 5 for propionate and 3.25 to 4.5 for butyrate. The ample variation in ATP generation in the propionate pathway is due to the partition between the randomizing and non-randomizing pathways, the utilization of ATP-equivalents in oxaloacetate (or malate) formation, and the stoichiometry of ATP generation by electron transport-linked phosphorylation during fumarate reduction. These limits may be narrower because ATP generation in different reactions within a pathway is likely interdependent. Changes in ATP generation in a pathway not only affect the availability of energy for microbial protein production but can shift the VFA profile by altering VFA equilibrium. Ultimately, the nature of thermodynamic control of the VFA profile determines that a decrease in ATP generation of a pathway should make it thermodynamically more favorable and shift more carbon in that direction until a new equilibrium is reached.

Key Words: Rumen, Fermentation, ATP

M252 Buffer pH and clarified ruminal liquid effects on stability of an exogenous fibrolytic enzyme. E. Meraz-Romero¹, S. S. González*¹, G. Mendoza-Martínez², O. Loera-Corral³, M. Meneses-Mayo¹, M. Cobos-Peralta¹, and J. Avellaneda-Cevallos⁴, ¹*Colegio de Postgraduados, Montecillo, Edo. de México, México,* ²*UAM-Xochimilco, México D.F., México,* ³*UAM-Iztapalapa, México D.F., México,* ⁴*Universidad Técnica Estatal de Quevedo, Quevedo, Ecuador.*

The objective of this trial was to evaluate the activities of xylanase, cellulase and laccase (phenoloxidoreductase), from an exogenous fibrolytic enzyme (Fibrozyme, ALLTECH Inc.; enzyme), under a buffer or anaerobic culture with clarified ruminal liquid. Treatments were buffer pH 6.0, buffer pH 7.0, clarified ruminal liquid pH 6.5. The experimental design was completely randomized, data was analyzed using SAS and treatment means were compared utilizing Tukey; besides, a first order kinetic model was fitted to the data. The enzyme showed xylanase ($292 \pm 0.02 \text{ IU g}^{-1}$) and cellulase ($36 \pm 0.007 \text{ IU g}^{-1}$) activities, but laccase activity was not detected. For buffer pH 6.0, cellulase was more stable than xylanase and both showed activities during 46 h. Rate constants (k) for enzymatic inactivation were -0.054 and 0.008 h^{-1} for xylanase and cellulase, whereas half time values ($t_{1/2}$) were 12.8 and 87.7 h, respectively. For buffer pH 7.0, cellulase activity was longer than xylanase which showed no activity at 32 h; k values were -0.07 and 0.009 h^{-1} and $t_{1/2}$ were 9.99 and 77.0 h for xylanase and cellulase, respectively. Under anaerobic culture with clarified ruminal liquid, cellulase activity was longer than xylanase which showed activity during 4 h ($k = -1.815$ and 0.009 h^{-1} ; $t_{1/2} = 0.38$ and 26.87 h, respectively). According to these results, both buffer pH and ruminal bacteria enzymes seem to affect stability of an exogenous fibrolytic enzyme.

Key Words: Exogenous fibrolytic enzyme, Enzymatic stability, Xylanase

M253 *In vitro* fermentative characteristics of tropical grasses supplemented with tree/shrub forage. E. González^{*1,2}, O. Cáceres¹, E. Albanell², G. Caja², and J. Arece¹, ¹*Estación Experimental de Pastos y Forrajes, Matanzas, Cuba*, ²*Universitat Autònoma de Barcelona, Bellaterra, Barcelona, Spain*.

In vitro fermentation of current forage diets under tropical agroforestry systems were evaluated. Two common tropical grasses (*Panicum maximum* cv. likoni, PM; *Pennisetum purpureum* cv. CT-115, PP) were supplemented with four tree/shrub forage (*Leucaena leucocephala*, LL; *Gliricidia sepium*, GS; *Trichanthera gigantea*, TG; *Morus alba*, MA). Representative forage samples were randomly selected in an agroforestry experimental field of Matanzas, Cuba (22°48'N, 81°2'W; 60 masl). The *in vitro* gas production (IVGP) technique of Theodorou *et al.* (1994) was used in two consecutive incubation series (96h), using rumen inoculum from two ruminally cannulated *Holstein Frisian* dairy cows, previously adapted. A factorial arrangement design (2×4) was used to evaluate combination of grasses (n = 2) and trees or shrubs forage (n = 4) as supplements (ratio 60:40 of grass:supplement). Treatments were: 1) PM-LL; 2) PM-GS; 3) PM-TG; 4) PM-MA; 5) PP-LL; 6) PP-GS; 7) PP-TG; 8) PP-MA. Fermentation profiles of grasses (PP; PM; without supplement) were considered as "controls". The IVGP, fermentative parameters (*a*; *b*; *c*; "lag time", *T*), and *in vitro* disappearance of dry matter (IVDDM) and neutral detergent fiber (IVDADF) were determined. Gas production (GP) data were fitted to the France *et al.* (1993) equation. There were significant differences (*P* < 0.05) in fermentative patterns among diets. The IVGP (PP > PM), and IVDDM or IVDADF, were higher and lower (*P* < 0.05), respectively, for sole grasses compared to their respective combined diets. Except diet PM-GS (highest IVGP values), IVGP was lower (*P* < 0.05) in supplemented diets when compared to control (PM) despite its *T* value (2.18), degradation rates (μ) or IVDADF (559.4 g kg⁻¹DM). Supplement TG resulted with the lowest fermentative values for both grasses.

Table 1. Adjusted parameters and *in vitro* disappearance of DM and NDF

Diet	A	b	c	T	μ 48	IVDADF	IVDADF
PM	200	0.019	0.09	2.18	0.377	559	481
PM+MA	176	0.020	0.20	1.89	0.754	664	483
PM+TG	150	0.050	-0.01	1.68	0.160	622	554
PM+LL	172	0.001	0.23	2.07	0.815	607	454
PM+GS	275	-0.005	0.23	1.99	0.777	599	464
PP	212	0.024	0.09	1.81	0.383	629	560
PP+MA	170	0.040	0.09	1.46	0.447	681	533
PP+TG	157	0.046	0.05	1.76	0.330	646	584
PP+LL	171	0.021	0.14	2.13	0.541	621	619
PP+GS	163	0.010	0.24	2.21	0.857	618	634

A: potential GP at 96h (ml/800mg DM); *b*, *c*: rate constants (h⁻¹ and h^{-1/2}, respectively); *T*: lag time; μ : degradation rate (h⁻¹) at 48h

Key Words: Tropic forage, Grass, Tree fodder

M254 Microbial yield and fiber digestion from sucrose, starch, pectin and bermudagrass fiber fermentation. L. Holtshausen^{*1} and M. B. Hall², ¹*Stellenbosch University, Stellenbosch, South Africa*, ²*USDA-ARS, Madison, WI*.

Effect of nonfiber carbohydrates (NFC: sucrose, starch and pectin) fermented with isolated bermudagrass neutral detergent residue (iNDF) on microbial product yield and neutral detergent fiber (NDF) digestion

was examined. iNDF with three concentrations of individual NFC (~40 to 120 hexose equivalents; HE) were fermented in six 24 h anaerobic batch culture fermentations with Goering & Van Soest medium and rumen inoculum in 50 ml tubes fitted with gas release valves. Fermentation tubes were destructively sampled every 4 hours and analyzed for microbial glycogen (GLY), organic acids, microbial crude protein (MCP), and residual NDF. Differences among NFC treatments at their maxima with NFC expressed on an HE basis were evaluated by heterogeneity of regression analysis. Significance was declared at *P* < 0.05. The linear increase in maximum GLY per NFC HE was similar for sucrose and pectin, but their intercept values were numerically different and that for sucrose dwarfed the calculated increase per HE. Yield of total volatile fatty acids (VFA) per NFC HE at 24 h was similar among individual NFC. As NFC HE increased, the proportion of residual NDF at 24 h differed among pectin (less digestion), starch (almost no difference) and sucrose (more digestion). The pattern of MCP yield with increasing NFC HE was quadratic and similar among NFC. The NFC differed in fermentation product yield and effects on NDF fermentation. It is not warranted to regard the various NFC as a uniform entity in ruminant nutrition.

Table 1. Regression values by NFC for maximum yield of product. x = HE

Max. GLY (mg)		VFA at 24 h (acetate + propionate + butyrate)	
Starch	-	Starch	15.24 + 0.38x + 8.80E-04x ²
Sucrose	2.37 + 0.01x	Sucrose	25.83 - 0.05x + 2.09E-03x ²
Pectin	-0.19 + 0.03x	Pectin	17.57 + 0.22x + 8.25E-04x ²
24 h NDF (% of original NDF) Max. MCP (mg)			
Starch	60.55 + 4.54E-03x	Starch	3.56 + 0.27x + 9.00E-04x ²
Sucrose	61.29 - 0.01x	Sucrose	3.97 + 0.21x + 7.10E-04x ²
Pectin	62.89 + 0.03x	Pectin	6.30 + 0.19x + 1.70E-04x ²

Key Words: Nonfiber carbohydrates, Microbial product yield, Neutral detergent residue

M255 The relationship between feed acidogenic value and *in vitro* ruminal pH changes. B. Rustomo^{*}, J. P. Cant, M. P. Fan, T. F. Duffield, N. E. Odongo, and B. W. McBride, *University of Guelph, Guelph, Ontario, Canada*.

The increasing use of ruminally fermentable carbohydrate in diets is considered the critical link between nutrition and sub-acute ruminal acidosis in dairy cows. However, starch or non fibre carbohydrate (NFC) content of the diet is not a satisfactory predictor of rumen pH changes due to the high variation in the rate and extent of starch or NFC fermentation in the rumen. A simple *in vitro* technique was used to assess acidogenic value (AV) of feedstuffs. This technique is based on the dissolution of Ca from CaCO₃ after 24 and 48 h incubation of feedstuffs in rumen liquor. A series of feeds, ranging from energy, fiber and protein sources were evaluated. Ruminal fluid pH changes in the incubation medium were also measured at the end of 24 and 48 h incubation. The relationship between AV and rumen fluid pH and AV and feed chemical composition was determined using regression analysis. Comparison between 24 and 48 h incubations were conducted using paired t-test. Non fiber carbohydrate-rich feedstuffs had the highest AV; forage sources had intermediate AV and high-protein feedstuffs had the lowest AV. There were no differences in apparent AV and rumen fluid pH changes between 24 and 48 h incubation, suggesting a rapid initial fermentation rate and little or no further

fermentation after 24 h. Thus, the 24 h AV measurements might be acceptable to qualitatively rank feedstuffs based on the estimated accumulated acid-load during fermentation. The rate of rumen fluid pH changes showed similar patterns to AV in ranking feedstuffs. Energy sources showed the highest rumen fluid pH decrease; fiber sources were intermediate and protein sources were lowest in rumen fluid pH change after 24 h of incubation suggesting that NFC-rich feedstuffs had the lowest rumen buffering capacity compared to fiber and protein

rich feedstuffs. Rumen fluid pH changes after 24 h of incubation had a stronger relationships with AV for all feedstuffs ($R^2 = 0.74$) compared to starch ($R^2 = 0.35$) and NFC ($R^2 = 0.56$). The best predictors of feed AV were NFC and ADF ($R^2 = 0.81$). However, further studies are needed to examine the effect of feed AV on in vivo ruminal pH changes in dairy cows.

Key Words: Acidogenic value, In vitro, Ruminal pH

Swine Species

M256 Effects of conjugated linoleic acid (CLA) on sow and litter performance. R. Patterson*, M. L. Connor, C. M. Nyachoti, and D. O. Krause, *University of Manitoba, Winnipeg, Canada.*

The potential for CLA supplementation to improve physiological benefits affecting sow and litter performance was evaluated using 14 Cotswold sows in a completely randomized design with a 2x2 factorial arrangement of treatments. Diet (0% or 2% CLA) and parity (IM=Immature or M=Mature) corresponded to the following: 1) 0%IM n = 3; 2) 0%M n=3; 3) 2%IM n=4; 4) 2%M n=4. Treatment diets were fed as gestation rations from d 85 through d 110 and as lactation rations from d 110 until weaning. On gestation d 85, 105, and 112 and lactation d 1, 3 and 17 plus 4 d post-weaning, sow BW, back fat depths and condition scores were taken. Piglets were weighed on d 1, 3 and 17. Parity effects ($P < 0.01$) were observed for sow BW at each period. However, parity only affected ($P < 0.05$) back fat depth at d 17 of lactation and 4 d post-weaning and condition scores on d 1 of lactation and 4 d post-weaning. Diet did not affect ($P > 0.05$) piglet weaning weights. In a follow-up experiment, 78 of these piglets were weaned at 17 ± 1 d and randomly arranged in a 2x2 factorial based on lactation and weaning diets as follows: 1) 0:0 (0%CLA sow: 0%CLA piglet); 2) 0:2 (0%CLA sow: 2%CLA piglet); 3) 2:0 (2%CLA sow: 0%CLA piglet); 4) 2:2 (2%CLA sow: 2%CLA piglet). Piglets weaned from 2% sows had greater feed to gain ratios ($P < 0.035$) and tended ($P < 0.058$) to have higher ADFI compared to those weaned from 0% sows by d 28, but diet did not affect piglet performance by d 36. On d 28 piglets were given an oral *E.coli* K88+ challenge. Fecal scores were taken at 8, 24, 48 and 56 h post-challenge. Piglets weaned from 2% CLA sows had less severe scours ($P < 0.05$) at all sampling periods and a dietary interaction effect ($P < 0.05$) was observed at 56 hours. Weaning diets reduced ($P < 0.1$) scour incidence only at 48 hours. It is thus apparent that provision of CLA during gestation and lactation improves litter performance. Further work is intended to determine the immunological/physiological mechanisms underpinning these improvements.

Key Words: CLA, Sows, Piglets

M257 The effects of feeding grains naturally-contaminated with Fusarium mycotoxins to gestating and lactating sows on metabolism and reproduction and the efficacy of a polymeric glucomannan adsorbent in preventing those effects. G. Diaz-Llano* and T. K. Smith, *University of Guelph, Ontario, Canada.*

The feeding to swine of feedstuffs naturally-contaminated with *Fusarium* mycotoxins can reduce feed intake, and hepatic protein synthesis. An experiment was conducted to investigate the effects of feeding grains naturally-contaminated with *Fusarium* mycotoxins on reproductive performance, serum chemistry, ADFI and ADG of first parturition sows during late gestation and lactation, and to test the

efficacy of a polymeric glucomannan mycotoxin adsorbent (GMA) in preventing these effects. A completely randomised block design, 36 sows, 12 sows per treatment was used in the experiment. Diets consisted of corn, wheat and soybean meal and were fed from 91 days of gestation up to the weaning on d 21 post farrowing. The diets were: (1) control (C), (2) contaminated grains (CG) (5.5 ppm DON + 0.5 ppm 15-acetyl DON + 0.3 ppm zearalenone), and (3) contaminated grains + GMA. Means were compared using Tukey's test and significance was declared at $P < 0.05$. During gestation, *Fusarium* mycotoxins did not reduce ADFI. The ADG was reduced in sows fed CG ($P = 0.03$) but not in sows fed CG + GMA. Growth to feed ratio was also reduced in sows fed CG compared to C ($P = 0.047$), but not in sows fed CG + GMA. Stillbirth rate was increased in piglets born from sows fed CG compared to piglets born from sows fed CG + GMA ($P = 0.03$). During lactation, ADFI of sows fed CG and CG + GMA was reduced compared to C ($P < 0.001$). Higher body weight losses were seen in sows fed CG compared to controls ($P = 0.007$). Total serum protein concentrations were lower for sows fed CG compared to sows fed CG + GMA ($P = 0.045$). Weaning to estrus interval tended to increase in sows fed CG and CG + GMA compared to controls ($P = 0.094$). It was concluded that the feeding of grains naturally-contaminated with *Fusarium* mycotoxins reduces the reproductive efficiency of gestating and lactating sows. The feeding of GMA can prevent much of this inefficiency.

Key Words: Sows, *Fusarium*, Growth

M258 Effects of exogenous porcine somatotropin and transportation on physiological parameters in weaned pigs. C. J. Kojima*, P. E. Roberson, M. P. Roberts, T. Sun, and H. G. Kattesh, *University of Tennessee, Knoxville.*

An experiment was performed to examine effects of exogenous porcine somatotropin (S) on physiological measures of health and well-being in weaned pigs with or without subsequent transport (T). We hypothesized that S may abrogate stress-related decreases in health and well-being in recently weaned and transported pigs. On d 17 of lactation pigs were weighed and assigned to treatment groups (n=8/group): NS-NT (vehicle injection, no transport), S-NT (S injection, no transport), NS-T (vehicle injection, transport at weaning), and S-T (S injection, transport at weaning). Upon allocation, all pigs received daily intramuscular injections containing S (0.5 mg/kg) or vehicle for 5 d. On d 21, a blood sample was drawn immediately prior to injection (0800 h). At 1200 h on d 21, pigs were weighed and blood was collected. Pigs in the NT groups were then weaned into mixed nursery pens while pigs in the T groups were mixed and transported by truck for 3 h before being brought back to the nursery. All weaned pigs were fed a standard nursery diet. Blood samples and body weights were taken on d 22, 29 and 37. Data were analyzed by a mixed model procedure with a factorial design and repeated measures. Transport resulted in lower

body weights ($P<0.05$) at all time points post-weaning, and weight gain within the 14-d window postweaning was less in T pigs ($P=0.05$). Transport increased circulating neutrophil numbers and overall white cell count ($P<0.05$). An S*Time interaction was observed ($P<0.05$) such that S caused a sharp increase in circulating neutrophils 4 h after injection; however, neutrophil count returned to control levels within 24 h. Elevated concentrations of circulating cortisol were noted in all groups on d 22 (the morning after weaning; $P<0.0001$). On d 22, a Time*S*T interaction was observed ($P=0.05$) such that cortisol was higher in S-NT and NS-T than in NS-NT pigs, with S-T pigs not different than NS-NT pigs. We conclude that treatment with S altered immune and hormonal profiles in weanling pigs but was not effective in abrogating the weight loss observed in transported pigs.

Key Words: Pig, Stress, Weaning

M259 Use of a ground raw soybean diet to enhance reproductive efficiency in gilts. D. Sykes*, S. Couvillion, P. Gerard, M. Crenshaw, and P. Ryan, *Mississippi State University, Mississippi State.*

Soybeans contain high levels of phytoestrogens, a bioactive compound known to have beneficial effects on human health and reproduction in farm animals. Preliminary reports have suggested that raw soybean-based diets when fed to pigs have the potential to enhance ovarian function. Thus, the objective of this study was to determine the efficacy of a raw soybean (RSB) diet on reproductive performance in prepubertal gilts. To this end, Yorkshire x Landrace crossbred gilts ($n=20$; BW 75.9 ± 1.5 kg; age 140 d) were assigned to balanced isonitrogenous (CP 14%), isocaloric diets using either soybean meal supplemented with poultry fat (SBM, $n=10$) or ground raw soybeans (RSB, $n=10$). Soybeans accounted for 75% of the supplemental protein source for the first four weeks then increased to 100% thereafter. Gilts were housed in covered, outdoor pens with ad libitum access to feed and water and monitored daily (0600-0700) for signs of estrus using a teaser boar (exposure commenced at age 160 d). Gilts were bred by AI on the third standing estrus, then penned indoors individually and restricted to their respective diets (2.3 kg/d) through to d 35-40 of gestation when they were slaughtered for the recovery of the reproductive tract and carcass evaluation. Values given are mean \pm SE. No differences in BW were observed at time of AI (RSB, 136.3 ± 11.9 kg; SMB, 147.8 ± 20.1 kg). By the second week of boar exposure 70% of RSB gilts exhibited first estrus compared to 30% of SBM gilts. While there was no difference in age at onset of first estrus (RSB, 184 ± 3.9 d; SBM 193 ± 7.3 d), RSB gilts were lighter (136.3 ± 3.8 kg) than SMB gilts (147.8 ± 6.4 kg). At slaughter, 9 SBM and 10 RSB gilts were pregnant. While there were no differences in the mean number of corpora lutea on the ovaries (RSB, 16.9 ± 0.9 ; SBM, 18.3 ± 1.0) or mean total number of embryos recovered (RSB, 12.6 ± 0.8 ; SBM 14.9 ± 1.6) between the two groups, there was a higher incidence of embryo resorption in SBM gilts. In Phase II studies we will carry gilts to term and weaning to determine the benefit of feeding RSB diets.

Key Words: Raw soybeans, Gilts, Reproduction

M260 Litter performance in the swine nucleus herds of Sri Lanka. J. A. D. R. N. Appuhamy*, L. P. Silva, and C. M. B. Dematawewa, *University of Peradeniya, Peradeniya, Sri Lanka.*

Large White (LW) and Landrace (LR) nucleus sow herds are maintained separately in Horakele farm, Sri Lanka to produce breeding females

for multiplier herds. This study investigated the genetic variability and progeny performance of the sires and dams of the two herds with respect to litter size at birth (LSB), litter size at weaning (LSW), individual birth weight (BWT) and individual weaning weight (WWT). There were 24 sires and 40 dams in the LW nucleus, and 24 sires and 29 dams for the LR nucleus. Intensive management of the breeding stock included standard feeding and health practices, under tropical conditions. Average ambient temperature was 27°C with relative humidity of 80 percent. Weights (kg) and litter size data for 2057 pigs from 225 litters were used for the analysis. Least square means of traits for the two herds were compared using PROC GLM of SAS treating parity and birth year as fixed effects and age of dam as a covariate. In addition, sex of pigling was used as a fixed effect for BWT and WWT, while age at weaning was used as a covariate for WWT and LSW. Genetic and phenotypic variance components of the four traits were estimated using PROC VARCOMP in SAS (maximum likelihood method) for the two herds separately. There were no significant differences between the two herds with respect to any of the four traits ($P>0.05$). However, the other fixed effects and covariates fitted were significant ($P<0.05$), with better performance for male pigs and later parities and older sows. Dam components of variance were greater than sire components for all traits. Heritability estimates (full-sib method) for BWT, WWT, LSB and LSW for LW were 0.20, 0.51, 0.25 and 0.17, respectively. The respective estimates for LR were 0.66, 0.17, 0.38 and 0.35, respectively. Progeny means (\pm SD) of the LW nucleus sires for the above traits were 1.45 ± 0.07 , 9.27 ± 1.6 , 9.28 ± 1.9 , and 8.25 ± 1.9 , respectively. For the LR nucleus sires they were 1.48 ± 0.2 , 9.67 ± 1.5 , 9.69 ± 2.0 , and 8.34 ± 2.2 , respectively. Sufficient genetic variability and potential exists in the nucleus herds for genetic improvement of the four traits.

Key Words: Swine breeding, Nucleus, Sri Lanka

M261 Effect of the consistency of collection frequency on semen quality of boars. W. L. Flowers* and M. C. Seal, *North Carolina State University, Raleigh.*

Two experiments were conducted to examine the influence of varying the consistency of collection frequency on semen quality. Experiment 1 was a retrospective analyses of data obtained from a 250-boar stud. The planned collection frequency was 1.5 times per week. However, the actual collection frequency varied each week from 1 to 5 times due to changes in breeding demands and number of low quality ejaculates. Boars were retrospectively assigned to collection frequency groups as follows. Beginning in June, the collection frequency increased from 1.5 to 3 times or more per week for 122 of the 250 boars. For 80 of the 122 boars, the high collection frequency was consistently maintained through July and August (HC). Collection frequency varied randomly between 1 and 4 collections per week during the same time period for the other 42 boars (HV). For 128 of the boars, collection frequencies between June and August remained consistent at 1.5 times per week (LC). Insemination doses/ejaculate were highest for the LC; intermediate for the HC; and lowest for the HV groups ($P<0.01$). The order for ejaculates discarded due to increased sperm abnormalities was $HV>HC>LC$ ($P<0.01$). Experiment 2 was a prospective study in which 32 mature boars were collected for 12 weeks. Boars were collected at a high (H: 3 times/week) or low (L: 1 time/week) frequency under a consistent (C) or variable regimen (V). Boars assigned to the consistent regimen were collected on the same days each week. Days of collection for boars assigned to the variable regimen were determined with a random number generator at the beginning of each week. A frequency by regimen interaction was present ($P<0.05$) for

motility, normal morphology and acrosin activity of spermatozoa. Each of these variables was reduced ($P < 0.05$) in the HV boars compared with their counterparts in other treatments. No differences ($P = 0.27$) were observed among the LC, LV, and HC boars. In conclusion, the consistency at which high frequency collection regimens are administered to boars has an important effect on semen quality.

Key Words: Boars, Collection pattern, Spermatogenesis

M262 Effect of group size and floor space during the growing period on the growth performance of pigs after the heaviest pigs have been removed. J. M. DeDecker^{*1}, M. Ellis¹, B. F. Wolter², and B. A. Peterson¹, ¹*University of Illinois, Urbana*, ²*The Maschhoffs, Inc, Carlyle, IL*.

This study was carried out with 2600 crossbred pigs to investigate the effects of group size and floor space during the growing period on

performance at the end of the finishing period after the heaviest pigs were removed from the group. A randomized complete block design was used with a 2×5 factorial arrangement of treatments: 1) group size (26 vs 78 pigs/pen); 2) floor space (0.58 vs 0.64 vs 0.70 vs 0.76 vs 0.82 m²/pig). Floor spaces were created by adjusting pen sizes. Feeder space and number of waterers per pig were the same across all treatments. Pigs were allotted to treatments at weaning and the study started when the first pigs were removed from the group at a mean pen weight of 129.7 ± 1.2 kg and ended 21 days later. A total of 50 pens of pigs were involved. The same pig removal protocol was followed for all treatments. Pigs were removed at the start of the study (heaviest 30% of the pen) and on d 7 (heaviest 30%) and d 14 (heaviest 20%). No treatment interactions were found. In addition, there was no effect of group size or floor space on ADG, ADFI or G:F during the 21-d study period. However, groups of 26 pigs tended ($P = 0.06$) to have fewer pigs removed due to morbidity and mortality than groups of 78 (0.47 and 0.84% for the 26 and 78 pig groups, respectively) over the 21-d study period.

Key Words: Pigs, Group size, Floor space

Monday July 10, 2006

SYMPOSIA AND ORAL SESSIONS

Animal Health I

21 Application of a novel biochip for rapid detection of mastitis-causing pathogens in bulk tank milk in Taiwan. K. H. Lee*¹, Y. M. Shy¹, Y. T. Lin², L. Y. Liu², S. J. Lee¹, C. L. Chang¹, M. C. Wu¹, and C. H. Chi³, ¹Hsinchu Branch, COA-LRI, Hsinchu, Taiwan, R.O.C., ²DR. Chip Biotechnology Inc., Chu-Nan, Taiwan, R.O.C., ³University of Taiwan, Taipei, Taiwan, R.O.C.

In order to efficiently prevent and treat bovine mastitis and minimize its impact on dairy industry in Taiwan, a sensitive, rapid, and specific test is required for identifying the mastitis-causing pathogens. In the present study, a biochip was developed in collaboration with DR. Chip Biotechnology Inc. in Taiwan. The biochip is capable of detecting 6 common species of mastitis-causing pathogens within 6 hours, including *Streptococcus bovis*, *Streptococcus uberis*, *Streptococcus uberis*, *Streptococcus dysgalactiae*, *Escherichia coli* and *Staphylococcus aureus*. The technique is based on DNA amplification of genes specific to the target pathogens and consists of 4 basic steps: DNA extraction of bacteria, PCR reaction, DNA hybridization, colorimetric reaction. The sensitivity and accuracy of this Biochip, in comparison with conventional culture method, were verified by analyzing serial diluted fresh whole milk that were separately inoculated with the 6 species of bacteria that mentioned previously. The Biochip had a lower detecting limit and showed results that have a similar trend to those from the conventional method. Thereafter, the Biochip was used for detecting bacteria in bulk tank milk samples from 207 DHI-participating dairy farms in 2004. The results show that only 6 (3%) farms were negative on all 6 species of pathogens monitored. *Streptococcus bovis*, detected in samples from 161 (79.7%) farms, was the most prevalent species, followed by *Streptococcus uberis* (n=123, 60.9%), *Escherichia coli* (n=92, 45.5%), *Streptococcus dysgalactiae* (n=62, 30.7%), *Streptococcus agalactiae* (n=55, 27.2%), and *Staphylococcus aureus* (n=19, 9.4%). Results from this study reveal that the biochip is a feasible tool for a rapid diagnose of mastitis-causing pathogens in milk, which might prevent and cure mastitis more effectively.

Key Words: Mastitis, Pathogen, Biochip

22 Relationship of intramammary infection prevalence with somatic cell score in commercial herds. R. L. Bamber*¹, G. E. Shook¹, G. J. Bennett², Y. H. Schukken², and P. L. Ruegg¹, ¹University of Wisconsin, Madison, ²Cornell University, Ithaca, NY.

Our objective was to derive predictions of intramammary infection (IMI) prevalence based on somatic cell score (SCS), cow, and herd factors. IMI cultures on composite samples were performed by New York Quality Milk Production Services during 1992 to 2004. Cow records containing DHI SCS in IMI sampling month with 0, 1, or 2 pathogens were retained. Herds were required to test at least 60%

of cows and ≥ 30 cows tested. Final data set consisted of 79,308 cows from 1124 herds. Pathogens were classified as contagious or environmental. Models were derived using the glimmix macro in SAS with a logistic link function and employing backward elimination with $P < .01$. Three models were investigated with binary dependent variables: presence/absence of contagious IMI (CONT), environmental IMI (ENV), and all IMI (ALL). Independent variables included SCS, quadratic SCS (SCS²), parity, days in milk (DIM), milk/day, J5 vaccine use, survey type, production system, season, year, herd (fitted as a random effect), and significant interactions of SCS with other terms. For all models SCS, SCS², parity, DIM, and production system were significant. In each model additional terms were: CONT: survey type; ENV and ALL: year, parity*SCS, and parity*SCS²; ENV: milk/day and survey type; ALL: production system*SCS. Prevalence of IMI varied by herd and cow factors and increased at a decreasing rate as SCS increased. The rate of increase with SCS was uniform for CONT, but differed among production systems (ALL) and parities (ENV and ALL).

Table 1. Regression coefficients for IMI on SCS, herd and residual variances, and predicted prevalence (p) of IMI.

Model	a	b ₁	b ₂	Herd var.	Residual var.	SCS=2	SCS=4	SCS=6
CONT	-3.084	0.600	-0.042	1.711	0.839	0.144	0.205	0.270
ENV	-2.092	0.483	-0.027	0.403	0.966	0.225	0.356	0.459
ALL	-1.623	0.550	-0.025	0.601	0.972	0.349	0.544	0.685

Prevalence is shown for three levels of SCS for parity 2, DIM 60-120, years 2002-2004, voluntary survey, herds ≤ 240 cows in a freestall/parlor system, and 30 kg milk/day ($\ln(p/(1-p)) = a + b_1 \text{SCS} + b_2 \text{SCS}^2$).

Key Words: Intramammary infection, Somatic cell score

23 An evaluation of DeLaval DCC for determining udder health status in dairy cattle. K. Leslie*, J. Yeung, R. Dingwell, A. Bashiri, N. Perkins, and E. Vernooy, *University of Guelph, Guelph, Ontario, Canada.*

The DeLaval Direct Cell Counter (DCC) is a rapid, portable test for the quantification of SCC in milk. This study was designed to compare the DeLaval DCC to traditional in-lab methods, and to determine its usefulness in early postpartum cows. Composite samples were obtained from 120 lactating cows. Samples were analyzed using three methods for SCC determination: Fossomatic 5000, Bentley SomaCount 300 and the DeLaval DCC. A subset of these samples was tested using the

DeLaval DCC both on-farm and in the laboratory. In addition, 42 cows on two farms were enrolled on the first scheduled visit to the farm after their calving (1 – 4 DIM). Three additional samplings were performed on each cow over the next two weeks. At the time of initial and subsequent sampling, a CMT test was performed, and a milk sample was aseptically collected from each quarter. The samples were transported to the University Lab for standard milk bacteriological culture, Bentley SomaCount SCC determination and the DeLaval DCC test. Results were recorded and analyzed using Microsoft Excel. Log SCC data was plotted for the DeLaval DCC instrument versus the Bentley SomaCount 300 and the Fossomatic 5000 electronic SCC instruments. There was extremely high correlation between DeLaval DCC and the standard laboratory SCC instruments, with a coefficient of correlation of 0.92 in both cases. A subset of 36 cow composite samples was evaluated with the DeLaval DCC instrument both on-farm and in the lab. There was reasonably good correlation ($R^2 = 0.87$), indicating that on-farm use of the DeLaval DCC instrument could work well. In addition, the mean and standard deviation of the DeLaval DCC and laboratory SCC data were compared to the CMT results from postpartum cows. Both the DeLaval DCC and Bentley SCC instruments were well correlated with the CMT results. The decline of log SCC as days postpartum increased is precipitous, and equivalent using both instruments. These data suggest that the DeLaval DCC instrument could be used as a monitoring tool for udder health in the postpartum period, and for lactating cows in general.

Key Words: SCC, CMT, Rapid test

24 Effect of winter housing on cow dirt score, somatic cell score and mastitis incidence in dairy cows. K. O’Driscoll^{1,2}, L. Boyle¹, P. French¹, B. Meaney¹, and A. Hanlon², ¹*Dairy Production Research Centre, Teagasc, Moorepark, Fermoy, Co. Cork, Ireland*, ²*School of Agriculture, Food Science and Veterinary Medicine, NUI Dublin, Belfield, Dublin 4, Ireland*.

The aim of this study was to evaluate three overwinter housing options for spring calving dairy cows; indoor cubicles [IC], uncovered woodchip pad [UP] (12m²/cow) and sheltered woodchip pad [SP] (6m²/cow), with regard to cow dirt score, incidence of mastitis, and somatic cell score (SCS). Animals (n=147) were randomly assigned to the housing treatments from 6 Dec until calving (median = 14 Feb), and scored for dirtiness (1 to 5 in half score increments) prior to housing, then every 14 days until calving. Cows were quarter milk sampled (QMS) for microbiology and somatic cell count (SCC) prior to housing, at drying off and approx. 3 weeks post partum. QMS were also collected 2.2 ± 1.98 days post calving and assayed for California Mastitis Test (CMT) and microbiology. Clinical mastitis (CM) was diagnosed when macroscopic changes in the milk or udder were observed. Subclinical mastitis (SCM) was diagnosed in the event of SCC > 500,000 or CMT > 2, without macroscopic changes. SCC was recorded at 2 week intervals throughout the following lactation. A log transformation of SCC to SCS was used to normalize the data distribution. Average SCS was calculated for three stages of lactation: 6 to 60 days in milk (DIM) (early), 61 to 220 DIM (mid), and 221 to 305 DIM (late). Dirt scores and SCS were analyzed using the Mixed Procedure of SAS. Differences in the incidence of CM, SCM, and the incidence of pathogens detected in QMS were analyzed using Fishers exact probability test. Housing had an effect on animal dirtiness, with SP cows dirtiest, then UP, and IC cleanest ($P < 0.001$). There were no cases of CM prior to housing, at dry off or during the housing period, and no difference in incidence of SCM. Three weeks post calving combined incidence of CM and SCM was higher in SP than UP or IC

($P < 0.05$), and a higher number of cows from SP had an infectious agent isolated ($P < 0.05$). However there was no effect of treatment on SCS over the following lactation.

Key Words: Winter housing, Somatic cell count, Cow dirtiness

25 Intramammary infection affects incidence of clinical infection after infusion of *Streptococcus uberis*. K. M. Sanders¹, S. McDougall², L. R. McNaughton^{*1}, G. E. Stanley¹, D. L. Johnson¹, S. Harcourt¹, and R. J. Spelman¹, ¹*Livestock Improvement Corporation Ltd, Hamilton, Waikato, New Zealand*, ²*Animal Health Centre, Morrinsville, Waikato, New Zealand*.

Mastitis has a major impact on farm management and profitability in dairy production systems; therefore it is valuable to understand factors affecting susceptibility to infection. *Streptococcus uberis* is the most common pathogen causing clinical mastitis in New Zealand. The objective of this study was to identify factors contributing to clinical mastitis risk in the week after infusion in 263 F2 Friesian-Jersey cows. Animals were the daughters of 6 sires and averaged 109 days in milk at the time of infusion. Factors examined for their contribution to risk included sire, days in milk at infusion, SCC on the morning of infusion, mastitis treatment history, and the presence of any major pathogens at the time of infusion. 7-10 wks prior to infusion, milk samples were collected from all glands for bacteriology assessment, and antibiotic treatments were administered to clear infections. Treated glands were not selected for infusion. One gland from each cow was infused with an average of 104 colony-forming units (sd=22) of *Streptococcus uberis*. Milk samples were collected prior to infusion and at each milking post-infusion for 13 milkings, or until diagnosis of clinical mastitis. Logistic regression and survival analysis were used to determine risk factors. Overall, the cumulative incidence of clinical diagnosis was 71.9% (189/263) and the mean interval to clinical diagnosis was 66.2 (sd=36.5) hours. Sire had a significant ($P < 0.05$) effect on the incidence of clinical mastitis. Daughters of one sire had a significantly lower incidence of clinical mastitis. Results also showed that cows with a somatic cell count at infusion of ≥100,000 cells/ml had a lower incidence of clinical mastitis (18.3% vs. 81.5%; $P < 0.0001$). Infection status at infusion also had an effect on the incidence of clinical mastitis. The presence of *Staphylococcus aureus* at infusion for cows that had no pre-infusion mastitis treatment(s) resulted in a lower incidence of clinical mastitis (29.0% vs. 82.8%; $P < 0.0001$). Further research will be conducted to identify the causative mechanism behind the protective effect of infection at infusion.

Key Words: Mastitis, Lactation, *Staphylococcus aureus*

26 Antimicrobial susceptibility patterns and trends in resistance development in bacteria isolated from milk, 2000-2004. P. J. Rajala-Schultz^{*1} and B. C. Love², ¹*The Ohio State University, Columbus*, ²*Penn State University, University Park*.

Antimicrobial resistance has been a growing concern worldwide. The objective of this study was to evaluate whether susceptibility of mastitis pathogens has changed in recent years. Milk from dairy cattle, submitted to the Pennsylvania State University Animal Diagnostic Laboratory (PSU ADL) from 2000 through 2004, was cultured for bacterial pathogens. Minimum inhibitory concentrations (MIC) were determined for 2554 isolates, using a commercially-available broth microdilution method (Sensititre, Trek Diagnostics, Westlake, OH) and interpretations of sensitive, intermediate or resistant were assigned according to guidelines published by the Clinical and Laboratory

Standards Institute (CLSI). Isolates analyzed in this study included *Staphylococcus aureus* (N=242), coagulase negative staphylococci (N=367), *Streptococcus uberis* (N=393), *Streptococcus dysgalactiae* (N=304), *Escherichia coli* (N=299) and *Klebsiella pneumoniae* (N=261). Preliminary analyses indicate that a significant increase in resistance to beta-lactam-containing antimicrobials could be detected in streptococci, although not in staphylococci. Most of the antimicrobials included in the commercial mastitis panel have efficacy only against gram-positive organisms. Neither *E. coli* nor *K. pneumoniae* exhibited increasing resistance against ceftiofur or cephalothin over the years studied. It is generally accepted that antibiotics are beneficial in treatment of mastitis caused by gram-positive organisms. However, due to cost and the length of time required to identify the causative organism at a reference laboratory, and the potential of decreased efficacy if there is a delay in initiation of treatment, antibiotic treatment is frequently initiated without the knowledge about the causal agents. The increase in resistance to beta-lactam antibiotics seen in this study requires further study.

Key Words: Antimicrobial, Resistance, Mastitis

27 Neutrophil extracellular trap formation: An important neutrophil killing mechanism that is not inhibited by milk. J. Lippolis*, T. Reinhardt, J. Goff, and R. Horst, *National Animal Disease Center /ARS/USDA, Ames, IA.*

Neutrophils play a crucial role in protecting the mammary gland against bacterial infections. However, neutrophils incubated in milk have a decreased ability to kill bacteria in vitro and a decreased capacity to generate reactive oxygen species upon stimulation. Recently, a new neutrophil bacterial killing mechanism was described. When stimulated, human neutrophils release nuclear and granule material, and this extracellular material form webs that act as nets to trap and kill bacteria. We now show that bovine neutrophils form extracellular nets when stimulated by staining of extracellular DNA with Sytox-Orange and quantitated with a fluorescence plate reader. Furthermore, neutrophil extracellular traps can be formed even when neutrophils have been incubated for up to 6 hours (see Table). Extracellular nets formation in milk is not different from net formation in media. Stimulation of neutrophils with bacteria common to mammary gland infections (*S. aureus*, *S. marcescens* and two strains of *E. coli*) leads to the formation of the neutrophil extracellular nets in milk or culture media. In fact some bacteria (*E. faecalis*, *S. dysgalactiae* and one *E. coli*) were able to stimulate enhanced formation of extracellular traps in milk compared to culture media (student two-tailed T-test, $P < 0.05$). In contrast to other neutrophil functions that are inhibited by milk such as phagocytosis and oxidative burst, neutrophil extracellular traps may be an important innate immune mechanism in mammary infections because this ability remains intact in the milk environment.

Table 1. Effect on NET Formation of Pre-incubation of Neutrophils in Media or Milk

Environment	Time Prior to Stimulation (Hours)	Stimulation Index (Stimulated/Un-stimulated)
Milk	0	2.0
Media	0	2.4
Milk	1	2.4
Media	1	3.0
Milk	2	3.5
Media	2	3.5
Milk	4	3.4
Media	4	3.4
Milk	6	2.1
Media	6	3.1

Neutrophils from 12 cows were incubated in milk of media for various times, then stimulated (PMA+Ionomycin) or not in 6 replicates. Extracellular DNA was determined by SytoxOrange staining. No significant difference in NET formation was seen between Milk and Media (Repeated measures ANOVA with Time using Tukey's adjustment for multiple comparisons).

Key Words: Neutrophil, Milk, Antibacterial

28 Hepatic ApoB100 and ApoE mRNA in periparturient dairy cows. U. Bernabucci*¹, B. Ronchi¹, L. Basiricò¹, D. Pirazzi¹, F. Rueca², N. Lacetera¹, E. Lepri², and A. Nardone¹, ¹*DiPA, Università della Tuscia, Viterbo, Italy,* ²*Veterinary Medicine, Università di Perugia, Perugia, Italy.*

Previous research suggested that decreased mRNA for apolipoprotein-B100 (ApoB100) in transition cows may be consistent with decreased synthesis and/or secretion of very low density lipoproteins from liver during the periparturient period. The aim of the present study was to evaluate changes of hepatic ApoB100 and apolipoprotein-E (ApoE) mRNA in periparturient cows, and to evaluate possible relationship between apolipoproteins gene expression and liver status. Sixteen multiparous Holstein cows were monitored during the transition period. From -32 to 38 d relative to calving, body condition score (BCS) was registered, and plasma indices of energy metabolism (glucose, BHBA and NEFA) were determined to evaluate metabolic status. Liver biopsies were performed on d -32, 3, and 38 relative to calving. Gene expression of ApoB100 and ApoE was determined on liver tissue by Ribonuclease Protection Assay method; triglycerides (TG) accumulation in the liver was determined by histochemical method. After calving, BCS and plasma glucose decreased ($P < 0.01$), and plasma NEFA and BHBA increased ($P < 0.01$). Compared with values of day -32, synthesis of the ApoB100 mRNA was lower ($P < 0.05$) on 3 and 38 d after calving, whereas that of ApoE mRNA was higher ($P < 0.05$) on d 3 after calving. At 3 d after calving, positive relationships between plasma NEFA ($r=0.42$, $P < 0.01$) or BHBA ($r=0.49$, $P < 0.01$) with liver TG accumulation and negative relationship ($r=-0.29$, $P < 0.05$) between plasma glucose and TG accumulation were detected. In addition, at 3 d after calving negative ($r=-0.59$, $P < 0.01$) correlation between liver TG and ApoB100 mRNA abundance was observed. No relationship between ApoE and liver TG accumulation on d 3 after calving was observed. The study indicates that the accumulation of liver TG, occurring in dairy cows after calving, is associated with down-regulation of ApoB100 expression.

Key Words: ApoB100 ApoE mRNA, Liver, Dairy cow

29 Effect of isoflupredone acetate with or without long acting insulin on postparturient energy metabolism in lactating dairy cows. H. Seifi¹, S. LeBlanc², K. Leslie^{*2}, and T. Duffield², ¹*School of Veterinary Medicine, Ferdowsi University of Mashhad, Iran,* ²*Ontario Veterinary College, University of Guelph, Canada.*

Glucocorticoids are commonly used to treat cows with clinical ketosis and fatty liver disease. This study investigated the effects of isoflupredone acetate (IA), alone or with long-acting insulin, on the energy metabolism of early postpartum dairy cows. A total of 1162 Holstein cows and first lactation heifers received, by double blind random assignment, one of three treatment regimens between the day of calving and 8 DIM. The treatments were: 20 mg IA IM plus 100 units of insulin SC; 20 mg IA IM plus sterile water SC; 10 ml sterile water IM plus 1 ml sterile water SC (controls). Serum samples obtained at the time of treatment, and at weeks 1 and 2 following treatment, were analyzed for β -hydroxybutyrate (BHBA), non-esterified fatty acids (NEFA), glucose, calcium, potassium, sodium and chloride. Data were analyzed using a repeated measures mixed model that accounted for the effects of parity, BCS, and the random effects of cow and farm. BHBA and NEFA concentrations at 1 week following treatment were significantly higher ($P < 0.02$) in both treatment groups compared to control cows. In addition, cows that received IA plus insulin had lower glucose ($P < 0.01$) concentrations at 1 week after treatment. Calcium concentrations were significantly lower ($P < 0.01$) for cows treated with IA plus insulin, and IA alone, in week 1. Sodium, potassium and chloride concentrations were not influenced by treatment. Among 190 cows that were ketotic before treatment, neither treatment improved resolution of subclinical ketosis (SCK; ³ 1400 $\mu\text{mol/l}$) relative to control animals. In fact, cows receiving both IA and insulin tended (OR=2.0, $P = 0.06$) to be more likely than controls to remain ketotic at 1 Week after treatment. Among 972 cows that were not ketotic at enrollment, cows that received IA plus insulin, or IA alone, were 1.7 and 1.6 times more likely, respectively, to develop SCK 1 week after treatment. The results of this study indicate that IA plus insulin, or IA alone, was not effective for either the prevention or alleviation of subclinical ketosis in postpartum dairy cows.

Key Words: Subclinical ketosis, Therapy, Prevention

30 Use of rectal temperature monitoring to identify post-partum metritis in dairy cattle. J. R. Wenz^{*}, S. M. Scott, S. E. Dobberstein, and W. Wailes, *Colorado State University, Fort Collins.*

Rectal temperature monitoring (RTM) for the first 10 DIM has been advocated as a management tool to identify cows with post-partum disease, especially metritis. The objective of this study was to comparing the ability of this time consuming practice (RTM) with visual observation to identify cattle with metritis. Rectal temperature and milk production were recorded for the first 10 and 30 DIM respectively of 208 Holstein cows. Cows with temperatures $>103.0^{\circ}\text{F}$ (FEVER) were further examined for metritis (MET). MET diagnosed by dairy staff using visual observation (VO), calving ease, 5-25 DIM production (5-25dMLK) and first service conception rate (CR1) were also recorded. During their first 10 DIM, 40% of cows had FEVER. Of cows with FEVER, 41% had MET. More cows were diagnosed with MET by RTM (16%) than by VO (5.8%) ($P=0.0014$). More cows

with dystocia (49%) had FEVER vs. those without (35%) ($P = 0.047$). More cows had FEVER DIM 1-5 (22%) vs. DIM 6-10 (5.8%) ($P = 0.0001$) and only 2 of the 12 cows with FEVER during DIM 6-10 had MET. Cows with MET diagnosed by RTM made 304lbs less 5-25dMLK than those without MET ($P = 0.0476$), however, there was no difference in CR1 between the two groups. Percent cows with FEVER peaked on DIM3 (14%) and DIM4 (23%) for cows without and with dystocia, respectively. There was no difference in FEVER during DIM1-3 between cows with or without dystocia and many cows with FEVER during this time had MET. Twenty-nine % of cows had one consecutive day with FEVER and 23% of those cows had MET while 13% of cows had 2 or more consecutive days with FEVER and 70% of those cows had MET. These results suggest many cows with FEVER identified by RTM have MET and reduced milk production. Rectal temperature monitoring was more effective than visual observation for detection of metritis and may significantly improve the health and productivity of post-partum dairy cows.

Key Words: Fever, Metritis, Fresh cow

31 Rectal temperature measurement versus peripheral temperature sensing using radio-frequency implants in periparturient dairy cattle. E. D. Reid^{*}, K. E. Karvetski, J. M. Velasco, R. L. Wallace, and G. E. Dahl, *University of Illinois, Urbana.*

The periparturient cow is challenged by changing metabolic processes driven by parturition and the ensuing lactation. These challenges leave the animal more susceptible to both metabolic and pathogenic insults. The ability to detect disease earlier may result in faster treatment times and be associated with higher treatment success. Injectable radio frequency implants (RFI) with the ability to remotely monitor temperature at the site of implantation are available. Temperatures recorded from these RFI exhibit a positive correlation with baseline rectal temperatures and a negative correlation to rectal temperature when cattle are challenged with lipopolysaccharide. We hypothesized that the RFIs, implanted under the scutiform cartilage of the ear of periparturient cows, would be positively correlated to baseline rectal temperature and would be negatively correlated to rectal temperature during a known health event. We also hypothesized that increased temperature sampling would allow for quicker identification of disease in these periparturient cows relative to traditional methods. Multiparous dairy cattle ($n=40$) were implanted with an RFI one wk prior to dry off. Rectal and RFI temperatures (RT and RFIT) were recorded every 12 h until -7 d before expected calving date when sampling frequency increased to every 6 hours until 14 d after calving. Ambient temperature (AMB) was also logged at 30 min intervals and was included in the statistical model. Mean RT ($^{\circ}\text{C}$) varied throughout the day (39.7 ± 0.2 , 39.3 ± 0.1 , 38.7 ± 0.2 , 39.9 ± 0.1) for 03:00, 09:00, 15:00 and 21:00 respectively. Mean RFIT also varied (37.7 ± 0.2 , 37.5 ± 0.2 , 37.6 ± 0.2 , 38.1 ± 0.2) for the same time points. RFIT were positively correlated with RT ($r=0.46$, $P < 0.001$) and AMB was positively correlated with both RT and RFIT $r=0.41$ and 0.55 , $P < 0.001$ respectively). A negative correlation between RFIT and RT during diagnosed health events ($n=11$ total; 4 metabolic, 7 reproductive) was not consistently observed therefore this approach has limited value in early disease detection.

Key Words: RFID, Temperature

Breeding and Genetics: Statistical Breeding

32 A computer program for detecting additive, dominance, imprinting, sex-influenced and the overall QTL effects. Y. Duan, J. Garbe, N. London, and Y. Da*, *University of Minnesota, St. Paul.*

A computer program was developed to test the overall QTL effect and individual QTL effects including additive, dominance, imprinting, and sex-influenced QTL effect under the F-2 design. The least-squares analysis is used to implement the statistical test for each type of QTL effect. Bi-allelic and multi-allelic markers are allowed, and the program can accommodate an arbitrary number of fixed non-genetic factors. The computer program requires three input files, marker genotypes, phenotypes and pedigree, and a parameter file. Two output files are produced. The first output file prints significant individual QTL effects (additive, dominance, imprinting, and sex-influenced) at a user specified significance level. This file also prints test results of the overall QTL effect, which generally is more significant than any individual QTL effect. The second output file prints significant overall QTL effects at a user specified significance level and also prints test results of each individual QTL effect, which generally is less significant than the overall QTL effect. By default, QTL effects with “suggestive linkage” or “significant linkage” are printed in the output files. The computer program was applied to analyze swine QTL mapping data under an F-2 design.

Key Words: QTL, Computer program, Mapping

33 A mixed model approach to map QTL controlling complex binary disease traits and interacting with environments. Y. Li and H. N. Kadarmideen*, *Statistical Animal Genetics Group, Swiss Federal Institute of Technology, ETH Zentrum, Zürich, Switzerland.*

A statistical method using generalized mixed model which fitted QTL effects as random was proposed for mapping quantitative trait locus (QTL) affecting binary traits (e.g. disease) and showing QTL-by-environment interactions (QEI) in multi-family half-sib designs. Estimates of QTL variance and location and power were compared between two random models (I and II) using simulated datasets. Binary dataset was generated from twenty paternal half-sib families each with 200 progeny. The QTL was assumed to be interacting with environment, having different QTL substitution effects among five environments. Phenotypic values of offspring were first generated on the liability scale as a sum of population mean, polygenic effects of sire, environmental effect, the substitution effect of sire QTL allele, interactions (QEI) and residuals. The liability values were transformed into observable 0-1 binary (non-diseased vs diseased) phenotypes using a threshold value corresponding to disease incidence of 50%. The statistical model I did not fit QEI but only random common parent (sire) QTL effect. Model II fitted QTL substitution effects and their interactions with environment (QEI) as random effects. Environmental effects in both models were fitted as fixed effects. QTL variance component in the random model was directly estimated using a restricted maximum likelihood approach. The power of detecting the QTL was 5.5% and 89% in Model I and Model II, respectively. The variance estimate was 0.008 with Model I and 0.050 with Model II. It is concluded that when QEI are present in a population, the model which did not consider QEI was unable to detect the QTL whereas the model which considered QEI significantly improved power and variance estimates. This is the first study to map and estimate breeding

values at the QTL which differ across environments in half-sib populations using generalized mixed models and hence would be useful in environment-specific marker assisted genetic evaluation and selection.

Key Words: QTL mapping, QTL-by-environmental interaction, Generalized mixed model

34 A comparison of sire and animal model genetic parameter estimates from herds with high and low within-herd heritabilities. C. D. Dechow*¹ and H. D. Norman², ¹*The Pennsylvania State University, University Park,* ²*Animal Improvement Programs Laboratory, Beltsville, MD.*

The objectives of this study were to determine if within-herd heritability (WHH) estimated with regression techniques accurately reflects heritability (h^2) differences among herds and to compare sire and animal model genetic parameter estimates among herds varying in WHH. Milk, fat, and protein yield and somatic cell score (SCS) were obtained from states representing the Northeast, Southeast, Midwest and Western regions of the United States. Four random subsets of data were selected across regions. Within-herd heritabilities were estimated with daughter-dam regression (h^2_{DD}) and daughter-sire predicted transmitting ability (PTA) regression (h^2_{DS}) in ASReml with a model that included fixed effects of herd-year-season of calving, age, dam yield, and sire PTA. Dam yield and sire PTA were also treated as random covariables nested within herd to create h^2_{DD} and h^2_{DS} that were regressed toward the subset average. Herds were ranked from lowest to highest WHH for each trait and average WHH rank was calculated. Fifty herds with the highest and lowest average WHH were retained for further analysis in each subset. Milk, fat, protein and SCS were each considered two separate traits (one in the high, another in the low h^2 herds) and analyzed with two trait sire and animal models in ASReml. Fixed effects included herd-year-season of calving, age and lactation number. Random effects included animal, permanent environment and error. Sire and animal model h^2 estimates were greater in herds with high h^2 for all traits. Average h^2_{DD} across subsets for milk yield was 0.41 for high h^2 herds and 0.29 for low h^2 herds, while average milk yield h^2_{DS} were 0.35 and 0.13 from high and low h^2 herds, respectively. Sire model h^2 estimates were more highly correlated with h^2_{DS} (0.93) than with h^2_{DD} (0.85). Animal model h^2 estimates were more highly correlated with h^2_{DD} (0.91) than with h^2_{DS} (0.72). There are significant differences among herds for h^2 and it appears WHH estimated with daughter-dam and daughter-sire PTA regression reflect those differences with some accuracy.

Key Words: Within herd heritability, Daughter-dam, Daughter-sire

35 Modeling extended lactations in Holsteins. C. M. B. Dematawewa*¹, R. E. Pearson¹, and P. M. VanRaden², ¹*Virginia Polytechnic Institute and State University, Blacksburg,* ²*Animal Improvement Programs Laboratory, Agricultural Research Services, USDA, Beltsville, MD.*

The objective of this study was to develop an equation for predicting average yield of cows still in milk from 1 to 999 days. Test day yields (kg/d) of 903,529 lactations of 305,202 Holstein cows calved between 1997 and 2003 were used. Average daily yield (Y) for each 30–d

interval of lactation was calculated for each parity (9 parities), based on cows which were in milk during the month considered. Various lactation models available in literature (i.e. Wood's model and other variants of incomplete Gamma function, inverse polynomials and, mono-, di-, and multi-phasic curves) were tested, before and after a modification made by including a new additive parameter (**k**). Nonlinear regression procedures in SAS were carried out between Y (34 30-d means) and respective days in milk (**DIM**), within and across parities. R-squared value, mean square error, Bayesian information criteria, and autocorrelation of errors were considered as the model selection criteria. Standard models underestimated yields at later stages of lactation for all parities until modified to include the new parameter. The modified Dijkstra model (i.e. $Y = k + a[\exp(b(1 - \exp(-c \times DIM)) / c - d \times DIM)]$) fitted best (R squared = 0.99), both within and across parities, with the lowest estimates of mean square error and Bayesian information criteria (BIC=59.6). The parameter estimates for a, b, c, d, and k were 12.9088, 0.0183, 0.00806, and 0.00925, and 20.1303, respectively for across parities. Durbin-Watson statistic showed that the first order autocorrelations of errors were negligible for the above model for both within and across parities (DW=1.412, N=34). The modified mono-phasic curve (i.e. $Y = k + ab[1 - \tanh^2(b(DIM - c))]$) provided the second best fit for both within and across parities. These results show that modified Dijkstra formula stated above can be effective in modeling the mean yield of cows remaining in milk through lactations well beyond 305 days.

Key Words: Modeling, Lactation curve, Holsteins

36 Improving stability and reliability of test day model evaluation in the Italian Holstein. F. Canavesi*, S. Biffani, and F. Biscarini, *Associazione Nazionale Allevatori Frisone Italiana, Cremona, Italy.*

In November 2004 the first Italian genetic evaluation based on Test Day Random Regression Model (TDRRM) was published. The new model assumes that different genetic values can be expressed during the lactation and also across lactations. The published proof is a combination of the first three lactations. Along with the combined proof also breeding values for each lactation are published as well as the persistency Transmitting Ability in the three lactations and for each lactation. The advantage of the Test Day model is that it does not only provide farmers with the expected production superiority of the daughters of a particular bull but also with a description of the way the daughters of that bull behave in expressing their superiority during each lactation and across the first three lactations. Farmers can now choose the bulls that better match their herd management. The overall variability of such a complex system is larger than the variability observed with the former repeatability model based on lactation records. In order to improve the stability of the proofs, an extensive research program has been set up to investigate the scale of expression of the proofs and the definition of the fixed effects to be included in the model. In February 2006 few changes were introduced: the scale of expression of proofs was defined by the standard deviation of third parity cows in the genetic base population. The genetic base population is now defined by cows born in the triennium 1997-1999 and it is a rolling base that will be updated each year in the August evaluation. These changes improved stability over time by 15-20%. Differences across years of production and days open classes, that are not yet accounted for in the genetic evaluation model, were also investigated. Changes in the structure of fixed effects will be introduced in the August evaluation and this will further increase the stability and reliability of the genetic evaluation system.

Key Words: Proof stability, Test day model, Random regression

37 Use of phenotypic information to ascertain paternity. R. L. Sapp*, R. Rekaya, W. Zhang, and J. K. Bertrand, *The University of Georgia, Athens.*

A new method of implementing mixed model equations without constructing the inverse of the relationship matrix (WO-A) was developed and compared to the classical best linear unbiased prediction implementation where the inverse of the relationship matrix was constructed (W-A). Both methods were compared in a univariate case, the Pearson correlation between estimates of WO-A and W-A was 1.00 for fixed and random effects. Similarly, parameter estimates were exactly the same using W-A and WO-A for three correlated traits. These results indicate that W-A could be implemented without the need to construct or to invert the relationship matrix. The proposed method should not be considered as an alternative to the classical implementation except in situations where memory is a limiting factor, for iteration on data or in genetic evaluation with uncertain paternity. For the latter, the proposed method is, perhaps, the only viable procedure. The second objective was to investigate the implementation of a genetic evaluation using WO-A in presence of uncertain paternity. The scenarios investigated included either one or two records of a single trait with varying heritability and one record of three correlated traits. The average probability of the true sire being identified as such (PSA) was computed for all scenarios. As expected, PSA increased with increasing heritability using one trait. However, the results of the current study suggested that the probability of identifying the true sire was the highest when three correlated traits were used to compute PSA and the lowest when only one record was used. For traits such as birth weight and weaning weight where only one measurement is taken, the multiple-trait scenario could result in more animals being assigned the true sire than if birth or weaning weight was used separately. Further research is needed to determine the performance of this methodology in field data as well as the potential implementation of this methodology in conjunction with molecular information.

Key Words: Genetic evaluation, Uncertain paternity

38 Ascertaining paternity using phenotypic and molecular information. R. L. Sapp*, R. Rekaya, and J. K. Bertrand, *The University of Georgia, Athens.*

The objective of the current study was to evaluate the effectiveness of paternity assignments for 15 markers prior to and after inclusion of phenotypic information. Fifteen markers with the number of alleles per marker ranging from 3 to 7 were simulated for every animal in the pedigree file. A linear mixed model which included a fixed effect and random effects of additive breeding values and residual terms was used to generate and analyze data for three correlated traits. The marker information was used to assign paternity to all animals in the pedigree file, regardless of paternity status, assuming the mother's genotype was unknown. A paternity index (PI) was calculated for each of the 15 markers using the candidate sire (CS) and offspring's genotypes. The probability of paternity (W) was computed using the product of PI for the 15 markers. For animals with uncertain paternity, PI and W were calculated for each CS. The molecular information, on average, resolved 94% of the uncertain paternity cases. For the remaining 6% of animals with uncertain paternity, more than one CS was not excluded based on the marker information. The standardized probability of paternity for each non-excluded CS was used as prior information together with the phenotypic information to discriminate between those non-excluded sires. For the true sires of animals with more

than one non-excluded CS, the prior probability based on marker information was 0.58. Likewise, the prior probability for non-true CS was approximately 0.42. When combined with the phenotypic information, the posterior probability of paternity for the true sires increased to nearly 0.80. Thus, the true sire was correctly assigned 80% of the time when molecular information was not able to unambiguously assign paternity. The results of the current study indicated that when molecular information was available, but not able to determine paternity, phenotypic information could be used to ascertain paternity. Moreover, the method proposed in the current study was able to increase the probability of assigning the true sire using the molecular and phenotypic information.

Key Words: Paternity index, Paternity testing

39 The combination of genetic test information and phenotypic records for the prediction of breeding values. M. L. Spangler*, R. Rekaya, and J. K. Bertrand, *The University of Georgia, Athens.*

The use of marker assisted selection in the beef cattle industry to date has been comprised of using traditional EPDs in tandem with molecular test information. The combination of these two sources of information into one quantitative genetic value has clear advantages to livestock producers and genetic testing companies. The instances where molecular information is of the most benefit are those in which the trait of interest is difficult or expensive to measure or the heritability is low. In the current study a multiple trait simulation was carried out to create a beef cattle data set using genetic parameter estimates from the literature in order to identify the best procedure for combining both sources of information and to assess the added benefit of the procedure. To reach these objectives the following simulation/analysis steps were implemented: 1) all phenotypic records are observed without knowledge of a causal gene (A1) 2) all animals in the data file have phenotypic records for the trait of interest and molecular information is available on all animals in the pedigree (A2) and 3) varying percentages of missing records for the trait of interest and complete molecular information (A3). In the latest scenario the percentage of missing records for marbling score was kept very high in order to mimic real production systems. The data set for A3 included six correlated traits with complete records for five traits and only 5% of the records were observed for marbling score for which molecular information was available for a causative gene that explained 10% of the genetic variation. The preliminary results showed a better prediction of the true breeding values of the top 10% of sires (candidates for selection) using A3 compared to the case where genomic information was not considered. In fact, the rank correlation was increased by more than 21%. This study is currently being extended to situations with varying allelic frequencies for the causative gene and the genetic progress over several generations of selection is being assessed.

Key Words: Beef cattle, Best linear unbiased prediction, Gene-assisted selection

40 Genetic evaluations for mixed breed populations. P. M. VanRaden*, M. E. Tooker, J. B. Cole, G. R. Wiggans, and J. H. Megonigal, Jr., *Animal Improvement Programs Laboratory, USDA, Beltsville, MD.*

New programs to include data from crossbred animals were tested for genetic evaluation of US dairy cattle. An all-breed animal model including an adjustment for general heterosis was applied to usable

records back to 1960. Yield records were adjusted to 36 months of age instead of mature equivalent. Total numbers of cows with records were >20 million for yield traits, for productive life (PL), and for daughter pregnancy rate (DPR), and >10 million for somatic cell score (SCS). About 1% of recent cows are first generation (F1) crossbreds, and the percentage is growing. Unknown parent groups were separate by breed, pedigree path (dams of cows, sires of cows, and parents of sires), US or foreign origin, and birth year. Groups were formed when they included at least 500 animals within time periods and at least 2000 animals across all years. Heterogeneous variance adjustments were estimated separately within herd, year, and sire breed. Convergence of the animal model was fairly rapid, indicating sufficient connections among the breeds and crossbred groups. Genetic differences among breeds were similar to previous estimates, and genetic rankings were very highly correlated with previous within-breed evaluations. Correlations for high reliability bulls exceeded .999 for Holsteins and exceeded .98 within other breeds. Changes were largest in the smallest breeds. Predicted transmitting abilities (PTA) changed more for bulls with fewer daughters, and for cows. Additional group-mates of another breed can add accuracy but also could cause bias if managed differently or not modeled properly. Evaluations of crossbred animals are more accurate in all-breed than within-breed analyses because the relationship matrix can link to reliable sire PTA for breeds in both the maternal and paternal ancestry. Joint evaluation of all breeds and crossbred animals does not greatly change rankings for animals with mostly purebred group-mates and relatives, but provides routine calculation of breed differences. Evaluations may be converted back to original within-breed bases for display to the public.

Key Words: Genetic evaluations, Heterosis, Crossbreeding

41 A new statistical model and method of multiple breeds evaluation. L. Zhang*^{1,2}, E. J. Pollak², and R. L. Quaas², ¹*Inner Mongolia Agricultural University, Huhhot, China,* ²*Cornell University, Ithaca, NY.*

Crossbreeding and multiple breed genetic evaluations of beef cattle have triggered an urgent need for a reasonable and effective model to analyze simultaneously the mixture of multi-genome for crossbreeding and mixture of the multi-population for multi breeds to facilitate the estimation of the breeding values for both of the mixtures. Since the different breeds differ from each other in genetic background and belong to different population, it is reasonable to assume the existence of a probability distribution of for each breed. The mixtures of the gene pool and the populations taken from all breeds will have a new probability distribution which is a mixture of distributions of every breed. So, the model of multiple breed evaluation should be a new normal distribution in which the mixture of multiple normal distributions, multiple traits with common known/unknown covariance matrices, and different means within 3 standard deviations from common mean, when the proportions of the distributions of every breed were known a priori. By this definition, all the available linear models and algorithms are still worked without any new difficulties or limitations involved. In this mixture linear model, the effects of the breed and the combination of crossbreed were included in the fixed effects; the effects of genomic mixture among different breeds belong to random effects. When the coordinates represent measurements that are subject to random fluctuations of differing magnitudes, it is often desirable to weight coordinates subject to a great deal of variability less heavily than those that are not highly variable. A statistical distance that accounts for differences in variation and, in the presence of correlation

was developed. The statistical distances among the breeds, populations and individuals are the genetic or breeding differences which can be used to multiple breeds genetic evaluations.

Key Words: Mixture distribution, Statistical distance, Multiple breed

42 Use of Principal Components and Factor Analysis to factorize genetic correlation matrices of multivariate phenotypes. N. P. Macciotta*, N. Bacciu, C. Dimauro, and A. Cappio-Borlino, *Dipartimento di Scienze Zootecniche, Università di Sassari, Sassari, Italia.*

Principal Component Analysis (PCA) has been used by several authors to address issues of genetic analysis of multivariate complex phenotypes, i.e. large number of parameters to be estimated, computational constraints and sampling error. PCA is able to describe the maximum amount of original variation with the minimum number of orthogonal new variables. However, it is scarcely flexible and results are not always easy to interpret. In order to cope with these shortcomings, the multivariate Factor Analysis (FA) could be proposed. FA, via the rotation technique, is able to extract latent variables with defined

relationships with original variables. In the present work the ability of PCA and FA to factorize genetic correlation matrices (published data) of milk yield, logSCC for dairy cattle and weights at different ages for beef cattle is compared. The PCA yields a first component related to all original variables, able to explain most of the original variance (82%, 50%, 82% for milk yield, logSCC and body weight, respectively). Other principal components highlight the contribution of specific original variables to the total variance in decreasing order. On the other hand, FA extracts common latent factors related to specific groups of variables and that have a clear biological meaning: in the case of milk yield, for example, the first latent common factor is able to explain 55% of the original variance, it is related to the milk tests of the second part of lactation and can be considered as an index of lactation persistency; the second factor (42% of explained variance) is related with tests of the first part of lactation and can be considered as an index of level of production in early lactation. Similar results are obtained for body weights and, even if less defined, for logSCC. Results of the present work suggest that a combined use of PCA and FA could be usefully for a deep understanding of latent structure of correlations in multivariate complex phenotypes.

Key Words: Multivariate phenotypes, Principal component analysis, Factor analysis

Food Safety: Ruminants as Reservoirs for Shiga Toxin-Producing *Escherichia coli*

43 Shiga toxin-producing *Escherichia coli*: The big picture. C. L. Gyles*, *University of Guelph, Guelph, Ontario, Canada.*

Shiga toxin-producing *Escherichia coli* (STEC) represent a diverse group of *E. coli* that have one thing in common, namely, the ability to produce Shiga toxin (Stx). STEC behave as normal flora in ruminants, which are a major reservoir. In humans, STEC can cause disease of varying severity. Serotyping is used as an initial basis for differentiating STEC, and virulence characteristics that are serotype-related have allowed the concept of sero-pathotype to be developed. Serotype O157:H7 is the serotype that is most frequently implicated in outbreaks of disease and in severe disease in North America and several other regions. This serotype has therefore been the subject of the most intense investigation both with respect to its relation to its reservoir host, ruminants, and its accidental host, humans. Other serotypes are also implicated in outbreaks and in severe disease. STEC pathogenesis involves two phases: colonization of the intestine, and production of toxin. Several approaches have been used in attempts to identify the bases for virulence of STEC. These have resulted in recognition of a large number of putative virulence factors, but only a small number are clearly significant contributors to virulence. Most of the highly pathogenic STEC have the ability to produce a characteristic attaching and effacing lesion in the intestine. This lesion is the result of a bacterial type III secretion system that injects certain effector proteins into the host intestinal epithelial cell. Profound changes in the architecture and metabolism of the host cell occur and contribute to the diarrhea that develops. The severe complications that develop in a certain percentage of affected humans are attributable to the Shiga toxin, which exists as two major types, Stx1 and Stx2. STEC may produce one or both of these types of Stx. Production of Stx2 is associated with disease of greater severity, but strains that produce Stx1 may also cause severe disease. The genes for Stx are encoded on temperate bacteriophages in

the chromosome of the bacteria and production and release of the toxin are highly dependent on induction of lysis of the phages.

Key Words: Serotype, Virulence, Shiga toxin

44 Prevalence and pathogenicity of Shiga toxin-producing *Escherichia coli* in beef cattle and their products. H. S. Hussein*, *University of Nevada, Reno.*

In the past 25 years, many human illness outbreaks have been traced worldwide to consumption of undercooked ground beef and other beef products contaminated with Shiga toxin-producing *Escherichia coli* (STEC). Because of the global nature of food supply, the safety concerns with beef will continue and the challenges facing the beef industry will increase. To be prepared to address these concerns and challenges, it is critical to assess the beef cattle role in human infection with STEC. Because most STEC outbreaks in the US were traced to beef containing *E. coli* O157:H7, the epidemiological studies have focused on prevalence of this serotype in beef cattle. Worldwide, however, additional STEC serotypes (e.g., members of the O26, O91, O103, O111, O118, O145, and O166 serogroups) have been isolated from beef and caused human illnesses ranging from bloody diarrhea and hemorrhagic colitis to the life-threatening hemolytic uremic syndrome (HUS). To provide a global assessment of the STEC problem, published reports on beef and beef cattle in the past three decades were evaluated. Prevalence rates of *E. coli* O157 ranged from 0.1 to 54.2% in ground beef, from 0.1 to 4.4% in sausage, from 1.1 to 36.0% in various retail cuts, and from 0.01 to 43.4% in whole carcasses. The corresponding prevalence rates of non-O157 STEC were 2.4 to 30.0%, 17.0 to 49.2%, 11.4 to 49.6%, and 1.7 to 58.0%, respectively. Of the 161 STEC serotypes isolated from beef products, 43 were detected in HUS patients and 36 are known to cause other human illnesses. With

regard to beef cattle, prevalence rates of *E. coli* O157 ranged from 0.3 to 19.7% in the feedlot and from 0.7 to 27.3% on pasture. The corresponding prevalence rates of non-O157 STEC were 4.6 to 55.9% and 4.7 to 44.8%, respectively. Of the 350 STEC serotypes isolated from cattle feces or hides, 63 were detected in HUS patients and 61 are known to cause other human illnesses. The results indicated prevalence of a large number of pathogenic STEC in beef cattle and their products at high rates and emphasized the critical need for control measures to assure beef safety.

Key Words: Food safety, *Escherichia coli*, Beef cattle

45 Pre-harvest control of *Escherichia coli* O157. J. T. LeJeune* and A. N. Wetzel, *The Ohio State University, Wooster.*

Bovine manure is an important source of *Escherichia coli* O157 contamination of the environment and foods; therefore, effective interventions targeted at reducing the prevalence and magnitude of fecal *E. coli* O157 excretion by live cattle (pre-harvest) is desired. Pre-harvest intervention methods can be grouped into three approaches: (1) exposure reduction strategies; (2) exclusion strategies; and (3) direct anti-pathogen strategies. Exposure reduction involves environmental

management targeted at reducing bovine exposure to *E. coli* O157 through biosecurity and environmental niche management such as feed and drinking water hygiene, reduced exposure to insects or wildlife, and the condition of the bedding, or pen floor. In the category of exclusion, we group vaccination and dietary modifications such as, selection of specific feed components, in-feed delivery of prebiotics, probiotics, and competitive exclusion cultures-all strategies that would theoretically limit the proliferation of *E. coli* O157 in or on the live animal following exposure. Direct anti-pathogen strategies are those that are intended to be bacteriocidal to *E. coli* O157 in or on cattle. This includes treatment with chemicals (sodium chlorate, antibiotics), bacteriophages, or physical washing of animals pre-slaughter. Presently, only one pre-harvest control for *E. coli* O157 in cattle has been demonstrated repeatedly to be effective and gained widespread adoption (the feeding probiotic *Lactobacillus acidophilus*). Progress is being made in the direction of pre-harvest control strategies in cattle. More research into the effectiveness of parallel and simultaneous application of one or more pre-harvest control strategies, as well as the identification of new pre-harvest control techniques, may provide practical means to substantially reduce the incidence of human *E. coli* O157-related illnesses by intervening at the farm level.

Key Words: *E. coli* O157, Pre-harvest, Food safety

Forages and Pastures: Quality and Antiquity

46 The biochemistry of tannins: Role in ruminant production. J. Foster*, *USDA, ARS, Appalachian Farming Systems Research Center, Beaver, WV.*

Tannins are high molecular weight, water-soluble polyphenols that form reversible complexes with proteins through pH-dependent hydrogen bonding and hydrophobic interactions. Hydrolyzable tannins (HT) contain a carbohydrate core esterified with gallic or hexahydroxydiphenic acid. Binding of HT to abomasal mucosal proteins causes lesions that result in diarrhea or constipation. Hydrolytic products of HT are absorbed from the small intestine, disrupt liver and kidney function, and may cause photosensitization and dehydration. Condensed tannins (CT) or proanthocyanidins are oligomers of flavan-3-ols or flavan-3,4-diols that are linked by C-4/C-8 or C-4/C-6 interflavan bonds. Variations in chemical reactions of CT arise from differences in monomeric constituents, interflavan bond type, polymer length and branching, molecular weight, and concentration. High concentrations of CT in ruminant diets result in formation of stable, insoluble complexes with digestive enzymes and proteins in feed, saliva, and microbial cells, decreasing feed intake and digestibility and increasing fecal N excretion. Complexation of metal ions by CT can result in microbial mineral deficiencies. Protection against the negative effects of CT is provided by proline-rich salivary proteins in some ruminants and can be achieved with polyethylene glycol supplements which disrupt tannin-protein complexes. At low concentrations, CT decrease proteolysis of dietary proteins, rumen ammonia production, and rumen bacterial biomass, and increase N flow to the abomasum and absorption of essential amino acids in the small intestine. Results include increased animal weight gain; improved fiber, meat, and milk production; and higher ovulation rate. Protein-CT complex formation also reduces rumen gas formation and prevents production of a stable foam in the rumen, alleviating bloat in ruminants consuming protein-rich diets. Anthelmintic properties of CT in ruminants are associated

with improved nutrient supply to the lower gastrointestinal (GI) tract. Positive effects of CT on GI nematode parasites include lower fecal egg counts, decreased worm burdens, and inhibition of egg hatch and larval development.

Key Words: Tannins, Nutrient utilization, Herbal anthelmintic

47 Polyphenols and mechanical maceration shift protein fractions in legume hays from rapidly to slowly degraded forms. J. H. Grabber*, *USDA-Agricultural Research Service, US Dairy Forage Research Center, Madison, WI.*

Rapid proteolysis of forage protein during rumen fermentation can impair protein use by dairy cattle. The severity of conditioning at harvest may influence protein degradability in forages, particularly if protein-binding polyphenols are present. In 2002 and 2003, first and second cuttings of alfalfa, red clover with o-diphenols and polyphenol oxidase, and three birdsfoot trefoil populations with low to high tannin levels were conventionally conditioned with rolls or macerated and then dried as hay. Forage protein was partitioned with buffer and detergent solutions into rapidly (AB1), moderately (B2), and slowly (B3) degraded and undegradable (C) fractions. Treatment differences noted below were significant at the 0.05 level. Averaged over years and harvests, crude protein averaged 222 g/kg for alfalfa and 207 g/kg for trefoils and clover. Protein in roll conditioned alfalfa was comprised of 440 g/kg of AB1, 451 g/kg of B2, 75 g/kg of B3, and 34 g/kg of C. The high tannin trefoil had 64 g/kg less AB1, 59 g/kg more B2, similar B3, and 7 g/kg more C than alfalfa. Red clover had 107 g/kg less AB1, 40 g/kg more B2, 68 g/kg more B3, and similar C compared to alfalfa. Shifting from roll conditioning to maceration decreased AB1 by an average of 115 g/kg in all forages. Maceration increased B2 by 53 g/kg in alfalfa, decreased B2 by 41 g/kg in red clover, and had no effect on B2 in high tannin trefoil. Maceration increased B3 by 63 g/kg in

alfalfa, 94 g/kg in high tannin trefoil, and 163 g/kg in red clover, and increased C by 15 g/kg in high tannin trefoil and 7 g/kg in red clover without altering C in alfalfa. The results indicate that polyphenols and maceration shifted protein fractions from rapid to slowly degraded forms. Maceration enhanced the action of polyphenols, shifting protein to the slowly degraded B3 and undegradable C fractions. The impact of these shifts on milk production and nitrogen utilization by dairy cattle will be evaluated using nutrition models.

Key Words: Hay protein fractions, Mechanical conditioning methods, Polyphenols

48 Lipolysis of red clover with differing polyphenol oxidase activities in batch culture. M. R. F. Lee^{*1}, L. J. Parfitt², and F. R. Minchin¹, ¹*Institute of Grassland and Environmental Research, Aberystwyth, Ceredigion, UK*, ²*Institute of Rural Studies, University of Wales, Aberystwyth, Ceredigion, UK*.

Polyphenol oxidase (PPO) oxidizes endogenous phenols to quinones, which react with nucleophilic sites of other compounds such as proteins. In red clover (*Trifolium pratense* L.), this complexing reaction has been shown to reduce both plant mediated proteolysis and lipolysis. This experiment investigated the role of red clover PPO on lipolysis in the presence and absence of rumen microorganisms. Triplicate macerated shoot samples of two red clover lines, a wild type with a basal level of PPO activity (High PPO) and a mutant with reduced PPO activity (Low PPO), were incubated in anaerobic buffer, with and without strained rumen liquor inoculum (I+ and I-), at 39°C, and sampled at six time (0, 1, 2, 4, 6 and 24 h). At each time point the samples were destructively harvested and lipolysis measured as percentage loss of membrane lipid. Lipolysis data was analysed using a general analysis of variance with repeated measurements (Genstat 8®). The table shows the reducing effect of PPO on lipolysis (High vs Low) but also the elevated level of lipolysis when micro-organisms are present (I+ vs I-). If the PPO effect was solely due to the deactivation of plant lipases this difference should be neutralized through the addition of microbial lipases. The retention of the PPO effect in the I+ treatments suggests that PPO exerts some form of protection on the membrane lipids in a manner similar to the complexing of protein. The lipid in forages is mainly in the form of polar membrane lipids, and polar lipid - phenol complexes could form due to the highly electrophilic nature of the PPO-produced quinones.

Table 1.

	High PPO		Low PPO		s.e.d.	Significance		
	I+	I-	I+	I-		PPO	I	PPO×I
Lipolysis (%) at 1h	10.6	6.6	37.4	8.5	2.97	*	*	NS
2h	16.7	8.9	37.5	17.2	5.10	*	*	NS
4h	36.0	14.6	44.6	21.9	3.68	*	***	NS
6h	35.0	23.8	57.5	25.6	6.43	*	**	NS
24h	71.5	28.3	82.4	41.9	5.94	*	***	NS

*P<0.05, **P<0.01, ***P<0.001

Key Words: Polyphenol oxidase, Lipolysis, Red clover

49 Physiological changes in heifers following grazing of toxic or non-toxic tall fescue. G. E. Aiken^{*1}, M. L. Looper², and B. H. Kirch¹, ¹*USDA-ARS, Forage-Animal Production Research Unit*, ²*USDA-ARS, Dale Bumpers Small Farms Research Center*.

Rectal temperature and serum prolactin in yearling heifers were monitored for 22-d following a grazing trial that compared BW gains between Kentucky-31 and MaxQ tall fescues (*Lolium arundinaceum*). Response variables were used to compare physiological changes between heifers removed from Kentucky-31, infected with the toxic endophyte (*Neotyphodium coenophialum*), and those removed from MaxQ (cv. Jessup infected with a non-toxic endophyte). Heifers were stratified by BW and pregnancy status into 4 groups of 6 heifers and groups were randomly assigned to pastures in a completely randomized design with 2 replications. Grazing was initiated on 1 March, 2005 and terminated on 21 June, 2005. At termination of grazing, the heifers were maintained as a single group, and grazed on a 0.4-ha pasture of bermudagrass (*Cynodon dactylon*) and offered free choice bermudagrass hay. Following termination of fescue grazing, rectal temperatures were determined and blood samples were collected at 0830 on d 1, 3, 6, 8, 10, 14, 16, 20, and 22. Carryover effects from the fescue treatments were evaluated using pasture as the experimental unit. Rectal temperature was not affected ($P > 0.10$) by pregnancy status, but there was a cubic ($P < 0.05$) relationship between rectal temperature and days on bermudagrass. Rectal temperatures on Kentucky-31 were maximum (39.8°C) in 6 d, but declined and stabilized at 39.2°C in 14 d. Prolactin had a cubic ($P < 0.001$) relationship with days on bermudagrass, but the trends differed ($P < 0.001$) between the two fescues. Prolactin was initially low (15.0 ng/mL) in Kentucky-31 heifers, but increased nonlinearly and stabilized at approximately 113.8 ng/mL in 10 d. Although prolactin tended ($P < 0.10$) to be highest for pregnant heifers stocked on MaxQ, prolactin for both groups on MaxQ were initially high (pregnant = 292.8 ng/mL; open = 280.3 ng/mL), but decreased nonlinearly and stabilized (pregnant = 160.1 ng/mL; open = 127.3 ng/mL) in 10 d. Results indicated that heat stress can be alleviated for pregnant and open heifers grazed on toxic tall fescue by removing them from fescue and providing non-toxic diets for 10 to 14 days.

Key Words: Beef cattle, Tall fescue, Fescue toxicosis

50 Differences in morphological and cell wall traits of alfalfa plants selected for divergent stem in vitro fiber digestibility. H. G. Jung^{*} and J. S. F. Lamb, *USDA-ARS, St. Paul, MN*.

This study compared alfalfa clones identified as either low or high rapid (16 h), or low or high potential (96 h) stem in vitro neutral detergent fiber digestibility (IVNDFD) for stem fiber, cell wall, and morphology traits. Five clones of each selection group were grown in replicated field plots at two locations. Primary spring growth and first summer regrowth was harvested in 2002 and 2003. Data were analyzed as a randomized complete block in a split-split plot design. Results were averaged across growth environments and harvests because interactions with alfalfa selection groups were non-significant. As expected, the high rapid clonal group was greater for 16-h IVNDFD than the corresponding low rapid clonal group. Similarly, the high potential clonal group was greater than the low potential clonal group for 96-h IVNDFD. Comparing the low and high rapid clonal groups, NDF and cell wall concentrations were lower for the high clonal group, but ADL and Klason lignin concentrations were only marginally different. Cell wall pectin concentration was greater in the high rapid clonal group (data not shown). In contrast, NDF and cell wall

concentrations were not different between the low and high potential clonal groups, but both ADL and Klason lignin were substantially lower for the high potential clonal group than the corresponding low clonal group. Stem lengths were longer for the low rapid and high potential clonal groups than their corresponding clonal groups, and all clonal groups had similar numbers of stem internodes. Mean internode lengths were greater for the low rapid and high potential clonal groups than their corresponding clonal groups. Our results indicate that rapid IVNDFD of alfalfa stems was associated with reduced cell wall concentration, increased cell wall pectin, and short internodes. High potential IVNDFD of alfalfa stems was a result of reduced cell wall lignification and long internodes.

Table 1. Morphology, cell wall traits, and IVNDFD of selected alfalfa clonal groups.

Trait	Low Rapid	High Rapid	Low Potential	High Potential
16-h IVNDFD, %	21.2d	22.3a	21.6b	21.4c
96-h IVNDFD, %	40.7c	42.2b	38.9d	42.8a
NDF, % DM	61.4a	58.6c	60.5b	60.5b
ADL, % NDF	16.1b	16.2b	16.8a	15.3c
Cell wall, % DM	68.8a	66.7c	68.2b	68.4ab
Klason lignin, % CW	21.4b	21.2c	22.8a	20.8d
Stem length, cm	52a	49b	46c	50b
Internodes	11.5	11.8	11.7	11.6
Internode length, mm	4.6a	4.2c	4.0d	4.4b

Trait means not sharing a common letter were different ($P < 0.05$).

Key Words: Alfalfa, Fiber, Digestibility

51 Length of the daylight period before cutting improves rumen fermentation of alfalfa assessed by in vitro gas production. R. Berthiaume¹, G. Tremblay², Y. Castonguay², A. Bertrand², G. Bélanger², C. Lafrenière³, and R. Michaud², ¹Agriculture & Agri-Food Canada, Lennoxville, QC, Canada, ²Agriculture & Agri-Food Canada, Sainte-Foy, QC, Canada, ³Agriculture & Agri-Food Canada, Kapuskasing, ON, Canada.

The effect of the length of the daylight period before cutting (0, 2, 4, 8, or 12 hours) on water soluble carbohydrates, starch, and total non-structural carbohydrates (TNC) concentrations was assessed on alfalfa (*Medicago sativa* cv AC Caribou) grown under controlled conditions. We also determined the impact of the length of the daylight period on rumen fermentation assessed by in vitro gas production. Forage samples ($n=4$) at each sampling time were dried at 55°C immediately after harvest, ground to pass a 1 mm screen, and incubated for up to 142 h in an anaerobic medium inoculated with rumen fluid. Regular measurements of gas were taken to assess the rate of fermentation using the following gas production model ($Y = A \{1 - e^{-b(t-T) - c(\sqrt{t} - \sqrt{T})}\}$). At the end of the incubation period, samples of the liquid phase were analysed for ammonia-N and volatile fatty acids. Gas production model parameters and measured effluent parameters were analyzed as a completely randomized design with 5 duration of daylight and 4 replicates per treatment. Starch and TNC concentrations in alfalfa increased (mean starch = 4.2, 5.6, 5.6, 4.5 and 10.4% DM; mean TNC = 11.9, 13.7, 14.0, 12.9 and 18.5% DM; $P < 0.001$) with the length of the daylight period. Rumen fermentation also increased ($P < 0.01$) with the length of the daylight period before cutting as

shown by parameters (half-life; mean = 10.09, 10.61, 10.56, 10.24, 11.32 h and maximum values; mean = 231.5, 236.3, 236.9, 230.7, 248.9 ml) describing cumulated gas production curves. Propionate concentrations in the liquid phase increased linearly (mean = 11.8, 11.6, 12.8, 13.6, 14.6 mmol/L; $P = 0.01$) with a longer daylight period. Increasing the daylight period up to 12 h before cutting favoured the accumulation of starch and TNC in alfalfa and had a positive effect on rumen fermentation.

Key Words: Alfalfa, Carbohydrates, In vitro gas production

52 Effect of harvest schedule and plant part on in vitro gas production of temperate forages. J. L. Repetto¹, A. Britos¹, N. Errandonea¹, D. Cozzolino², and C. Cajarville¹, ¹Departamento de Nutrición Animal, Facultad de Veterinaria, Montevideo, Uruguay, ²The Australian Wine Research Institute, Adelaide, Australia.

The effects of harvest schedule and plant part on in vitro gas production and water soluble carbohydrate content (WSC), were studied on Uruguayan pastures in autumn. Two paddocks of Lucerne and one of Fescue (pastures) were sampled on 3 cuts (date): April 3, May 8 and May 30, at 3 moments (hour): 900, 1300 and 1700 h. Leaves (L), stems (S) and whole plant (WP) of each sample (part) were analyzed for WSC and nitrogen (N) content and were used as substrates to measure the in vitro gas production in ruminal liquor during 2, 4, 6, 9, 12, 24, 48 and 72 hours. Gas recordings (mL/g DM) were fitted to the model: $gas = a + b(1 - e^{-ct})$, where $a + b$ (mL) was the potential and c (%/h) the rate of gas production. Results were analyzed as a split-plot, using pasture as block, date and hour as main plots and part as split-plot. Correlations were made between chemical components and gas production. Afternoon harvests produced higher $a + b$ and c . The correlation between $a + b$ and WSC was non-significant, but there was a relationship between WSC and c ($r = 0.55$; $P < 0.001$). There were no differences in WSC among parts, but WSC/N was higher in S than in L. Leaves had the highest c values. Forages cut in the afternoon had higher ruminal fermentation capacity. This should be considered for grazing management.

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Table 1.

	a+b(mL/g)	c (%/h)	WSC (%/DM)	WSC/N	
hour	9	122.2	7.006	3.252	1.153
	13	125.6	7.212	4.766	1.820
	17	129.8	7.698	6.400	2.490
	SE	0.370	0.027	0.246	0.148
	P (hour)	0.018	0.003	<0.001	<0.001
	P (date×hour)	ns	ns	ns	ns
part	WP	124.3	7.231	5.069	1.645
	L	125.7	7.751	4.417	1.151
	S	127.5	6.934	4.931	2.667
	SE	0.123	0.009	0.142	0.085
	P (part)	ns	<0.001	ns	<0.001
	P (hour×part)	ns	ns	ns	ns

SE: standard error; ns: non-significant ($P > 0.05$)

Key Words: In vitro fermentation, Temperate pastures, Soluble carbohydrates

53 Effect of the timing of cut on ruminal environment of lambs consuming temperate pastures. C. Cajarville*, A. Pérez, M. Aguerre, A. Britos, and J. L. Repetto, *Departamento de Nutrición Animal, Facultad de Veterinaria, Montevideo, Uruguay.*

The objective of this experiment was to determine if time of day (t) affects ruminal environment of the animal that consumes a pasture. The study was conducted in Uruguay during August. Four Corriedale×Milkschaf lambs (25±0.86 kg BW) were individually fed fresh forage (grass and legume mix). The forage was cut at 700 or 1800 h and immediately offered to lambs in a cross-over design with 2 periods of 17-d each. The forage (500 g of DM/lamb/day) was consumed in less than 4 h. Samples of ruminal liquor were extracted each hour (h) during 24 h using permanent ruminal tubes (fixed via a cannula), and pH and ammonia were determined. Concentrations of acetic, propionic, butyric, isobutyric, valeric, isovaleric, and total volatile fatty acids (VFA) were determined hourly from hours -1 to 8 relative to time of feeding. Data were analyzed as repeated measures using the mixed model and included animal, period, t, h, and t×h interaction effects. Ruminal pH was lower and higher butyric concentrations were observed for 1800 h feeding. Minimum values of pH were observed 4 and 3 h after the beginning of the ingestion for 700- (5.69) and 1800-h (5.35) feedings. Maximum values of ammonia were observed 4 h after the beginning of the ingestion for both treatments (32.57 and 25.29 for 700- and 1800-h feedings). The shape of pH and ammonia curves were similar for both treatments as the interaction t×h was non-significant. The lower pH observed when forage was fed in the afternoon suggests that ruminal fermentation was improved.

Acknowledgements Funded by CSIC and CIDECA (UdelaR)

Table 1.

			SE	P		
	700 h	1800 h		t	h	t×h
ammonia (mg/100 mL)	17.78	18.53	1.405	ns	0.002	ns
pH	6.470	6.285	0.057	0.001	<0.001	ns
VFA (mM)	92.53	95.42	4.043	ns	<0.001	ns
acetic (mM)	54.57	53.92	2.636	ns	<0.001	ns
propionic (mM)	25.93	25.82	1.757	ns	<0.001	ns
butyric (mM)	8.757	11.88	0.872	<0.001	<0.001	ns
isobutyric (mM)	0.886	0.597	0.218	ns	0.002	ns

SE: standard error; ns: non-significant (P>0.05)

Key Words: Rempere pastures, Ruminal pH, Volatile fatty acids

54 Gas production and volatile fatty acid profile of subtropical grasses from México incubated in rumen fluid *in vitro*. A. S. Juárez-Reyes¹, M. A. Cerrillo-Soto^{*1}, E. Gutiérrez-Ornelas², E. Romero-Treviño³, J. Colín-Negrete², and H. Bernal-Barragán², ¹Universidad Juárez del Estado de Durango, Durango, Dgo. México, ²Universidad Autónoma de Nuevo León, Monterrey, N.L. México, ³Instituto Tecnológico Agropecuario N° 4, Altamira, Tamps. México.

Six species of grasses commonly used for beef cattle production systems in the subtropical region of northern México were incubated in rumen fluid *in vitro* in order to determine their gas production and volatile fatty acid (VFA) profile. Samples of Guinea (*Panicum maximum*), Pangola (*Digitaria decumbens*), Bermuda (*Cynodon*

dactylon), Pretoria 90 (*Dichantium annulatum*), Buffel (*Cenchrus ciliaris*) and Tanzania (*Panicum maximum var Tanzania*) were collected at flowering stage of maturity. Samples (500 mg DM) were incubated in calibrated 100 ml glass syringes using rumen fluid from two sheep fed alfalfa hay and commercial concentrate (75:25) as inoculum. Gas production was recorded at 3, 6, 9, 12 and 24 h. Incubations were terminated after 24 h and VFA determination was subsequently performed in 5 ml aliquots of centrifuged syringe content mixed with 1 ml of 25% metaphosphoric acid using gas chromatography. Data were analyzed by ANOVA according to a completely randomized design (SAS). Simple linear correlation coefficients between total VFA concentration and gas production were computed by PROC REG (SAS). Values for *in vitro* gas production, were higher in Pangola while lower in Buffel (P<0.05). Similarly, VFA concentrations were higher in Pangola (P<0.05), whereas lower (P<0.05) values were observed in Guinea, Buffel and Tanzania grasses. A significant (P<0.05) correlation coefficient between total VFA and *in vitro* gas production was calculated (r=0.688). The ratio of acetate:propionate (A:P ratio) was similar between grasses with a mean value of 6.60. The results obtained in the present study indicated that *in vitro* gas production technique discriminated subtropical grasses in the same pattern as VFA production technique did, and Pangola grass offered the best profile in terms of studied variables. Moreover, these variables contribute to the evaluation of the nutritional value of different grasses and they allowed to recognize the good potential of Pangola grass for grazing cattle of the subtropic in Northern Mexico.

Table 1. Gas production and volatile fatty acid profile of subtropical grasses of Northern Mexico

Grass	Gas 24h (ml/500 mg DM)	Acetate (mM/L)	Propionate (mM/L)	Butyrate (mM/L)	Total VFA (mM/L)	A:P ratio
Guinea	53.9 ^b	8.69 ^d	1.27 ^c	0.41 ^c	10.7 ^d	6.84 ^a
Bermuda	50.0 ^b	11.9 ^c	2.12 ^b	0.46 ^b	15.1 ^c	5.62 ^a
Pangola	76.4 ^a	19.7 ^a	2.95 ^a	1.17 ^a	24.3 ^a	6.68 ^a
Pretoria	52.3 ^b	16.5 ^b	2.37 ^b	0.83 ^b	20.0 ^b	6.93 ^a
Buffel	37.1 ^c	9.33 ^{cd}	1.43 ^c	0.30 ^c	11.5 ^d	6.57 ^a
Tanzania	52.1 ^b	8.45 ^d	1.33 ^c	0.41 ^c	10.7 ^d	6.91 ^a
Mean	53.6	12.4	1.91	0.65	15.4	6.60
sem	6.35	2.02	0.29	0.18	2.41	1.06

Means between columns with different superscript differ (P<0.05)

Key Words: Gas production, Volatile fatty acids, Grazing cattle

55 Coastal, Russell and Tifton 85 bermudagrass hay consumption by growing beef steers and in situ digestion. V. A. Corriher*, G. M. Hill, and B. G. Mullinix, Jr., *University of Georgia, Tifton.*

Steer performance and in situ digestion of Coastal (C), Russell (R), and Tifton 85 (T85) bermudagrass hays were determined in two experiments. Hays were produced on the same farm and harvested the same day, containing DM, CP, ADF and NDF (%), respectively: C=91.6, 11.4, 33.8, 71.5; R=91.7, 12.2, 36.4, 75.3; T85=92.0, 10.0, 40.6, 76.8. Exp1. Hays were fed free-choice for 40 d with a supplement (2.94 kg DM/steer daily; 85% corn, 10% SBM, 6% dried molasses, and 1.5% minerals; 89% DM, 14% CP) to beef steers (n=30; age=11 mo, 232 ± 24.7kg initial BW). Steers were randomly assigned to six pens in a completely random design. Steer ADG and hay DMI (Table) were affected by hay cultivar, with higher gains and DMI on C than R or T85. Exp 2. Two ruminally cannulated Polled Hereford (PH) steers were fed Tifton 85 hay ad libitum for 11 d. Starting on d 8, C, R,

and T85 ground samples were, placed in nylon in situ bags, and ruminally incubated for 0, 6, 12, 24, 36, 48, and 72 h. The average in situ digestion for the times sampled (Table) was similar for digestion of DM (DMD), ADF (DADF), and NDF (DNDF), but digestion of CP (DCP) was higher for C than T85. Incubation time affected all variables ($P < 0.01$), and after data was centered (28.28 h), digestion rate/h increased linearly for DDM (+0.48 %/h), and decreased linearly at the same rate for DADF and DNDF (0.12 %/h). For DCP digestion, hay and time interacted ($P < 0.01$), and rate of digestion increased linearly for C (+0.100%/h), R (+0.098%/h) and T85(+0.137%/h). Steers had higher DMI and gains on C than R or T85 hays, but chemical composition and overall average digestion of the hays was similar. Results differ from studies in which cattle gains and digestibility were consistently higher for T85 than C hays and pasture forages.

Table 1.

Item	C	R	T85	SE	$P <$
Final BW, kg	268.3	254.3	255.3	1.74	0.05
ADG, kg	0.90	0.58	0.55	0.04	0.01
Hay DMI, kg	5.43	4.04	4.11	0.08	0.16
Total DMI, kg	8.37	7.01	12.05	0.10	0.20
DDM, %	42.7	37.3	38.2	2.02	0.17
DCP, %	16.5	16.2	15.8	0.19	0.02
DADF, %	39.7	40.3	41.4	0.60	0.18
DNDF, %	83.0	83.1	83.2	0.67	0.90

Key Words: Bermudagrass hay, In situ, Steer

Goat Species: Potential of Goats as Biological Agents to Produce Meat, Control Vegetation and Restore Land

56 Meat goat industry, an emerging animal-agriculture enterprise in the U.S. S. Solaiman*, Tuskegee University, Tuskegee, AL.

Goats are the most popular farm animals in the world, and goat meat and milk are the most consumed of all animal products. Goats are popular with small land holders because of their efficient conversion of feed into edible and high quality meat, milk and hide. Goats are also used as holistic tools for land vegetation management and fire fuel load control. With proper grazing management, goats can eliminate noxious weeds, restore native grasses and prevent fires through fuel load reduction. In the U.S., meat goat production has been gaining popularity in recent years particularly because of a growing population of ethnic and faith-based groups who consume goat meat. The national estimates, based on import data only, indicate that the U.S. is more than 500,000 head deficient in meeting current demands for goat meat. However, when the demand for goat meat is estimated based on increasing ethnic populations and faith-based consumers in the U.S., it far exceeds this number. Australia has been experiencing enormous growth in export of its goat meat, from about 2000 metric tones in 1999 to more than 8000 metric tones in 2004, and this has pressured Australian exporters to market their bush or feral goats to fulfill their existing contracts. This increase in demand of goat meat is also supported by the more than 19% increase in number of goat farms with over a 12% increase in the goat population from 1997-2002 in the U.S.; more-over, the number of farms selling goats increased by over 45%, and goat sales were up by more than 55%. Goat industry is in its infancy and is just like beef industry that was turned around when European breeds were imported to the U.S. For the industry to grow, Meat Goat Quality Assurance programs using Hazard Analysis Critical Control Points (HACCP) principals for pre- and post-harvest meat goats similar to those for beef, pork, and poultry must be developed to assure quality and uniformity of product. Meat goat industry is a new and emerging industry and it is an opportunity for U.S. animal agriculture to present another quality product to consumers.

Key Words: Emerging industry, Goat meat, U.S.

57 Nutritional quality assessment of browse for goats . W. Pittroff*, University of California, Davis.

Goats are classified as an intermediate ruminant feeding type, i.e. selecting a major proportion of their diet as browse. In recent years,

the nutritional properties of browse for goats have received increased attention, for two reasons: (1) goats are recognized as an important element of the livelihoods of rural poor in developing countries, and (2) goats are emerging as the potentially most effective biocontrol agent for removal of fire fuel and invasive species biomass. In both cases, the major constraint to the more effective use of goats is the near total lack of knowledge about the specific nutritional and anti-nutritional properties of browse species. A cost effective solution to this problem is an in vitro method capable of providing solid data on ME concentration of browse species. The Hohenheim Gas Production Test, coupled with crude protein analysis, has proven to meet this requirement. A thorough discussion of the method and its application for the development of nutritional tables for the use of goats in fire fuel management in California is presented. This approach has the potential to serve as the method of choice for determination of nutritional quality of forage and browse species of low economic significance in cases where research budgets do not allow to perform exhaustive in vivo experiments. We further demonstrate the use of this method to assess the effects of nutritional and non-nutritional supplementation, and as a bioassay for tannins. Correlations between in vivo data on consumption and digestibility of tannin-rich browse with and without PEG supplementation clearly illustrate this capability. Further, the capability to infer rumen fermentation properties from the non-linear analysis of gas production profiles is emerging as a powerful tool to describe ruminant feedstuffs in a more differentiated manner, for example in regards to their potential impact on emission levels from livestock production.

Key Words: Gas test, Goats, Nutritional quality

58 Vegetation control using goats. S. Hart*, Langston University, Langston, OK.

Goats can be a valuable biological agent for brush and weed control, converting these unwanted plant materials into an income stream with minimal adverse impact on the environment. It is well established that goats can control a number of species of weeds and brush, however, there is a lack of knowledge on many specific plant species. The objective of brush or weed control is to overgraze (defoliate repeatedly before the plant can restore its carbohydrate reserves) the target species. Achieving this objective requires that the goat consume the target species. Predicting the species of plants that goats will consume is

complicated by the fact that goat dietary preferences are affected by previous animal experience, availability of alternative species, season of the year and the soil/environment that the plant is growing in. Therefore, information on goat dietary preferences may not apply to a specific case due to the aforementioned factors. Also, since plant preference is affected by season of year or stage of plant growth, the time of grazing can be important. However, if goats consume the target species, it is only a matter of time until the species is controlled because weeds and brush are not very tolerant of defoliation and require long rest periods to restore root carbohydrates. If goats do not consume the target species, animals which do consume the species may be brought in to train naive animals. Recent research shows that cattle may be trained to eat certain weeds and it may be possible to use similar techniques to train goats to consume the target species. We have observed goats consuming novel species when forage became limiting, but goats have also been observed to starve rather than eat some species. Goats may be more interested in a plant the second year they are exposed to it and research indicates progeny may consume more of a target species than their dams if availability is high when they are young. We have observed breed differences in the ability to graze. Goats consume many brushy and weedy species, but it takes good management to utilize this attribute effectively and profitably for weed and brush control.

Key Words: Behavior, Goats, Vegetation management

59 Utilization of goats for rejuvenation, reclamation and land cleaning. A. Peischel*, *Tennessee State University, Nashville.*

The goat is an extremely agile, gregarious and opportunistic creature. It is the ability of management, through innovation and creativity, to

successfully use those characteristics for the enhancement of lands. The management goal encompasses use of all ecosystems, biological and environmental, with success centering on flexibility of management plans and the ability to re-plan. To accomplish this, biodiversity must be maintained, the physiology of plants and soil understood along with the ability of man to make environmental, economical and socially sound decisions. Goats, under control are being used to enhance land productivity and encourage vegetative biodiversity. Energy is universal and can be used, stored, concentrated or spread with the primary source being the sun. To use the natural energy flow efficiently, it is vital to control: the time of grazing/browsing, the area to be grazed/browsed, the season of grazing/browsing, the plant specie to be grazed/browsed and the goat(s) that are being used for land management. The use of goats in vegetative management takes on many diverse avenues. They can be used for: noxious weed abatement, rejuvenation of abandoned and eroded lands, edging back of woody and forb species, fire breaking and fuel load reduction, poisonous/toxic plant eradication and enhance timber producing forests through silvopasture and agroforestry techniques eliminating competition of unwanted species. Goats can stabilize stream banks and riparian areas, clean along irrigation ditches, minimize old fence lines, clear farm ponds and create flyways for ducks and geese along with landscaping around homes and land cleaning in citrus orchards, nut farms and vineyards. The management criterion is to never underestimate the nutritional value of plants and vegetative re-growth; encourage a change of regression plant communities into succession plant communities. Biodiversity provides year round selection for goats, avoiding problems such as those associated with monocultures. Goats provide mankind with meat/milk/fibre/skins; products to enhance our lives. The goat is truly an opportunity for man to manage.

Key Words: Goats, Land restoration, Vegetation management

Graduate Student Paper Competition: Northeastern ASAS/ADSA Graduate Competition

60 Milk production of dairy cows fed diets constant or varied in phosphorus content during lactation. J. Elizondo*¹, D. Beegle¹, J. Fergusson², and Z. Wu¹, ¹*Pennsylvania State University, University Park*, ²*University of Pennsylvania, Kennett Square.*

The current NRC (2001) suggests that diets fed to dairy cows contain high concentrations of P during early lactation and low concentrations of P in late lactation based on milk production. Milk production response to diets containing constant or varied P concentrations during lactation was determined. Thirty multiparous Holsteins were blocked by mature equivalent milk yield and calving date, and assigned to one of three dietary treatments for complete lactation. For the first treatment, the diet was formulated to contain 0.36% P for the entire lactation (constant P, 0.36-0.36-0.36). Treatment 2 included 0.36% dietary P for 30 wk followed by 0.29% P during the last 14 wk (P changed once, 0.36-0.36-0.29). The third treatment consisted of 0.43% P for the first 10 wk, 0.36% P for the second 10 wk, and 0.29% P for the last 14 wk (P changed twice, 0.43-0.36-0.29). Milk yield and milk component production did not differ among treatments. Keeping dietary P concentration constant or varying the concentration once or twice during lactation did not affect milk production.

Acknowledgement: Sincere appreciation to Pennsylvania Department of Agriculture for funding (Award ME443245).

Table 1.

Item	0.36– 0.36–0.36	0.36– 0.36–0.29	0.43– 0.36–0.29	SEM	P changed	
					Constant vs. varied P ¹	once vs. twice ¹
Milk, kg/d	33.3	33.3	36.0	2.2	0.63	0.39
Fat, %	4.24	4.00	4.04	0.21	0.40	0.88
Fat, kg/d	1.454	1.390	1.491	0.086	0.91	0.41
Protein, %	3.08	3.12	3.08	0.05	0.85	0.56
Protein, kg/d	1.074	1.068	1.145	0.063	0.68	0.39
3.5% FCM, kg/d	38.8	37.6	40.5	2.2	0.94	0.35

¹P values for contrasts.

Key Words: Phosphorus requirement , Dairy cows, Milk production

61 Effects of forage source and corn particle size on milk production and composition, nutrient digestibility and ammonia emission from manure in Holstein dairy cows. N. E. Brown*, V. A. Ishler, T. W. Cassidy, K. Heyler, and G. A. Varga, *The Pennsylvania State University, University Park.*

A replicated 4 X 4 Latin square design was conducted to evaluate the effects of forage source and corn particle size on cow performance, nutrient digestibility and ammonia (NH₃) emissions from manure. The four treatments were: 1) grass silage (G) with fine (F) ground corn (GF), 2) G with coarse (C) ground corn (GC), 3) alfalfa silage (A) with F (AF) and 4) A with C (AC) in diets for lactating cows. Cows averaged 119 ± 5 d in milk. Diets were formulated to contain approximately 1.5 NE_L Mcal/kg, 16.5% CP, and 32% NDF. Each period lasted 28 d, the final 7 d were used for sample collection of milk yield and components, nutrient digestibility and NH₃ from manure. A photo-acoustic gas monitor was used to record NH₃ concentrations in 20 min intervals from manure samples. Cows fed A had greater dry matter intake (DMI) ($P < 0.01$) compared to cows fed G (27.9 vs. 22.1 kg/d, respectively). The increased DMI for cows fed A resulted in greater ($P < 0.01$) milk yield (MY; 35.3 vs. 30 kg/d) than for cows fed G. MY efficiency was greater ($P < 0.02$) for cows provided G vs. cows fed A (1.43 vs. 1.30, respectively). Corn particle size had no effect on DMI, MY, FCM, or milk yield efficiency. Milk fat, protein and milk protein % were higher for cows fed A vs. G diets. Cows fed G had higher ($P < 0.08$) milk urea N compared to cows fed A. DM digestibility was not affected by forage source but was higher ($P < 0.02$) for F vs. C (58.8% vs. 55.1%, respectively). A greater decrease ($P < 0.04$) in DM digestibility was observed with C for cows on G compared to A (57.4% vs. 56.4%). Fiber digestibility was higher ($P < 0.04$) for F vs. C (34.7% vs. 29.1%). No differences were observed between forage or corn source on manure NH₃. Results of this study demonstrate that fiber from G is more filling than A resulting in reduced DMI and milk yield. Corn particle size may impact nutrient digestibility and these effects may differ based on forage source.

Key Words: Grass silage, Alfalfa silage, Ammonia emission

62 Withdrawn by author.

63 Accelerated calf growth: When does it make sense? D. Berthiaume* and J. Smith, *University of Vermont, Burlington.*

Scientific evidence is lacking on which to base recommendations of the age at which feeding levels should be increased to maximize gains without compromising health in milk-fed calves. In this experiment, growth and health response of Holstein heifer calves fed different types of milk replacer (MR) at different feeding rates were determined. Calves (n=30) weighing 40-50 kg at birth were randomly assigned to 1 of 5 treatments. Treatment 1 were control calves fed MR containing 20% Crude Protein (CP) and 20% fat, offered 0.272 kg Dry Matter (DM) 2 times per day reconstituted to 12.5% w/w. All other treatments were fed a 26% CP, 18% fat MR. There were 3 levels of milk replacer fed twice per day: 0.272 kg reconstituted to 12.5%, 0.408 kg reconstituted to 14.7%, and 0.544 kg reconstituted to 16.1% w/w. Calves were initially fed 0.272 kg per feeding. Amounts fed were increased to level 2 on d 3, 10, 14, or 3 for treatments 2, 3, 4, and 5, respectively and to level 3 on d 7, 14, 21 and 7 for treatments 2, 3, 4, and 5 respectively. Treatments 1-4 received free choice starter grain from 3 d through weaning; treatment 5 did not receive starter until 21 d of age. During wk 5 all calves were offered 0.272 kg DM once per day and were weaned at 42 d of age. Weights and hip heights were measured weekly for 8 weeks. Body temperatures, respiratory scores, and fecal scores were recorded daily. Blood samples were obtained at birth, 24, 48, and 96 h after colostrum feeding, and weekly thereafter for 8 wk and analyzed for immunoglobulins, nonesterified fatty acids and β-hydroxybutyrate. Although ADG through wk 8 were not different among treatments, days scouring were affected by treatment.

Table 1. Treatment Results

Treatment	1	2	3	4	5	P-value
Total MR						
DM intake, kg	44±1.3	77±2.0	71±3.2	66±7.5	77±6.8	<0.001
Total starter						
DM intake, kg	40±6.1	37±4.5	40±5.9	40±2.8	29±7.1	.029
ADG, kg/d	0.6±.10	0.7±.09	0.7±.12	0.7±.07	0.6±.12	.347
Days Scouring	6±2.3	5±2.9	10±2.9	7±3.5	7±3.1	.001

¹- Fecal scores ranged from 1=solid to 4=liquid * - A score 3+ was considered scouring

Key Words: Calf, Growth, Protein

Graduate Student Paper Competition: National ADSA Dairy Foods Division

64 Fatty acid composition and thermal properties of lipid from milk and butter from lactating Holstein cows fed a supplemental lipid either high or low in palmitic acid. M. K. Beam*¹, L. W. Lassonde², B. C. Veltri¹, S. J. Taylor¹, R. Jimenez-Flores², and E. J. DePeters¹, ¹University of California, Davis, ²California Polytechnic State University, San Luis Obispo.

Milk fat offers new roles as a functional-food ingredient in many foods. Modification of the fatty acid (FA) composition of the triacylglycerol (TG) and phospholipid (PL) components impacts the nutritional value and physio-chemical properties of milk lipids. The objectives were to determine the impact of feeding either a low (LP) or a high (HP) palmitic acid supplemental fat to lactating cows on the (1) FA composition of lipids in milk fat and the subsequent butter and buttermilk and (2) thermal properties of the butter. Multiparous (8) and primiparous (4) Holstein cows were used in a cross-over design. Diets were similar in composition with the only difference the supplemental

fat included at 2% of diet dry matter used to alter the palmitic acid intake of cows. The HP supplement was Energizer-RP10, and the LP supplement was yellow grease. Milk yield did not differ, but dry matter intake tended ($P < 0.06$) to be lower for HP (24.8 kg/d) than LP (25.1 kg/d). Yields of 4% fat-corrected milk (44.1 vs 41.2 kg/d) and fat (1.8 vs 1.6 kg/d) were significantly greater for HP than LP. Changes in the FA composition of TG and PL occurred. C16:0 in TG was higher for HP than LP (41.9 vs 28.2 g/100 g fat) while C18:1 *cis* was lower (18.1 vs 23.1 g/100 g fat). Total C18:1 *trans* was lower for HP (2.63 g/100g fat) than LP (4.82 g/100 g fat). Buttermilk PL was high in unsaturated FA. Butter from each cow was noticeably harder when cows were fed HP than LP. Textural analysis found that anhydrous milk fat (AMF) from HP was harder at both ambient and 10°C temperatures than AMF from LP. Diet of the cow can be used to modify the FA composition of the TG and PL components of milk lipids as an approach to enhance milk fat's potential role as a functional-food ingredient.

Key Words: Fatty acid, Milk fat, Palmitic acid

65 Influence of fatty acid chain length and unsaturation on mid-infrared milk analysis. K. Kaylegian* and D. Barbano, *Cornell University, Ithaca.*

The general influences of fatty acid chain length and unsaturation on mid-infrared (MIR) fat measurement in milk are known, and the focus of this study was to quantify these effects. The use of a Fourier transform (FT) MIR milk analyzer allowed the optical settings used to measure fat, lactose, and protein to be fine tuned. The first objective was to optimize the sample and reference peak wavelengths and bandwidths to minimize the influence of the other components, which was indicated by the size of the intercorrection factors. The bandwidth and the proximity of the peak wavelength to areas near intense water absorption had the largest effect on the intercorrection factors. The use of narrow bandwidths allowed movement of the peak wavelengths away from areas of intense water absorption and reduced the intercorrection factors. The second objective was to quantify the influence of fatty acid chain length and unsaturation on the measurement of fat B and fat A using an FT MIR milk analyzer with optimized virtual filters and an MIR milk analyzer with optical filters. Model milk emulsions were made with pure monoacid triglycerides (C14:0, C16:0, C18:0, and C18:1) and pasteurized skim milk to produce one series that varied only in mean chain length and another series that varied only in the mean degree of unsaturation. The MIR absorbance at the fat B sample peak wavelength increased with increasing chain length and decreased with increasing unsaturation. At the fat A sample wavelength, the absorbance decreased with increasing chain length and was relatively insensitive to changes in unsaturation. The changes in the difference between corrected MIR values for fat (B or A) and reference chemistry as chain length or unsaturation increased were similar to those observed for absorbance. The application of this data will be to explain the variation in the difference between MIR fat prediction and reference chemistry of natural milk, which changes in chain length and unsaturation simultaneously.

Key Words: Infrared milk analysis, Fatty acid composition

66 Binding of flavor compounds to native and denatured whey protein using headspace solid-phase microextraction. J. Kühn*^{1,2}, T. Considine³, and H. Singh¹, ¹*Riddet Centre, Palmerston North, New Zealand*, ²*Institute of Food, Nutrition, and Human Health, Palmerston North, New Zealand*, ³*Fonterra Research Centre, Palmerston North, New Zealand.*

Whey proteins are known to bind flavor compounds of different chemical classes. These interactions can have a strong influence on flavor perception. In the present study, the binding of three flavor compounds, 2-nonanone, 1-nonanal, and *trans*-2-nonenal, to whey protein isolate (WPI) in aqueous solution was investigated. Since heat treatment is an important step during the processing of many protein containing foods, heat-denatured proteins are of great importance. The aim was to reveal how the unfolding and aggregation of whey proteins upon heat denaturation affect their binding affinity for flavors. The free flavor was quantified using headspace solid-phase microextraction (SPME) followed by gas chromatography (GC) and flame ionization detection (FID). At room temperature, the binding of WPI and the flavors investigated was strong and decreased in the order *trans*-2-nonenal > 1-nonanal > 2-nonanone. This finding is attributed to hydrophobic interactions only in the case of 2-nonanone, whereas the aldehydes, in particular *trans*-2-nonenal, may also react covalently. Heat denaturation (80 °C, 0-80 min) released protein-bound 2-nonanone. This may be explained with the aggregation of whey proteins upon heat

denaturation, making the flavor binding sites inaccessible. The binding of 1-nonanal remained unaffected, suggesting covalent binding via the aldehyde function may not be influenced by protein aggregation. In contrast, the binding of *trans*-2-nonenal increased with increasing heating time, possibly due to chemical reaction with amino acid residues. The extent of binding was not influenced by the addition of flavor before or after heat treatment. We can conclude that heat treatment affects protein-flavor binding depending on the nature of the flavor compound, and may therefore notably influence the overall flavor profile of protein-based foods.

Key Words: Whey protein isolate, Flavor binding, Denaturation

67 Improving the texture of nonfat processed cheese for use in baking applications. C. A. Brickley*^{1,2}, S. Govindasamy-Lucey³, J. J. Jaeggi³, M. E. Johnson³, P. L. H. McSweeney¹, and J. A. Lucey², ¹*University College Cork, Cork, Ireland*, ²*University of Wisconsin, Madison*, ³*Wisconsin Center for Dairy Research, Madison, WI.*

Nonfat cheese tends to have problems including poor melt, pale colour and chewy texture. Our objective was to develop a nonfat processed cheese (PC) suitable as a pizza topping. We proposed to overcome these problems by altering the properties of the cheese base and with the selection of suitable emulsifying salts (ES). Stirred curd cheese bases were made from skim milk by direct acidification using lactic acid to pH values 5.0, 5.2 and 5.4. Various levels of trisodium citrate (TSC) (0.5, 1, 1.5, 2, 2.5, 3 and 5%), disodium phosphate (DSP) or trisodium phosphate (TSP) (1, 2, 3 and 4%) were blended with nonfat cheese base during lab-scale processing at 1 d. Cheese, ES and water were weighed into a steel container which was placed in a waterbath at 98°C then stirred using an overhead stirrer for 9 min. Molten cheese was poured into containers, sealed and stored at 4°C for 7 d before being analyzed for pH, moisture, TPA hardness and adhesiveness, and extent of flow (EOF) using the UW Meltprofiler. During manufacture, the pH 5.2 and 5.4 curds were sticky. The pH 5.2 and 5.4 curds had a pale colour and pH 5.0 curd was white in colour. Total calcium contents were ~ 400, 185 and 139 mg/100g for pH 5.4, 5.2 and 5.0 cheeses, respectively. Addition of DSP resulted in a PC with lowest EOF and at ES levels above 2% crystal formation was apparent. PC manufactured from pH 5.0 curd and TSP showed reduced melt and increased stickiness whereas melt was significantly increased and stickiness was reduced in PC made with pH 5.4 curd base and TSP. However, the pH of PC made from the pH 5.4 cheese and TSP (1%) was > 6.20 and crystals were observed. Use of TSC increased EOF up to a maximum at 2% ES for all cheese bases. High levels of TSC (for pH 5.2 and 5.4 cheeses) resulted in increased stickiness. These initial trials suggest that the pH 5.0 cheese base was most promising for further research as it had a creamy colour, reasonable melt and it did not have high adhesiveness when TSC was used.

Key Words: Nonfat, Processed cheese, Emulsifying salts

68 Impact of mixtures of emulsifying salts on the properties of process cheese. S. Kaliappan*, M. E. Johnson, J. J. Jaeggi, and J. A. Lucey, *University of Wisconsin, Madison.*

Mixtures of emulsifying salts (ES) are often used in the manufacture of process cheese (PC). Although ES are known to stabilize PC by interacting with cheese components, such as, casein and Ca phosphate, their underlying mechanisms of interaction are still not clearly elucidated. Objective of this study was to investigate how binary ES

mixtures influence PC functionality. Three types of binary ES mixtures were prepared by combining trisodium citrate (TSC) with disodium orthophosphate (DSP), tetrasodium pyrophosphate (TSPP) or sodium hexametaphosphate (SHMP). For a total ES concentration of 3% (w/w), five different proportions (0.25:2.75, 0.875:2.125, 1.5:1.5, 2.125:0.875 and 2.75:0.25) of these mixtures were used. PC were made with constant pH (5.6 ± 0.05) and moisture content ($39.2 \pm 0.5\%$) using 4 month old natural Cheddar cheese as base. Functional and microstructural properties were studied using small amplitude oscillatory rheology, texture profile analysis (TPA), UW-Meltprofiler and fluorescence microscopy. The state of Ca and phosphorous (P) in cheese was determined by acid-base titration and by measuring the amount of insoluble Ca and P. The rheological parameter, loss tangent, and meltability increased while hardness (from TPA) decreased in mixtures that had high proportions of TSC or SHMP but the opposite trend was observed in mixtures that had high ratios of DSP or TSPP. The % insoluble Ca or P as % of total Ca or P increased with increasing amount of phosphate in mixtures of phosphate-based ES with TSC. Acid-base titration indicated that various types of Ca-phosphate interaction occurred in cheese depending on the types of ES used. These results suggested that ES interacted with cheese components by several mechanisms, such as, dispersion of the original insoluble Ca phosphate, formation of new Ca salts and casein polymerization. A greater understanding of how ES mixtures influence cheese properties will help manufacturers to control the functional behavior of PC.

Key Words: Process cheese, Functionality, Emulsifying salts

69 Improving texture and flavor of reduced fat Cheddar cheese using an exopolysaccharide-producing culture and ultrafiltration. P. Agrawal* and A. N. Hassan, *South Dakota State University, Brookings.*

The texture of reduced fat Cheddar cheese is typically rubbery, dry and grainy. In previous studies (Awad et al., JDS 88:4204-4213; Hassan et al., JDS 88:4221-4227), an exopolysaccharide-(EPS) producing culture improved textural, melting and viscoelastic properties of reduced fat Cheddar cheese. However, this EPS-positive cheese developed bitterness after 2 to 3 months of ripening due to increased residual chymosin activity. We hypothesized that the reduced amount of chymosin needed to coagulate ultrafiltered milk might result in reduced residual chymosin activity and bitterness in cheese. The objective of this study was to improve the texture and flavor of reduced fat Cheddar cheese using a combination of EPS-producing cultures and ultrafiltration (UF). Reduced fat Cheddar cheeses were manufactured with EPS-producing and non-producing cultures using skim milk or ultrafiltered skim milk (1.2 X) adjusted to a casein/fat ratio of 1.35. The EPS-producing culture increased yield, moisture in nonfat substance, and residual chymosin activity in reduced fat Cheddar cheese. In addition, EPS-positive cheese was softer, and less gummy and rubbery than the EPS-negative cheese. The viscoelastic moduli were higher in young EPS-negative reduced fat cheese than in the EPS-positive cheese. After 3 months of ripening, whereas the viscoelastic moduli increased in the EPS-positive cheese, they decreased in the EPS-negative cheese. The creep/recovery test showed that young EPS-positive cheese was less rigid and more deformable than EPS-negative cheese. Lower ($P < 0.05$) residual chymosin activity was found in cheese made from UF milk compared to that in cheese made from control milk. The low UF concentration level (1.2X) did not affect the textural characteristics of cheese. Panelists reported that UF-EPS-positive cheese was less ($P < 0.05$) bitter than EPS-positive cheese made from control milk. Using an EPS-producing culture improved the texture and UF at

1.2 X reduced bitterness of reduced fat Cheddar cheese, which has commercial implications in the manufacture of this type of cheese.

Key Words: Exopolysaccharides, Ultrafiltration, Reduced fat cheese

70 Ecology of psychrotolerant aerobic sporeformers present in dairy production systems. J. Huck*, B. Hammond, S. Murphy, and K. Boor, *Milk Quality Improvement Program, Cornell University, Ithaca, NY.*

The presence of psychrotolerant *Bacillus* species and related sporeformers (e.g., *Paenibacillus* spp.) in high-temperature-short-time pasteurized milks has emerged as a key hurdle in achieving fluid products with extended shelf-lives (>14 days). Pasteurization survival by sporeformers makes their presence in raw milk a major potential cause of milk spoilage. Utilizing a recently developed *rpoB* subtyping method to track sporeforming spoilage microbes through raw milk transport and receiving containers into packaged products, we have gained insight into the ecology and transmission of these microbial contaminants. Thirty-three raw milk samples were collected from all incoming bulk tank trucks over a two day period in two New York State fluid milk plants currently achieving shelf-lives >14 days. Thirteen additional samples were systematically collected from raw milk storage silos and packaged products. Pasteurized and heat-treated (80°C for 12 minutes) raw milks were held over shelf life at 6°C and plated at days 1, 7 and 14. Day 14 standard plate counts (SPC) ranged from 140 to >6,000,000 CFU/mL. Ninety-three representative colony-types were isolated from day 14 SPC's and subsequently subtyped. This DNA sequence-based method allows sensitive identification and differentiation of sporeforming microbes isolated from dairy processing systems. Our results indicate the presence of 28 *rpoB* allelic types. The 4 predominant subtypes represent 19%, 8%, 4% and 3% of the total isolates recovered, of which 2 predominant *Paenibacillus* spp. subtypes can be tracked systematically from raw transport tanks into storage silos and into packaged products. The persistence and transmission of these thermophilic spoilage organisms suggests the need to improve our understanding of the ecology of psychrotolerant *Bacillus* species and related sporeformers throughout the dairy production chain. This new information will allow identification and elimination of bacterial niches that harbor these spoilage organisms, hence reducing the prevalence of milk contamination and improving product quality and shelf-lives.

Key Words: *Bacillus*, Fluid milk, Molecular subtyping

71 Growth and enterotoxin production by *Staphylococcus aureus* in milk. N. M. Kauffman* and R. F. Roberts, *The Pennsylvania State University, University Park.*

A provision was added to the 2003 edition of the PMO allowing processing runs to exceed one day prior to cleaning. Growth and subsequent enterotoxin production by *Staphylococcus aureus* is of specific concern when extending processing runs, because of its association with mastitis infections in dairy cows. The optimum temperatures for staphylococcal enterotoxin (SE) production exist within the regeneration section of HTST pasteurization systems. During extended processing runs, *S. aureus* may have sufficient time to grow and produce SE in eddy regions, that could form during operation of this plate heat exchanger (PHE). The objectives of this study were to characterize strains of *S. aureus* isolated from mastitic cows and evaluate *S. aureus* growth and enterotoxin production in milk at various temperatures. Fifteen *S. aureus* strains previously isolated from mastitic

cows milk were characterized by growth on selective media, Gram stain, coagulase gene polymorphism, thermonuclease gene fragment amplification and activity on toluidine blue-o agar. SE production was evaluated using PCR and immunoassay. Growth and SE production in UHT milk were quantified at temperatures ranging from 21 to 45°C over 72 h. Two strains did not exhibit the expected coagulase gene polymorphism profile and were discarded from the study. Two of 15 strains were positive for toxin production. One expressed gene fragments for SEC and TSST-1 and one for SEA and SEC. SEC and SEA production by these two strains was confirmed by immunoassay. Two control strains and two SE-producing isolates were evaluated for growth and SE production. Strains grew at temperatures ranging from 21 to 45°C with an optimum at 40°C. The highest concentration of SE was produced at 31°C after 72 h incubation and the shortest time to SE production was observed at 40°C. Enterotoxin production data was used to estimate the amount of SE that might be produced in PHE as a function of processing time, temperature, eddy size and batch size. Preliminary calculations revealed production of SE during extended runs would not lead to human illness.

Key Words: Staphylococcus aureus, Staphylococcal enterotoxin, Extended run

72 Development of a novel immunoassay system for immunobiotics that modulate intestinal immunity through Toll-like receptor 2. M. Tohno*, T. Shimosato, Y. Kawai, T. Saito, and H. Kitazawa, *Graduate School of Agricultural Science, Tohoku University, Sendai, Japan.*

Studies on the biological functions of immunobiotic lactic acid bacteria (LAB) have contributed to their worldwide application as functional

foods and supplements. The beneficial effects of activating intestinal immunity with LAB are very important, but the cellular and molecular mechanisms by which immunobiotics regulate intestinal immune homeostasis have not been elucidated. Recently, Toll-like receptor (TLR) 2 was identified as a specific receptor for bacterial cell wall components, although some of the biochemical and immunological mechanisms by which TLR2 recognize and respond to immunobiotic bacteria remain unclear. In the present study, we investigated the role of TLR2 in the modulation of intestinal immunity by immunobiotic LAB. First, we isolated a cDNA encoding TLR2 from swine Peyer's patches, which are considered to be a good model of the human intestinal immune system. The complete open reading frame of swine TLR2 contained 2358 bp, corresponding to a 785-amino acid polypeptide with a calculated molecular mass of 89.6 kDa. We then transfected mammalian cells with the swine TLR2 cDNA to develop an immunoassay for immunobiotic LAB. The swine TLR2-expressing transfectant was able to recognize not only yeast cell wall zymosan but also intact LAB, which resulted in the activation of nuclear factor- κ B (NF- κ B). Furthermore, high levels of TLR2 were detected in the follicle-associated epithelium of swine gut-associated lymphoid tissues, including membranous (M) cells and antigen-presenting cells such as dendritic cells. These findings indicate that TLR2-expressing cells in the gut-associated lymphoid tissues allow the host defense to respond to a variety of immunobiotic LAB. This finding may help clarify how LAB modulate intestinal immunity through TLR2, information that can aid in the development of immunobiotic foods.

Key Words: Immunobiotics, Lactic acid bacteria, Toll-like receptor 2

Graduate Student Paper Competition: National ADSA Production Division

73 Evaluation of feeding dried distillers grains plus solubles (DDGS) with corn silage or alfalfa hay as the primary forage source. D. H. Kleinschmit*, D. J. Schingoethe, A. R. Hippen, and K. F. Kalscheur, *South Dakota State University, Brookings.*

Nine multiparous (250 ± 6 DIM) and three primiparous (204 ± 6 DIM) Holstein cows were utilized in a 3×3 Latin-square design to evaluate the lactation performance of dairy cows fed a diet containing DDGS with either corn silage or alfalfa hay as forage. All cows were fed a total mixed diet containing corn silage (CS), 50% corn silage and 50% alfalfa hay (CSAH), or alfalfa hay (AH) as the forage source. All diets had a 50:50 forage to concentrate ratio and contained 15% DDGS in the concentrate mix. Diets were formulated to provide similar amounts of metabolizable protein but concentrations of CP increased when alfalfa was added. Dry matter intake (22.5, 23.5, and 20.5 kg/d for CS, CSAH, and AH, respectively) had a quadratic relationship ($P < 0.01$) with the addition of alfalfa. Yields of milk, 4% FCM, and energy-corrected milk (29.0, 30.7, and 31.0 kg/d) were similar for all diets. Feed efficiency (1.33, 1.39, and 1.54 kg ECM/kg DM intake) improved linearly ($P < 0.01$) with increased concentrations of alfalfa in the diet. Milk fat concentration (3.86, 3.72, and 3.58%) decreased linearly ($P < 0.01$) with addition of alfalfa, but this result was more drastic in primiparous cows than in multiparous cows. Differences in milk fat yield were not observed among diets. Milk protein concentration (3.32, 3.29, and 3.29%) and yield (0.90, 0.96, and 0.98 kg/d) were not affected by diet. Increasing the alfalfa content in the diets increased ($P < 0.01$) the concentration of milk urea nitrogen

linearly due to greater concentrations of dietary CP. Ruminant molar proportions of acetate (63.4%), propionate (21.4%), and butyrate (10.1%) were similar across diets. Concentrations of ruminal ammonia were also similar (5.75 mg/dL). In conclusion, with the exception of a depression in milk fat content, replacing corn silage with alfalfa hay in diets containing 15% DDGS did not affect yields of milk and milk components, milk composition, and ruminal VFA and ammonia. The addition of alfalfa decreased DMI while maintaining milk production thus improving feed efficiency.

Key Words: Dried distillers grains plus solubles, Dairy cattle, Forage source

74 The effect of supplemental dietary forage on the concentration of phosphorus and nitrogen in feces of lactating cows. E. M. O'Rourke*, J. J. Michal¹, R. L. Kincaid¹, J. H. Harrison², and C. T. Gaskins¹, ¹Washington State University, Pullman, ²Washington State University, Puyallup.

Sixteen multiparous Holstein cows were assigned to a study to determine if added dietary forage affected diurnal variation in the concentration of phosphorus (P) and nitrogen (N) in feces. At the start of the experiment, the cows averaged 262 DIM, 757 kg BW, and 37 kg daily milk yield. Dietary treatments were a control TMR consisting of 25% alfalfa haylage, 23% alfalfa hay, 10.3% whole cottonseeds, 7.3% wheat millrun, and 34.4% concentrate, and a treatment diet where cows were fed 2.27 kg alfalfa hay as a top-dress supplement to the

control ration. The TMR contained 19% CP, 36 % NDF, 27% ADF, and 0.42 % P. The treatment diet contained 19.2 % CP, 36.3 % NDF, 27.3 % ADF, and 0.42 % P. All cows were fed the TMR at 1400 h daily and the alfalfa hay offered as a top-dress at 0700 h. Cows had ad libitum access to feed except between 0800 to 1000 h, and 1100 to 1400 h. On d 21, fecal grab samples (200 g) were collected approximately every 4 h for 48 h in such a manner as to represent every 2 h in a diurnal period. The dry matter intake (DMI) averaged 26 kg/d and was not affected by treatment. Similarly, average milk yield was 38 kg/d and not affected by treatment. The concentration of P in the feces (0.70 and 0.71% for control and supplemental cows, respectively) was not affected ($P > 0.1$) by either supplemental forage or time of sampling. Although the concentration of N in the feces was affected ($P < 0.05$) by both the supplemental forage and time of sampling, the ratio of P to N (mean = 0.285) was not significantly changed by either supplemental forage or time of sampling. In conclusion, for dairy cows fed a TMR containing 0.42 % P there was no diurnal change in the % P in feces nor did a forage top-dress affect the % P in feces. However, both time of sampling and the forage top-dress affected the % N in the fecal samples. Fecal grab sampling appears to be a reasonable method by which P excretion may be determined.

Key Words: Phosphorus, Feces, Nitrogen

75 Suppressor of cytokine signaling-2 mRNA increases after calving in dairy cows and is associated with elevated estradiol-17 β concentrations before calving. L. A. Winkelman^{*1}, M. C. Lucy², and C. K. Reynolds¹, ¹The Ohio State University, Columbus, ²University of Missouri, Columbia.

Suppressors of cytokine signaling (SOCS) inhibit intracellular growth hormone (GH) signaling. After calving, the somatotrophic axis of the dairy cow is uncoupled, partially due to reduced liver specific GH receptor (GHR 1A) on the liver cell surface. Estradiol-17 β (E2) concentrations increase at calving, and E2 upregulates SOCS-2 mRNA. The presence of SOCS in the liver of transition dairy cows has yet to be examined. We hypothesize SOCS-2 mRNA is upregulated after calving. Multiparous Holstein cows (n = 18) were dried off 45 d before expected calving and fed diets at ad libitum (AL) or restricted (R) DMI during the dry period. The R diet was formulated to meet nutrient requirements at a DMI of 9.4 kg/d, while AL cows consumed 13.7 kg DM/d. All cows were fed the same diet ad libitum for 4 wk after calving. Coccygeal or jugular vein blood samples were collected weekly and more frequently near calving. Liver biopsies obtained at -21, -7, +2, and +28 d relative to calving were assessed for SOCS-2 and GHR 1A mRNA by real time RT-qPCR and were normalized to controls. The relative amount of SOCS-2 mRNA increased after calving ($P < 0.01$) and was greater on +2 d for R vs. AL cows (0.81 vs 0.45, $P < 0.05$). Plasma E2 was greater in R vs. AL (304 vs. 215 pM, $P < 0.05$) and increased before calving ($P < 0.01$). Amount of GHR 1A mRNA did not differ between diets, but tended to decrease on +2 d ($P < 0.20$). In addition to reduced GHR 1A, increased SOCS-2 mRNA after calving, perhaps due to increased E2, may further uncouple GH signaling in the liver of the transition dairy cow.

Table 1. Relative amounts of SOCS-2 and GHR 1A mRNA

Day relative to calving		-21	-7	+2	+28
	No. donor ewes	No. oocytes recovered	No. with PB (%)	No. reconstructed embryos (%)	No. blastocyst (5) from oocytes with PB a
Scottish Blackface	216	1764	1541 (87%) b	1619 (92%)b	11/636 (2%)b
Relative amount of SOCS-2 mRNA ¹	Restricted	0.24	0.36	0.81	0.47
	Ad Libitum	0.26	0.45	0.52	0.62
Poll Dorset	255	1921	1164 (61%)	1540 (80%)	39/399 (10%)c
	SEM	0.045	0.074	0.070	0.095

¹Relative steady state concentration of mRNA, normalized to β -actin. ²Values are expressed as the fold difference in arbitrary units (AU) relative to the amount in a medium control.

Key Words: SOCS-2, Liver, GHR 1A

76 Effects of dietary allocation of barley grains differing in expected starch digestion on rumen fermentation and productivity of lactating dairy cows. C. Silveira^{*1}, M. Oba¹, W. Z. Yang², and K. A. Beauchemin², ¹University of Alberta, Edmonton, AB, Canada, ²Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.

The objective was to evaluate effects of dietary allocation of barley grains differing in expected starch digestion on dry matter intake, rumen fermentation, and milk production of dairy cows. Four primiparous ruminally cannulated (123 \pm 69 d in milk; mean \pm SD) and 4 multiparous ruminally and duodenally cannulated (46 \pm 14 d in milk) cows were used in a 4 \times 4 Latin Square design with a 2 \times 2 factorial arrangement of treatments with 16 d per period. Treatments were two levels of dietary grain allocation (39.4 vs. 26.7% of dietary DM) and two steam-rolled barley grains differing in expected ruminal starch digestion (Xena vs. Dillon). Xena used in this study had higher starch concentration (58.7 vs. 50.0%) and greater in vitro 6-h starch digestibility (78.0 vs. 73.5%) compared with Dillon. All experimental diets were formulated for 17.5% CP and 20.0% forage NDF. Dry matter intake and milk yield were not affected by treatment. Milk fat concentration (3.55 vs. 3.29%; $P < 0.01$) was greater for cows fed Dillon compared with Xena, but not affected by dietary grain allocation. Ruminal acetate concentration was lower, and propionate concentration was greater for cows fed Xena and high grain diets compared with cows fed Dillon and low grain diets, respectively. High grain diets tended to decrease mean ruminal pH (6.10 vs. 6.17; $P < 0.10$) and to increase time below pH 5.8 (6.4 vs. 4.2 h/d; $P < 0.06$), and increased the area below pH 5.8 (5715 vs. 3375 pH \times sec; $P < 0.05$) compared with low grain diets. Cows fed Xena had longer time that ruminal pH was below 5.8 (6.6 vs. 4.0 h/d; $P < 0.03$) and tended to have lower minimum pH (5.45 vs. 5.59; $P < 0.06$) compared with cows fed Dillon. These results indicate that selection of barley grain can affect milk production and rumen fermentation to an extent at least as great as changes in dietary grain allocation.

Key Words: Barley grain, Starch digestibility, Rumen fermentation

77 Characterization of cytokine gene expression in periparturient dairy cows naturally infected with *Mycobacterium avium* subsp. paratuberculosis. E. L. Williams* and J. R. Stabel, *USDA-ARS-National Animal Disease Center, Ames, IA.*

Johne's disease (JD), caused by *Mycobacterium avium* subsp. paratuberculosis (MAP), is estimated to infect more than 22% of US dairy herds. Periods of immunosuppression, typically seen at parturition, may contribute to the transition from subclinical, or asymptomatic, to clinical stage of infection. Understanding the effects of stressors disease may provide information that will help manage JD. The objective of this study was to characterize cytokine gene expression in periparturient dairy cows naturally infected with MAP. Twenty-two multiparous Holstein cows were placed into 3 groups consisting of 5 noninfected healthy cows, 12 subclinical cows, and 5 clinical cows. Blood was collected from the jugular vein 3 wks pre- and 4 wks post-calving. Peripheral blood mononuclear cells (PBMC) were isolated from the buffy coat fractions of blood and cultured for 24 h with and without concanavalin A. At 24 h, RNA was extracted from all cells and converted to first-strand cDNA. Real-time PCR was performed on each sample to evaluate the expression of the following genes: IFN- γ , TNF- α , IL-12, IL-10, TGF- β , IL-4 and β -actin gene. All reactions were performed in triplicate and RT-PCR data was analyzed using delta-Ct values and Proc Mix procedure of SAS. Across the periparturient period, expression of IFN- γ , TNF- α , and TGF- β mRNA did not differ between nil- and stimulated PBMCs isolated from infected and control cows. ConA-stimulated PBMCs showed greater IL-12 mRNA expression for both subclinical ($P < 0.03$) and clinical ($P < 0.04$) cows compared to controls. Expression of IL-4 mRNA from nil- ($P < 0.03$) and stimulated ($P < 0.01$) PBMCs was greater in infected compared to healthy control cows. Expression of IL-10 mRNA from nil- ($P < 0.08$) and stimulated ($P < 0.05$) PBMCs was greater for infected cows compared to control cows. The data indicate an ability of parturition to regulate IL-12 and IL-4 gene expression, but not IFN- γ , TNF- α , TGF- β , or IL-10. Expression for the Th1 cytokine IL-12 and the Th2 cytokines IL-4 and IL-10 from infected cows were significantly elevated compared to healthy controls.

Key Words: Periparturient, Cytokines, Johne's disease

78 Response in diurnal variation of circulating blood metabolites to nocturnal vs. diurnal provision of fresh feed in lactating cows. A. Nikkhah*, J. C. Plaizier, C. Furedi, and A. D. Kennedy, *University of Manitoba, Winnipeg, MB, Canada.*

Our objective was to evaluate the impact of providing fresh TMR at 9 am or at 9 pm on daily average and 24-h variation of blood metabolites in lactating cows. Four multiparous (645 ± 75 kg body weight, BW; 90 ± 33 days in milk) and 4 primiparous (576 ± 46 kg BW; 77 ± 25 days in milk) lactating Holsteins were used in a 2×2 cross-over design with two 6-week periods. Each period consisted of a 4-week adaptation period followed by 2 sampling weeks. A TMR containing 50% concentrate on a dry mater basis was fed ad libitum allowing for between 5 and 10% orts. Blood was sampled via jugular catheter every 2 h for 24-h at week-5 of each period. Data were analyzed using Proc Mixed of SAS (v. 9.1) with appropriate covariance structure for repeated measures. Fresh feed delivery at 9 pm instead of 9 am did not affect daily averages of glucose, lactate, and urea in blood plasma (Table 1). All metabolites showed diurnal variation (H, $P < 0.05$) which for glucose and urea was altered markedly by time of feeding ($T \times H$, $P < 0.0001$, Table 1). Blood glucose in cows fed at 9 pm showed a dramatic preprandial decline lasting until 2 h after feeding, and a

remarkable postprandial rise shortly thereafter. Although less dramatic than in evening fed cows, blood glucose in morning fed cows started to drop at 4 h before feeding and rose gradually at 2 h after feeding. Both groups exhibited a postprandial increase in blood lactate, which was higher and more long-lasting in cows fed at 9 pm than in cows fed at 9 am. Blood urea increased shortly after feeding in morning fed cows but not in evening fed cows. After peak at 2 h post-feeding, blood urea declined progressively until 10 h post-feeding in all cows. Results showed that provision of fresh TMR at different times of a 24-h period alters the diurnal variation of blood metabolites and, thereby, may affect the peripheral nutrient utilization by lactating cows.

Table 1. Effect of time of feeding (T), parity (Par), hour of sampling (H), and the interactions on blood metabolites

Item	Time of feeding			Fixed effect, P					
	9 am	9 pm	SEM T	Par	T \times Par	H	T \times H	Par \times H	
Glucose, mg/dL	75.7	74.9	1.1	0.43	0.60	0.33	0.04	<0.0001	0.01
Lactate, mM	0.67	0.72	0.03	0.23	0.97	0.99	<0.0001	0.19	0.64
Urea, mM	5.06	5.35	0.46	0.32	0.47	0.90	<0.0001	<0.0001	0.66

Key Words: Time of feeding, Diurnal variation, Blood metabolites

79 Assessment of the effects of cinnamon leaf oil on rumen microbial fermentation using two continuous culture systems. G. R. Fraser*¹, A. V. Chaves², Y. Wang², T. A. McAllister², K. A. Beauchemin², and C. Benchaar³, ¹*Nova Scotia Agricultural College, Truro, NS, Canada*, ²*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*, ³*Agriculture and Agri-Food Canada, Dairy and Swine R&D Centre, Lennoxville, QC, Canada.*

The Rumen Simulation Technique (RUSITEC) and a dual flow (DF) continuous culture system were used to investigate the effects of cinnamon leaf oil on rumen microbial fermentation. Incubations were conducted concurrently in the two systems, with the oil added at 0 (control, CON), and 500 μ g/mL (CIN). Eight RUSITEC (920 mL; $n=4$) and six DF (1300 mL; $n=3$) fermenters were randomly assigned to treatment. Inoculum was prepared from four ruminally cannulated, lactating Holstein cattle fed a 50:50 forage to concentrate TMR diet (16.7% CP, 34.4% NDF). Data were analyzed using the PROC MIXED procedure of SAS with a repeated measures analysis of covariance. The model tested main and interactive effects of system type (RUSITEC vs. DF), treatment (CON vs. CIN), and sampling day. In both systems, mean pH was similar ($P > 0.05$) between treatments. Concentration of NH₃ was decreased ($P < 0.01$) by CIN in the RUSITEC (15.4 vs. 20.7 mM) but not in the DF system (average 18.2 mM). In both systems total VFA ($PP < 0.05$) and propionate concentrations ($P < 0.01$) were reduced by CIN, but acetate, butyrate, and branched chain VFA concentrations were unaffected ($P > 0.05$). Protozoa were less numerous ($P < 0.01$) with CIN than in the controls (both systems). Headspace CH₄ concentration was unaffected ($P > 0.05$) by treatment in the RUSITEC (average 1.95%), but was increased ($P < 0.01$) by CIN in the DF system (3.0 vs. 5.6%). Digestibility of DM was similar between CIN and CON in DF (61.8%) but was decreased by CIN (68 vs. 82%; $P < 0.01$) in the RUSITEC for both silage and concentrate feeds. This study suggests that CIN reduces fermentative activity in continuous cultures, possibly as result of its antiprotozoal activity.

Key Words: Essential oils, Rumen microbial fermentation, Continuous culture system

80 Feed peas can successfully replace soybean meal and corn grain in dairy cow diets. M. Vander Pol* and A. N. Hristov, *University of Idaho, Moscow.*

The objective of this experiment was to investigate the effect of partial substitution of soybean meal and corn grain with feed peas in dairy cow diets on DM intake and milk yield and composition. Twenty-four lactating Holstein cows were blocked into 12 groups based on DIM and milk yield at the end of a 2-week covariate period (average DIM, 104±8.0 and milk yield, 39±1.2 kg/d). Cows within group were randomly assigned to two treatments: Control diet (% on DM basis): alfalfa hay, 28.0; corn silage, 17.7; whole cottonseed, 7.0; dry distillers grains, 6.0; rolled barley grain, 12.0; solvent-extracted soybean meal, 7.4; steam-rolled corn, 19.9; and mineral/vitamin supplement, 2.0) and Pea diet (alfalfa hay, 28.1; corn silage, 17.7; whole cottonseed, 7.0; dry distillers grains, 6.0; rolled barley grain, 11.8; solvent-extracted soybean meal, 1.6; steam-rolled corn grain, 10.8; feed peas, 15; and mineral/vitamin supplement, 2.0). Diets were isonitrogenous (18.4% CP) and isoenergetic (1.58 Mcal/kg NE_L). The peas used in the trial (U.S. No. 1 feed peas), contained 25% CP and estimated 1.98 Mcal/kg NE_L. The experiment continued for 70 days. Dry matter intake (25.9 and 26.3 kg/d; SE = 0.67; Control and Pea diet, respectively), milk yield (35.8 and 35.6 kg/d; SE = 0.75), 4% FCM yield (32.6 and 34.3 kg/d; SE = 1.37), milk fat (3.54 and 3.76%; SE = 0.124) and protein (3.00 and 2.99%; SE = 0.047) content and yields were not affected by diet ($P = 0.148$ to 0.851). Concentration of milk urea nitrogen was also not affected ($P = 0.239$) by treatment (14.4 and 15.0 mg/dl, SE = 0.35, respectively). Organoleptic characteristics of milk were evaluated by a consumer panel. Regardless of whether the treatment or the control sample was presented as the reference, panelists guessed right or wrong about 50% of the time ($P = 0.712$). This experiment demonstrated that inclusion of 15% (DM basis) feed peas in dairy cow diets, replacing solvent-extracted soybean meal and corn grain had no effect on DM intake and milk yield, composition, and quality.

Key Words: Feed pea, Dairy cow, Milk production

81 17 β -estradiol concentration in raw and pasteurized/homogenized whole milk. D. A. Pape-Zambito*, R. F. Roberts, N. M. Kauffman, and R. S. Kensinger, *Pennsylvania State University, University Park.*

Many fear that estrogens in dairy products may lead to growth of estrogen sensitive cancers in humans. The presence of estradiol (E₂) in raw whole cow's milk has been previously confirmed. The objective of this study was to determine if pasteurization/homogenization affects E₂ concentration in milk. One hundred kg of fresh raw milk was collected from the PSU dairy herd bulk tank on 4 consecutive days. On each day 1 liter of raw milk was sub-sampled and subjected to no further treatment (C). The remaining milk was pasteurized at 79.4C for 16-18 s and either homogenized at 6.89 MPa (1st stage) and 3.45 MPa (2nd stage) (A), or 17.23 MPa (1st stage) and 3.45 MPa (2nd stage) (B). Milk fat and solids were analyzed with a Smart Trac analyzer. Fat globule size was determined using a Horiba laser scattering particle size analyzer. E₂ was quantified by radioimmunoassay after ethyl

acetate extraction, triglyceride precipitation, and Sephadex LH-20 column chromatography. Tritiated E₂ was used as an internal standard to determine recovery. Statistical analyses were completed using SAS. Milk fat and solids averaged 3.56 ± 0.01 % and 12.44 ± 0.02 %, respectively, and were not affected by treatment. Pasteurization/homogenization reduced fat globule size with mean diameters (D_{3,2}) of 4.58, 0.59, and 0.39 μ m for treatments C, A, and B, respectively. E₂ was correlated with milk fat percent ($R = 0.58$, $P < 0.05$). Concentrations of E₂ were not affected by treatment with means of 0.70, 0.58, and 0.64 pg/ml for C, A, and B, respectively ($P > 0.3$). Based upon these findings, this method can be used to quantify E₂ in fluid milk products. Concentrations of E₂ in raw and pasteurized/homogenized whole milk are low relative to endogenous E₂ in humans, thus are unlikely to cause health problems.

Key Words: 17 β -estradiol, Milk, Pasteurization/homogenization

82 Effects of varying CLA doses on production and bioenergetic variables during the transition period. L. J. Odens*¹, R. Burgos¹, B. C. Pollard¹, M. L. Innocenti^{1,2}, S. H. Baker¹, S. R. Sanders¹, J. K. Kay¹, M. L. Rhoads¹, C. E. Moore¹, M. J. VanBaale¹, and L. H. Baumgard¹, ¹The University of Arizona, Tucson, ²University of Milan, Milan, Italy.

Supplementing a high dose (600 g/d) of rumen-inert CLA inhibits milk fat synthesis in dairy cows immediately postpartum. During negative EBAL it appears moderate CLA-induced milk fat depression (MFD) causes a positive response in milk yield (MY); however, as MFD becomes more severe (>35%), the MY response diminishes. Multiparous Holstein cows (n=31) were randomly assigned to 1 of 3 trts beginning ~10 d prior to expected calving and ceased at 40 DIM: 1) 578 g/d of a RI palm fatty acid (FA) distillate (control), 2) 600 g/d of CLA for the entire trial period (CLA-1), and 3) 600 g/d of CLA until 10 DIM followed by 200 g/d (CLA-2) for the remainder of the trial. Each dose provided equal amounts of FA by replacing and balancing trt with a RI palm FA distillate. Doses provided a total of 522 g of FA/d and either 0, 58 or 174 g of CLA (mixed isomers)/d. To improve palatability, doses were mixed with 600 g/d of dried molasses; one-half of the supplement was fed at 0800 h, and the remaining at 1900 h. Individual MY, DMI and BW were recorded daily and milk composition determined every other d. There was no overall CLA effect on either the content or yield of milk protein or lactose. Both CLA trts decreased overall milk fat content (26.0 & 18.3%) and yield (22.5 & 17.3%) with CLA-induced MFD becoming significant by d 8. The CLA-induced MFD increased in severity with progressing DIM until plateauing on d 18 for CLA-1 (43%) and d 20 for CLA-2 (24%); although neither milk fat t10, c12 CLA content (1.8 mg/g) nor its transfer efficiency (7.3%) changed over time. Trts had no effect on overall DMI or MY, but there was a trt x time interaction ($P < 0.05$) for MY, as cows fed either CLA trt tended to have an increased MY at wk 3, 4 & 6. In addition, cows fed either CLA trt had a significant improvement in overall EBAL (-5.1 vs. -1.8 Mcal/d), a decrease in overall NEFA levels (12%) and an overall increase in glucose levels (11%).

Key Words: CLA, Transition, Milk fat

Meat Science and Muscle Biology

83 Dose titration of ractopamine evaluating the effects on carcass cutout yields in feedlot steers. A. Schroeder*¹, D. Hancock¹, D. Mowrey¹, S. Laudert¹, G. Vogel¹, D. Polser¹, and F. McKeith², ¹*Elanco Animal Health, Greenfield, IN*, ²*University of Illinois, Champaign.*

Ractopamine (RAC), was recently approved by the US FDA CVM for feeding to cattle during the last 28 to 42 of the finishing period. A randomized complete block design, replicated at five sites, was used to evaluate carcass cutout yields of beef steers assigned to one of four treatments (0, 10, 20, or 30 ppm, 100% DM). This resulted in a total of 25 experimental units (8-10 steers/pen) per RAC concentration. A subset of each pen (2 carcasses/pen with HCW nearest to the pen average) was selected. Fifty beef sides from each treatment were fabricated according to standard IMPS specifications for 12 cuts. All cuts were trimmed to 0.1 cm fat thickness. Carcass cutout yields were calculated as a percentage of standardized side weight. Least squares means are given in Table 1. Side weight and standardized side weight were increased ($P<.05$) for the 20 and 30 ppm. When expressed as a percentage of standardized weight, the yields of trimmed shoulder clod, tenderloin, inside round, and gooseneck round were increased ($P\leq.07$) for RAC treatments above control. Total wt of closely trimmed subprimal cuts were increased ($P<.05$) for 20 and 30 ppm (59.3 vs 61.6 and 61.7 kg, respectively.) The yield of total closely trimmed subprimal cuts expressed as a percentage of the standardized side was increased ($P=.07$) for 20 and 30 ppm (36.4 vs 37.1 and 37.1%, respectively.) These data demonstrate that feeding RAC can increase carcass value by improving carcass cutout yields when fed at 20 and 30 ppm for the last 28 to 42 days of the finishing period.

Table 1. Effect of RAC on Cutout Yields

Item	RAC ppm				SE
	0	10	20	30	
Standardized Side, kg	162.67 ^b	163.12 ^b	165.92 ^a	166.28 ^a	0.70
Chuck Roll, %	5.04	5.10	5.12	5.06	0.08
Clod, %	4.26 ^b	4.43 ^a	4.38 ^a	4.35 ^b	0.14
Brisket, %	2.70	2.76	2.72	2.77	0.05
Ribeye, %	3.17	3.22	3.18	3.14	0.04
Back Ribs, %	1.60	1.63	1.60	1.58	0.004
Striploin 1x1, %	2.64	2.59	2.64	2.61	0.03
Tenderloin, %	1.05 ^b	1.08 ^b	1.10 ^a	1.10 ^a	0.04
Top Butt, %	2.83	2.83	2.89	2.92	0.05
Peeled Knuckle, %	2.31	2.34	2.38	2.37	0.08
Inside Round, %	4.59 ^b	4.74 ^a	4.70 ^b	4.74 ^a	0.13
Gooseneck, %	5.72 ^b	5.77 ^b	5.92 ^a	6.02 ^a	0.25
Flank Steak, %	0.49	0.49	0.49	0.47	0.007

^{ab}Means within a row with different superscripts differ from control ($P\leq.07$)

Key Words: Beef steers, Cutout yields, Ractopamine

84 Selection for improvement in pig growth rate does not alter fresh pork quality. C. E. Wagner*¹, E. Huff-Lonergan¹, M. F. Rothschild¹, A. A. Sosnicki^{1,2}, S. B. Jungst², K. J. Prusa¹, and S. M. Lonergan¹, ¹*Iowa State University, Ames*, ²*PIC North America, Franklin, KY.*

It has been hypothesized that selection for improved growth rate can result in a reduction in fresh pork quality. The objective of this study was to investigate the contribution of selection for improved growth

rate to variation in fresh pork quality. A pig population derived from the cross between a commercial line of Duroc sires and white line dams was subdivided according to the sires' estimated breeding value (EBV) for age at 125 kg. The first slaughter group included the most rapid growing pigs sired by High EBV growth boars (n=48) and a control group (n=16). The second slaughter group consisted of the slowest growing pigs sired by Low EBV growth boars (n=48), and a control group (n=16). Loin pH and temperature decline were monitored on each carcass. Fresh pork quality characteristics and water holding capacity were monitored at 2 d postmortem. Sensory traits (juiciness, tenderness, chewiness, flavor, and off-flavor) and star probe texture were measured 10 d postmortem. Pork quality data were analyzed using a mixed linear model including EBV group, sire within EBV group, harvest day, EBV group x harvest day interaction and gender as fixed effects. Dam was considered in the initial analysis, but was removed from final analysis because it did not contribute to the variation of quality traits. Pigs sired by High EBV growth boars were younger at 125 kg (153 d vs. 177 d). Sire EBV group did not affect pH decline in the longissimus dorsi, however, loin temperature at 6 h postmortem was significantly lower in carcasses from pigs sired by Low EBV growth boars. Loin color and drip loss were not affected by EBV group. Loins from pigs sired by fast growth boars had higher subjective marbling scores and higher lipid content than loins from pigs sired by slow growth boars. Sire group did not affect star probe or sensory quality of fresh pork loin. Use of sires with different genetic merit for growth significantly changed growth performance of progeny, but did not significantly affect the quality of fresh pork loin.

Key Words: Growth, Pork quality, Sensory quality

85 Interaction of MC4R and PRKAG3 genotypes with genetic potential for growth on meat quality traits. S. E. F. Guimaraes^{1,3}, M. F. Rothschild¹, E. Huff-Lonergan¹, A. A. Sosnicki^{1,2}, S. B. Jungst², M. Yu¹, and S. M. Lonergan*¹, ¹*Iowa State University, Ames*, ²*PIC North America, Franklin, KY*, ³*Universidade Federal de Vicosa, Vicosa, MG, Brazil.*

Discovery of genetic and biochemical factors that contribute to variation in fresh pork quality is required to improve the value of pork. The objective of this project was to examine individual gene effects on pork loin quality within commercial lines sired by boars within the same overall genetic background but with different genetic merit for growth. A commercial population derived from the cross between a commercial line of Duroc sires and white line dams was subdivided in two groups of slaughter pigs according to the sires' estimated breeding value (EBV) for growth as measured by age to 125 kilograms. Loin pH and temperature decline were monitored on each carcass. Pork quality traits were monitored at 2 d postmortem. Sensory traits were measured 10 d postmortem by a trained panel. The genotypes for MC4R, and PRKAG3 (I199V) were defined. Associations between the genotypes and loin quality traits were tested using the general linear model procedure with a model including EBV group, genotype, sex, sire within EBV group, dam within sire and EBV group, interaction between EBV group and genotype, and slaughter day. PRKAG3 genotype 22 had higher ($P<0.07$) marbling score (2.0) compared to genotype 11 and 12 (1.7 and 1.5). PRKAG3 genotype 22 also resulted in higher ($P<0.05$) off-flavor score (4.2) than genotypes 11 and 12 (3.2 and 3.8). MC4R genotype 12 had higher pH at 120 hr (5.70 vs. 5.66), higher flavor scores and lower off-flavor scores than genotype 22. There was an interaction between growth EBV and MC4R genotype

for pH at 48 h, and 120 h. In both cases, genotype 12 had higher pH than genotype 22 only in pigs sired by fast growing boars. Interestingly, genotype 22 resulted in lower tenderness scores in loins from pigs sired by fast growing boars, but higher tenderness scores in loins from pigs sired by slow growing boars. These results confirm that genotypic effects depend on the background genetic merit for growth.

Key Words: MC4R, PRKAG3, Pork quality

86 Associations between animal, transportation, and slaughterhouse practices and meat pH in beef. N. Mach¹, M. Devant¹, A. Bach^{2,1}, and A. Velarde³, ¹Unitat Remugants, IRTA, Barcelona, Spain, ²ICREA, Barcelona, Spain, ³Centre de Tecnologia de la Carn, IRTA, Spain.

Prolonged muscular activity or stress before slaughter usually results in depletion of glycogen in the muscles, with a consequent reduction of lactic acid production post-mortem. The objective of this study was to evaluate the influence of factors related to animal, farm, transportation, and animal handling at the slaughterhouse, as well as their interactions, on pH of beef meat. A total of 5,649 cattle (341±45 d of age) from 181 different Spanish farms were surveyed in 3 periods (spring, summer, and winter) and 33 variables related to animal, farm, transportation, and animal handling at the slaughterhouse were recorded. Ultimate meat pH was measured at the *Longissimus dorsi* 24 h after slaughter (pH24). After a variable selection procedure a mixed-effects model was conducted with 10 variables (4 random and 6 fixed) to identify the main factors and their interactions affecting pH24. Average incidence of pH24 above 5.8 was 13.81%. The pH24 was greater ($P < 0.01$) in winter (5.74 ± 0.025) than in spring (5.66 ± 0.008) and summer (5.67 ± 0.008), and increased ($P < 0.01$) as transportation time increased (0.0001 ± 0.00006 pH24 increase per km). Bulls pH24 increased ($P < 0.01$) when loaded into a truck with cattle from other farms (5.67 vs 5.70 ± 0.012 , one vs several origins, respectively), when waiting time at slaughterhouse increased ($5.66, 5.69, 5.69, 5.74 \pm 0.013, < 8$ h, $8-12$ h, $12-16$ h, > 16 h, respectively), and when slaughterhouse stocking density was between 3.27 m² to 3.84 m². When the daily number of animals slaughtered was large and waiting time at slaughterhouse increased, pH24 also increased ($P = 0.06$). Despite that the present study indicates that bull handling before slaughter plays an important role in pH24, there is a large proportion of the observed variance on pH that could not be explained.

Key Words: Beef, Meat pH, Preslaughter management

87 The role of integrin and desmin in water-holding capacity in pork. W. Zhang*, E. Huff-Lonergan, and S. Lonergan, Iowa state University, Ames.

The purpose of this study was to examine relationship between the degradation of the proteins integrin and desmin, μ -calpain autolysis and water-holding capacity in pork. Drip loss was measured in the loin after 1 and 5 days of postmortem storage and sirloin purge loss was analyzed after 7 days of storage in meat from sixty-four Duroc x Yorkshire pigs. μ -Calpain autolysis (d 1), intact integrin (d 1, d 5) and intact desmin (d 1, d 7) were evaluated in muscle samples using western blotting. Intensity of intact integrin in postmortem samples at d 1 was negatively correlated with d 1 drip loss ($-0.302, P < 0.05$) and total drip loss (cumulative over d 1-5) ($-0.286, P < 0.05$). At d 5 postmortem, the intensity of intact integrin was significantly negatively correlated to d 2-5 (cumulative) drip loss ($-0.254, P < 0.05$) and d

1-7 (cumulative) total purge loss ($-0.287, P < 0.05$). There were no significant correlations between the intensity of intact integrin at d 1 or d 5 and μ -calpain autolysis at d 1. Intensity of intact desmin at d 1 was positively correlated with d 2-5 (cumulative) drip loss ($0.308, P < 0.05$) and d 1-7 (cumulative) purge loss ($0.480, P < 0.01$). There were significant correlations between the intensity of intact desmin from 7 days samples and d 1 drip loss ($0.363, P < 0.01$), d 2-5 (cumulative) drip loss ($0.259, P < 0.05$), d 1-5 (cumulative) total drip loss ($0.394, P < 0.01$) and d 1-7 (cumulative) total purge loss ($0.279, P < 0.05$). The intensity of intact desmin at d 7 was positively correlated with 80 kDa ($0.346, P < 0.05$) and 78 kDa subunits of μ -calpain ($0.286, P < 0.05$), while it was negatively correlated with 76 kDa subunit ($-0.396, P < 0.01$). However, the intensity of intact desmin at d 1 was not correlated with the μ -calpain autolysis at d 1. Less degradation of integrin was associated with less drip loss in fresh pork. However, more degradation of desmin was associated with less drip loss. These data indicate that these proteins could play different roles in governing drip loss in early postmortem pork.

Key Words: Integrin, Desmin, μ -calpain

88 Impacts of beef cattle diets containing corn or sorghum distillers grains on beef color, fatty acid profiles, and sensory attributes. R. K. Gill¹, D. L. VanOverbeke², and A. DiCostanzo¹, ¹University of Minnesota, St. Paul, ²Oklahoma State University, Stillwater.

Strip loins from 260 carcasses, of crossbred-yearling steers, were evaluated to test the effects of feeding corn (C) or sorghum (S) distillers grains (DG) on beef color, lipid oxidation, fatty acid profiles, tenderness, and sensory attributes. Dietary treatments consisted of a steam-flaked corn (SF C) diet without (control) or with 15% C dry or wet DG (C D DG; C W DG) or S dry or wet DG (S D DG; S W DG) and alfalfa hay (R). Additional treatments included S D DG or S W DG with no hay (NR). In Harvest 2, steaks from steers fed SF C or S DG had lower L*, but higher a* ($P < 0.05$) values than those from steers fed DG or C DG, respectively. Also, L* values in steaks from steers fed S W DG with R were higher ($P < 0.05$) than those from steers fed S W DG with NR. In Harvest 1, feeding DG increased ($P < 0.05$) omega-6 fatty acid concentrations. In both harvest groups, feeding D DG increased ($P < 0.05$) linoleic acid concentrations. In Harvest 2, C DG diets increased ($P < 0.05$) linoleic acid concentrations compared to S DG diets. In addition, increased ($P < 0.05$) concentrations of α -linolenic acid in steaks resulted from feeding S D DG or S W DG with R. Across both Harvest groups, feeding DG increased ($P < 0.05$) the omega-6:omega-3 ratio when compared to SF C, and feeding C DG increased ($P < 0.05$) this ratio when compared to S DG. Furthermore, steaks from steers fed C DG had greater ($P < 0.05$) concentrations of *trans*-vaccenic acid than those steaks from steers fed S DG. Also, in Harvest 1, the CLA isomer 18:2, *trans*-10, *cis*-12 was increased ($P < 0.05$) in steaks from DG diets. On d 1 of retail display, in Harvest 2, steaks from steers fed S D DG with R had higher ($P < 0.05$) TBAR values than those from steers fed S D DG with NR. Feeding DG at 15% of the dietary DM did not affect sensory attributes or WBSF values.

Key Words: Distillers grains, Beef quality, Fatty acid profiles

89 Solution enhancement and post-enhancement storage effects on the quality, sensory and retail display characteristics of beef triceps brachii muscles. C. W. Rowe*¹, R. T. Baublits¹, A. H. Brown, Jr.¹, F. W. Pohlman¹, E. J. Yancey², Z. B. Johnson¹, and P. Dias-Morse¹, ¹University of Arkansas, Fayetteville, ²Tyson Foods, Inc., Rogers, AR.

Beef triceps brachii muscles (6 d postmortem; n = 15; muscle sections, n = 45) were sectioned into thirds and allocated to one of three treatments. The treatments were untreated (CNT), or injected at a 12% pump rate with either tap water-only (H2O) or a solution comprising tetrasodium pyrophosphate and sodium chloride at 0.4% and 1.0% target final product weight concentrations, respectively (TSPP/NaCl). Each muscle (comprising all three treatments) was then allocated to 2, 14, or 28 d of vacuum-packaged 1 °C storage. Purge losses during storage were greatest ($P < 0.05$) for H2O muscles and least ($P < 0.05$) for TSPP/NaCl muscles. Purge losses also increased ($P < 0.05$) from 2 d to 14 d of storage. Steaks enhanced with TSPP/NaCl had less ($P < 0.05$) free water and lower ($P < 0.05$) cooking losses than either CNT or H2O steaks. Storage duration did not affect ($P > 0.05$) Warner-Bratzler shear force (WBS) or sensory tenderness, but juiciness decreased ($P < 0.05$) with increased storage duration. While storage duration did not impact ($P > 0.05$) instrumental color characteristics, aerobic plate counts generally increased during storage. The TSPP/NaCl steaks had lower ($P < 0.05$) WBS values, and improved ($P < 0.05$) sensory tenderness and juiciness characteristics compared to CNT or H2O steaks. While CNT steaks had greater ($P < 0.05$) L* values (lightness) than TSPP/NaCl steaks, TSPP/NaCl steaks had similar ($P > 0.05$) oxymyoglobin proportions (630/580 nm) and a* values (redness) as CNT steaks. These results suggest enhancement with TSPP/NaCl can improve triceps brachii yield and palatability characteristics. Increased post-enhancement storage did not impact or worsened palatability while increasing purge losses, suggesting general deleterious effects of increased postmortem storage for this muscle.

Key Words: Beef, Enhancement, Storage

90 Dietary high-tannin sorghum reduces oxidation in rat muscles. R. Larrain* and J. Reed, University of Wisconsin, Madison.

High tannin sorghums (HTS) contain proanthocyanidins (condensed tannins), which have antioxidant activity. The objective of this study was to test if diets containing HTS reduce lipid and protein oxidation in muscles of rats. Male Sprague Dawley rats were used in a factorial design with four diets and two feeding periods. Diets modified from NIH-07 contained corn and HTS at a ratio of 0:50, 20:30, 35:15 and 50:0 percent of the diet (S0, S20, S35 and S50, respectively). HTS had 37.6 mg/g proanthocyanidins (vanillin method). Feeding periods were 2 and 10 weeks (2W and 10W). Rats were randomly assigned to diets within each feeding period (n=9 or 10). Rats in 2W and 10 W groups started the experiment at 13 and 5 weeks of age, respectively. They were killed by decapitation. Samples of longissimus and soleus muscles were taken immediately post-mortem. After 48 hrs of storage at 4°C, same muscles from the other half of the carcass were sampled and stored wrapped in O₂ permeable film at 4°C in the dark for 6 days. Markers of lipid and protein oxidation (TBARS and carbonyl content) were evaluated. Each muscle was analyzed independently. Factors in the model were diet, feeding period, storage and their interactions. Comparisons were made using LSD to S0 within storage and feeding period. After 6 days of storage, soleus muscle from 2W-S50 had

significantly lower ($P < 0.05$) TBARS than 2W-S0 (6.86 ± 1.49 vs. 11.22 ± 1.57 nmol/mg protein) and 10W-S35 had significantly lower TBARS than 10W-S0 (5.95 ± 1.57 vs. 10.54 ± 1.49). Carbonyls were significantly lower in 2W-S35 and 2W-S50 compared to 2W-S0 in aged soleus (4.71 ± 0.43 and 4.12 ± 0.41 vs. 6.15 ± 0.43 nmol/mg protein) and in 10W-S20, 10W-S35 and 10W-S50 compared to 10W-S0 in aged longissimus (7.23 ± 0.23 , 6.47 ± 0.23 , 7.03 ± 0.21 vs. 8.12 ± 0.21). Oxidation markers were reduced in rat muscles after 6 days of storage and were muscle dependent: longissimus had differences only in carbonyls while soleus in both TBARS and carbonyls. HTS has the potential to be used in animal diets to reduce oxidation in muscle foods.

Key Words: Proanthocyanidins, Oxidation, Sorghum

91 Effect of birth weight and feeding strategies during the growing-finishing period on growth performance, carcass characteristics, and meat quality in pigs. G. Bee*, C. Biolley, B. Dougoud, W. Herzog, and G. Guex, Agroscope Liebefeld-Posieux, Swiss Federal Research Station for Animal Production and Dairy Products (ALP), Posieux, Fribourg, Switzerland.

Compared to heavier littermates, low-birth-weight pigs tend to exhibit slower growth, increased fat deposition, and impaired meat quality such as tenderness. Feeding strategies aiming to reduce large intra-litter variations in muscle growth will benefit production economy and improve quality uniformity of pork. Thus, the effects of 3 feeding regimes applied during the growing-finishing period on growth performance, carcass characteristics, and meat quality traits of the LM and dark (STD) portion of the semitendinosus were assessed in low-(LW = 1.12 kg) and high-birth-weight barrows (HW = 1.94 kg). From 21 litters the lightest and heaviest barrow was selected and randomly assigned to one of 3 dietary treatments; AA: ad libitum feed access from 27 to 102 kg BW, RA: restricted feeding from 27 to 63 kg and ad libitum feed access from 63 to 102 kg BW, and RR: restricted feeding from 27 to 102 kg BW. Regardless of the birth weight, AA- and RA-barrows grew faster ($P < 0.01$) than RR-barrows (0.76 vs. 0.66 kg/d). The ADFI was highest ($P < 0.01$) in AA- (2.11 kg), intermediate in RA- (1.99 kg), and lowest in RR-barrows (1.77 kg). In the 3 treatment groups LW-barrows consumed more feed (204 vs. 193 kg; $P < 0.01$) and were less efficient (G/F: 367 vs. 380 g/kg; $P = 0.01$) than HW-barrows. Carcasses of the LW-barrows had lower ($P = 0.02$) lean percentage (55.0 vs. 56.5%) and higher ($P = 0.03$) percentages of subcutaneous (14.9 vs. 13.4%) and omental fat (1.8 vs. 1.5%) than HW-barrows. The LM of RA-barrows was lighter (L*: 52.6 vs. 50.6; $P = 0.03$) than the LM of AA- and RR-barrows. Shear force values tended to be higher ($P = 0.08$) in the LM (4.0 vs. 4.3 kg) and STD (4.2 vs. 4.7 kg) of RR- than of AA- and RA-barrows. The LM of LW-barrows was more yellow (b*: 3.2 vs. 2.8; $P = 0.05$) and redder (a*: 6.4 vs. 5.9; $P = 0.08$) than the LM of HW-barrows. The present findings revealed that independent of the feeding regime low birth weight was associated with impaired carcass quality. Furthermore, compensatory growth positively affected meat tenderness also in low birth weight pigs.

Key Words: Birth weight, Compensatory growth, Meat quality

92 Intramuscular administration of zinc metallothionein to preslaughter-stressed pigs improves anti-oxidative function and pork quality. L. L. Li¹, Z. P. Hou¹, Y. H. Liu², D. X. Hou³, B. Zhang², G. Y. Wu^{1,4}, C. B. Yang¹, X. J. Yang¹, Z. R. Tang¹, Y. L. Yin^{*1}, and M. Z. Fan^{1,5}, ¹*Institute of Subtropical Agriculture, The Chinese Academy of Sciences, Changsha, Hunan, P.R. China*, ²*Hunan Agricultural University, Changsha, Hunan, P.R. China*, ³*Kagoshima University, Kagoshima, Japan*, ⁴*Texas A&M University, College Station*, ⁵*University of Guelph, Guelph, Ontario, Canada*.

This study was conducted to determine the effects of exogenous zinc-metlothionein (Zn-MT) on anti-oxidative function in pork meat. After feeding a corn- and soybean meal-based diet for two weeks, 48 pigs (Duroc×Landrace×Chinese Black Pig) were assigned randomly into one of four treatment groups (12 pigs/group). Pigs in group 1 were maintained under non-stress conditions, whereas pigs in groups 2, 3 and 4 were aggressively handled for 25 min to produce stress. Then, pigs in groups 1 (control group) and 2 (negative control group)

received intramuscular administration of saline, while pigs in groups 3 (low dose group) and 4 (high dose group) received 0.8 and 1.6 mg rabbit liver Zn-MT per kg body weight, respectively. Pigs were slaughtered at 3 and 6 h post-injection. Zn-MT treatment increased ($P < 0.05$) the activities of superoxide dismutase (SOD) and glutathione-peroxidase (GSH-PX) while decreasing the concentration of malondialdehyde (MDA) in the liver. These responses were greater ($P < 0.05$) at 6 h than at 3 h post Zn-MT injection. Zn-MT treatment increased ($P < 0.05$) hepatic SOD mRNA levels in a time- and dose-dependent manner, and decreased ($P < 0.05$) blood activities of glutamate-pyruvate transaminase and lactate dehydrogenase (indicators of tissue integrity). Zn-MT administration decreased ($P < 0.05$) lactic acid concentrations, thereby increasing ($P < 0.05$) the pH and water-holding capacity of the meat. Collectively, our results indicate that intramuscular administration of Zn-MT to preslaughter-stressed pigs improves tissue anti-oxidative ability and pork quality. Supported by funds from the Chinese Academy of Sciences and China NSF.

Key Words: Stress, Metallothionein, Pork quality

Nonruminant Nutrition: Nursery Nutrition - Swine

93 Supplemental inulin affects digesta soluble Fe and sulfide concentrations in weanling pigs. K. Yasuda^{*1}, K. R. Roneker¹, D. D. Miller², R. M. Welch³, and X. G. Lei¹, ¹*Cornell University, Ithaca, NY*, ²*Cornell University, Ithaca, NY*, ³*USDA/ARS, U.S. Plant, Soil and Nutrition Laboratory, Ithaca, NY*.

Our laboratory has shown previously the improvement of bioavailability of dietary Fe for hemoglobin repletion by supplemental inulin in weanling pigs. The objective of this study was to determine the metabolic mechanisms for that improvement conferred by inulin. Twelve weanling pigs (BW = 7.70 ± 0.19 kg, n=6 per treatment,) were fed a corn-soybean meal based diet (BD, without inorganic Fe addition, 54 mg Fe/kg) or the BD + 4% inulin (Synergy 1, Orafiti, Tienen, Belgium) for 6 wk. Body weight gain and blood hemoglobin concentrations of individual pigs were measured weekly, and feed intake of individual pigs was recorded daily. All pigs were killed at the end of trial to collect digesta samples from stomach, duodenum, jejunum, cecum, and colon to assay for pH, phytase activity, and concentrations of total soluble Fe and sulfide. Compared with those fed the BD, pigs fed 4% inulin had higher ($P < 0.05$) hemoglobin repletion efficiency (20.4 vs. 24.9%), soluble Fe concentration in colon digesta (1.2-1.6 vs. 2.1-2.9 μmol/g), and phytase activity in lower jejunum digesta (19.1 vs. 42.5 mU/g), but lower ($P < 0.05$) sulfide concentration in distal colon digesta (4.8 vs. 3.3 μmol/g). There was no significant difference in growth performance, digesta pH, or digesta concentrations of total Fe between the two groups of pigs. In conclusion, supplemental inulin enhanced Fe solubility and decreased Fe binding compound sulfide in colon digesta. (Supported in part by a grant from Harvest-Plus, International Food Policy Research Institute, Washington DC).

Key Words: Inulin, Pigs, Iron

94 Additivity of effects of copper and zinc in diets for weaned piglets on a commercial farm. V. G. Perez-Mendoza^{*1}, M. U. Steidinger², G. R. Hollis¹, T. M. Fakler³, and J. E. Pettigrew¹, ¹*University of Illinois, Urbana-Champaign*, ²*Swine Nutrition Services Inc, Anchor, IL*, ³*Zinpro Corporation, Eden Prairie, MN*.

A total of 1008 newly weaned pigs (21 d old; 5.25±1.0 kg) were used in a commercial farm to test whether the performance effects of

organic copper (Availa-Cu) are additive to the performance effects of zinc oxide (ZnO). This was a RCBD with 4 dietary treatments in a 2x2 factorial arrangement of Availa-Cu (0 vs. 100 ppm Cu) and ZnO (0 vs. 3000 ppm Zn); pigs were blocked by weight and room (3 wt categories and 4 rooms). Pens were experimental units with 21 pigs; gender distribution was equal within blocks. Copper was added throughout the entire experiment (6 wk) and ZnO only during the first 2 wk; these high levels of Cu and Zn were in addition to the nutrient levels provided by the standard trace mineral premix. This was a 4-stage feeding program with decreasing diet complexity: 1, 1, 2 and 2 wk per phase. Diets used in phases 1 and 2 were in mini-pellet form, and phases 3 and 4 were in meal form. The only interaction ($P=0.05$) between Cu and Zn was in ADFI during the first week, which was increased by Zn in the absence (106 vs. 134 g; $P < 0.01$), but not in the presence (130 vs. 132 g; SEM=6.5; $P=0.88$) of Cu. During the entire 6-wk period both Cu and Zn increased ($P < 0.001$) ADG and ADFI: Availa-Cu increased ADG by 33 g in the absence of Zn (250 vs. 283 g; $P < 0.001$), and by 15 g in the presence of Zn (300 vs. 315 g; SEM=12.3; $P < 0.09$); there was not an interaction ($P=0.14$). Availa-Cu increased ADFI by 44 g in the absence of Zn (401 vs. 445 g; $P < 0.001$), and by 22 g in the presence of Zn (459 vs. 481 g; SEM=17.1; $P < 0.06$); there was not an interaction ($P=0.18$). An outbreak of diarrhea due to *E. coli* caused a high rate of pig removal (including mortality), which was reduced ($P < 0.001$) by Zn (17.1 vs. 6.6%; SEM=2.1). These results show beneficial effects of both Availa-Cu and zinc oxide, and the lack of significant interaction suggest that the effects are at least partially additive. These results also confirm the protective effect of ZnO against enteric infections.

Key Words: Organic copper, Zinc oxide, Weaned pigs

95 Importance of vitamin B₁₂ enterohepatic cycle in growing pigs. D. P. Prévraud^{*1,2}, C. L. Girard¹, F. Guay², N. Le Floc'h³, and J. J. Matte¹, ¹*Agriculture and Agri-Food Canada, Lennoxville, Qc, Canada*, ²*Laval University, Ste-Foy, Qc, Canada*, ³*INRA, St-Gilles, France*.

Endogenous B₁₂ in the small intestine originates from the enterohepatic cycle (EHC) and from the low bioavailable B₁₂ vitamers synthesized

by enteric bacteria. This EHC allows the release of B₁₂ from the liver into the duodenum through the bile secretion and its reabsorption further in the small intestine. Although the concept is well known, its physiological importance for B₁₂ homeostasis remains to be established. This study aimed to estimate the absorption of intestinal endogenous B₁₂ in pigs. Six pigs (32.4 ± 2.8 kg BW) fed a B₁₂ free diet since weaning at 21 d of age were surgically equipped with catheters in the portal vein and in a carotid; an ultrasonic flow probe was also installed around the portal vein. Blood samples were collected simultaneously from the 2 catheters for B₁₂ determination and portal flow measurements were recorded every 45 min for the first 3 h post-feeding, and every hour for the following 21 h. The portal net flux of B₁₂ was calculated at each sampling time and the area under that curve represented the total daily amount of B₁₂ reaching the portal circulation. For a 24 h period, the mean value (±SE) was 1.1 ± 1.0 µg and, globally, did not differ from 0 (P=0.35). During the first 6 h post-feeding, the portal net flux of B₁₂ was negative, possibly due to B₁₂ utilization by the intestinal wall. From 12 to 18 h post-feeding, the portal net flux of B₁₂ became positive and different from 0 (P<0.05) suggesting then a late but small net absorption of B₁₂. Using the B₁₂ content measured in bile and its volume produced daily (Juste, 1982. INRA publ.12:155-73), the estimated total B₁₂ released through the bile was 1.3 µg/d. Based on this value, a maximum of 85.4 % of the amount of biliary B₁₂ would be reabsorbed in the ileum assuming that the enteric provision of bacterial B₁₂ is negligible. Such value was similar to what was estimated in humans. In conclusion, it appears that B₁₂ from the EHC, although apparently highly bioavailable, represents a small pool of B₁₂ and is unlikely to interfere with the evaluation of B₁₂ absorption when pigs are fed dietary levels of ±15 µg/kg as recommended by NRC (1998).

Key Words: Vitamin B₁₂, Enterohepatic cycle, Pigs

96 Bioavailability of dietary cyanocobalamin (vitamin B₁₂) in growing pigs. J. J. Matte*¹, D. P. Prévraud^{1,2}, F. Guay², and C. L. Girard¹, ¹*Agriculture and Agri-Food Canada, Lennoxville, QC, Canada*, ²*Université Laval, Québec, QC, Canada*.

There are few data on bioavailability of vitamin B₁₂ in pigs; isotope tracer methods were used in the 70's (Ford et al, 1975, Br. J. Nutr.34:469-92) with suckling piglets. There is no reference value for older pigs. The present study aimed to generate such information using body deposition of the vitamin as the criterion in growing pigs. Piglets were fed a diet without supplemental B₁₂ from 3 (weaning) up to 8 wk of age. Blood samples were collected in order to determine plasma B₁₂. Fifteen repetitions of 3 pigs were formed according to their B₁₂ status evaluated from the plasma B₁₂ and plasma volume (estimated at 4 % of BW, 31.7 ± 0.5 kg). Then, one pig (IN) from each repetition (n = 15) was sacrificed. Liver, empty digestive tract and carcass were weighed, frozen and minced. Representative samples were collected and analysed for B₁₂ concentration. The remaining 2 piglets, in each repetition, were transferred to metabolic cages and fed for 8 d, 25 or 250 µg of cyanocobalamin per day (corresponding to 20 or 200 ppb, respectively). Urine was collected and sampled twice a day during the whole period. At the end of the collection period, the pigs were sacrificed as for pig IN of each repetition. Results are summarized in the Table. Although affected by the dietary treatments (P<0.01), it appears that urine is a negligible pool of B₁₂ (<1 %). The total content of B₁₂ in the carcass and intestinal tract rose (P≤0.01) as dietary B₁₂ increased. The additional amount of B₁₂ transferred in the carcass (vs 0 ppb) was 58.4 % higher (P<0.01) with 200 ppb (75.4 ± 7.9 µg) than with 20 ppb (47.6 ± 7.0 µg). For the intestinal tract, the pool was small

at ± 5 % of the whole body. In liver, the B₁₂ content tended (P<.07) to increase with the level of dietary B₁₂. For the whole body, the B₁₂ content increased (P<0.01) with the level of dietary B₁₂, the effect being more marked, as for liver, between 0 and 20 ppb. In conclusion, the bioavailability of B₁₂ decreased considerably with dietary levels of cyanocobalamin. Nevertheless, the effect on carcass indicated that a supplement of 200 ppb could be a valuable tool to enrich pork meat in vitamin B₁₂.

Table 1. B₁₂(µg) in the different metabolic pools

Dietary B12 (ppb)	Urine	Carcass	Liver	Intestinal tract	Whole body	Bioavailability (%)
0	--	132.4±4.7 ^a	96.2±5.8 ^x	10.2±0.4 ^a	238.8±8.7 ^a	--
20	1.0±.3 ^a	180.0±7.5 ^b	117.4±7.1 ^y	14.7±.6 ^b	313.0±12.2 ^b	37.1±5.9 ^a
200	2.2±.3 ^b	207.8±8.2 ^c	113.8±7.5 ^y	19.4±.9 ^c	343.1±12.1 ^b	5.2±.6 ^b

Values (mean±SE) with ^{a, b or c} and ^{x,y} are different at P≤0.01 and P≤0.07, respectively

Key Words: Vitamin B₁₂, Bioavailability, Pigs

97 Evaluation of a extruded wheat and milk by-product mixture in diets for early-weaned pigs. J. C. Sánchez, M. P. Serrano, D. G. Valencia, R. Lázaro, and G. G. Mateos*, *Universidad Politécnica de Madrid, Spain*.

Condensed whey (MP) is a by-product of the cheese and milk protein industry that results from the ultrafiltration and pasteurization of liquid whey. On DM bases. MP is rich in lactose (46%) and has a moderate amount of CP (12%), MP is high in electrolytes (6.1% K; 3.8% Cl; 2.1% Na). The MP, conveniently mixed with wheat (W), can be extruded (HP), a process that reduces the moisture content of the mixture to less than 10%. We studied the benefits of including a mixture (W-MP) composed of 80% wheat and 20% MP (W-MP) on coefficient of total tract apparent digestibility (CTTAD) and performance of pigs weaned at 21 d. There were five experimental diets: 1) 49% raw wheat and 20% dried whey; 2) 31% W-MP, 25% raw wheat, and 14% dried whey; 3) 62% W-MP and 8% dried whey; and 4) and 5) same than diets 1 and 2 but replacing the raw wheat for HP wheat. All the diets have similar nutrient content except for the electrolytes that increased with increasing levels of MP. Each treatment was replicated seven times (six piglets) and the trial lasted 28 d. From 21 to 39 d of age piglets fed diets containing HP wheat grew more (308 vs. 282 g/d; P ≤ 0.05) and tended to be more efficient (1.14 vs. 1.19 g/g; P ≤ 0.10) than piglets fed diets containing W-MP but the effects disappeared with age. Replacing wheat (either raw or HP) and dried whey with equivalent amounts of W-MP increased CTTAD of nutrients (P ≤ 0.01). Also, HP of wheat increased the digestibility of OM, CP, and GE (P ≤ 0.01) over raw wheat. Pigs fed diets with high levels of MP and HP wheat (diets 3 and 5) had a higher incidence of diarrhea than pigs fed diets based on raw wheat and dried whey (P ≤ 0.01). We conclude that the inclusion of an extruded mixture of wheat and milk by-product increased nutrient digestibility but has little effect on productive traits. The high content of minerals of the milk by-product tested may be responsible for the higher incidence of diarrhea observed and might preclude its use at high levels in diets for young pigs.

Key Words: Piglet performance, Wheat, Milk by-product

98 Use of rice in substitution of corn and zinc oxide in diets for young pigs. B. Vicente, D. G. Valencia, J. C. Sánchez, R. Lázaro, and G. G. Mateos*, *Universidad Politécnica de Madrid, Spain.*

We studied the influence of the cereal (rice vs corn) and the inclusion of zinc oxide (ZnO) in the diet on performance of pigs weaned at 21 d. Control pigs received a complex diet based on milk products, fish meal, and 47% extruded corn. Neither animal plasma nor growth promoters were included in this diet. The experimental groups received the same complex diet as the control group but corn was substituted by rice either raw, cooked or extruded. In addition, there was an extra diet based on extruded rice that included 0.3% ZnO. Each treatment was replicated six times (six piglets penned together) and the trial lasted 28 d. The percentages of starch gelatinisation (SG) and resistant starch of the cereal were 83.6 % and 4.04% for extruded corn, 20% and 2.70% for raw rice, 51.2% and 2.68% for cooked rice, and 76.2% and 2.85% for extruded rice. From 21 to 28 d of age ZnO inclusion reduced the incidence of scours (7.05 vs. 0.80 %; $P < 0.01$) and improved growth (196 vs. 133 g/d; $P < 0.05$) and G:F ratio (1.09 vs. 0.90 g/g; $P < 0.10$). At the end of the trial (49 d of age) ZnO inclusion tended to increase ADFI (501 vs. 453 g/d; $P < 0.10$) but did not affect ADG or G:F ratio. Also at this age, piglets fed the rice containing diets grew faster (402 vs. 341 g/d; $P < 0.01$), tended to eat more feed (500 vs. 479 g/d; $P < 0.10$), and had better G:F ratio (0.80 vs. 0.71 g/g; $P < 0.01$) than piglets fed corn. Rice extrusion did not improve piglet performance ($P < 0.01$) as compared to raw or cooked rice. It is concluded that the inclusion of ZnO reduces the incidence of scours and improves growth from 21 to 28 d and that rice, either raw or cooked to obtain a moderate degree of SG improves piglet performance from 21 to 49 d. A further increase in the degree of SG, as that obtained with extrusion of rice, did not improve pig performance. The inclusion of ZnO during the first days after weaning and of rice either raw or moderately cooked during the prestarter phase is recommended in piglet diets.

Key Words: Rice, Piglet performance, Starch gelatinization

99 Dietary spray dried (immune) plasma protects against experimental F4+ Escherichia coli post-weaning diarrhea in pigs. T. Niewold¹, A. Van Dijk*², P. Geenen³, H. Roodink⁴, R. Margry², and J. Van Der Meulen¹, ¹*Katholieke Universiteit Leuven, Leuven, Belgium*, ²*CCL Research, Veghel, The Netherlands*, ³*Utrecht University, Utrecht, The Netherlands*, ⁴*Sonac, Loenen, The Netherlands*, ⁵*Animal Sciences Group of Wageningen UR, Lelystad, The Netherlands.*

In order to establish the effect of spray dried porcine plasma powder (SDPP) and spray dried porcine immune plasma powder (SDPIP) on pig health and performance, a diet containing either SDPP or SDPIP was compared to a standard weaning ration in a model of enterotoxigenic F4+ Escherichia coli post-weaning diarrhea. Plasma was obtained at slaughter from non-immunized pigs, and from pigs immunized with a vaccine containing F4 and LT. Newly weaned piglets (n=96) were housed in groups of eight and were given pelleted control feed, or feed containing either 8% SDPP, or 8% SDPIP. Rectal fecal samples were taken daily and were assessed for diarrhea (as percentage of dry matter), and F4+ E. coli excretion (CFU/g). Average daily gain of the piglets was determined. At necropsy, jejunal samples were taken for determination of the F4R status by brush border adhesion assay. In total 30% of the piglets were determined to be F4 receptor positive (F4R+). Statistical analysis (REML variance components analysis) showed a significant correlation between F4R status and morbidity. SDPIP significantly improved all parameters in F4R+ animals and reduced diarrhea in F4R- piglets. SDPP however, reduced diarrhea

in F4R+ animals without reduction of F4+ E. coli excretion. We believe that this could (partly) be explained by the occurrence of neutralizing anti-LT antibodies in SDPP, which reflects natural exposure to pathogens. Antibody titers of the piglets against F4 and LT were found to be related to parity of the sow, diet, and F4R status of the piglets. In conclusion, comparing SDPP and SDPIP it is evident that the latter not only protects against diarrhea, but also reduces F4+ E. coli excretion. As a consequence, transmission within a herd will be reduced, and a larger effect on pig health and performance can be expected.

Key Words: Pig, E.coli, Plasma

100 Effects of soybean meal concentration on growth performance of nursery pigs fed simple and complex diets. P. M. Clark*, J. D. Hancock, K. C. Behnke, and A. C. Fahrenholz, *Kansas State University, Manhattan.*

Two 35-d growth assays were conducted to determine the effects of soybean meal (SBM) concentration on performance of nursery pigs fed simple and complex diets. For Exp. 1, 168 weaning pigs (avg initial BW of 6.9 kg) were used. The control diet for d 0 to 7 was formulated to 1.80% lysine. Treatments were none, 10, 20, and 30% SBM added to replace corn on a wt:wt basis. A common diet was fed to all pigs from d 7 to 21 (1.6% lysine) and d 21 to 35 (1.35% lysine). For d 0 to 7, ADG and ADFI were not affected ($P > 0.21$) by concentration of SBM in the diet. However, there were linear increases in G:F for d 0 to 7 ($P < 0.001$), d 0 to 21 ($P < 0.05$), and overall (d 0 to 35, $P < 0.01$) as SBM concentration was increased from none to 30%. For Exp. 2, another 168 weaning pigs (avg initial BW of 6.3 kg) were used. Treatments were diet complexity (without and with 10% fishmeal and 10% plasma protein) and SBM concentration (none and 30%) arranged as a 2 x 2 factorial. For d 0 to 7, there were no interactions among diet complexity and SBM concentration for ADG, ADFI, and G:F ($P > 0.39$). However, ADG was 30% greater for pigs fed complex vs simple diets ($P < 0.001$) and 22% greater for pigs fed diets with 30% SBM vs none ($P < 0.003$). Overall (d 0 to 35) there were no significant treatment interactions or main effects on ADG, ADFI, and G:F ($P > 0.13$). In conclusion, it appears that use of high concentrations of SBM in simple and complex diets for weaning pigs had no negative effects on growth performance.

Table 1.

	Exp. 1, d 0 to 7				SE
	SBM, % 0	SBM, % 10	SBM, % 20	SBM, % 30	
ADG, g	353	335	368	362	17
ADFI, g	281	270	274	258	13
G:F, g/kg	1,256	1,240	1,343	1,403	31
	Exp. 2, d 0 to 7				SE
	Simple None	Simple 30%	Complex None	Complex 30%	
ADG, g	209	278	296	337	14
ADFI, g	225	254	256	270	16
G:F, g/kg	928	1,094	1,156	1,248	94

Key Words: Nursery pig, Soybean meal, Diet complexity

101 Supplemental effects of lactobacillus based probiotics on aerial odor production and growth performance of pigs. S. K. Kommera*, R. D. Mateo, D. A. Monson, and S. W. Kim, *Texas Tech University, Lubbock*.

Probiotics (Lactocare, GBTech) containing *Lactobacillus plantarum* and *Lactobacillus salivarius* were added to pig diets to test their effect on odor emission from pig excreta and growth performance of pigs. Ninety six, 28 d old, pigs were allotted to three treatments: the CON (without any probiotics), the LL (with the liquid type probiotic at 0.1%) and the SB (with the powder type probiotic at 0.1%). There were 4 replicates per treatment and 8 pigs per pen. Pigs were fed the assigned diets ad libitum for 5-wk. Weight gain and feed intake of pigs were measured weekly until wk 3. From wk 3, all pigs in each pen were moved to a pen (1.2 x 2.4 m) in a ventilated environmental chamber (3.0 x 3.0 x 2.4 m) for 70 h to measure aerial ammonia, amine, and hydrogen sulfide production from the pigs under controlled conditions at 10 min intervals using two gas monitors (Pac III and Miniwarn, Draeger Safety, Inc., Pittsburgh, PA). The fan was working continuously and constantly during the experimental period. Feed intake and weight gain of pigs during the 70 h period were also measured. Pigs in the SL and LL had greater ($P < 0.05$) ADG and ADFI than pigs in the CON during the 3 wk feeding period, whereas gain:feed ratios were the same among the treatments. Averaged ammonia levels during the last 2-h collection period from the SL (8.4 ppm) and LL (7.8 ppm) were lower ($P < 0.05$) than that from the CON (9.3 ppm). Averaged amine level during the last 2-h collection period from the LL (7.3 ppm) was lower ($P < 0.05$) than that from the CON (9.5 ppm) and was not different from the SL (8.0 ppm). Using the slope ratio analysis, the rates of increase of aerial ammonia and amine from the LL (0.108 and 0.062, respectively) and the SL (0.107 and 0.066, respectively) were different ($P < 0.001$) from the CON (0.129 and 0.080, respectively). Hydrogen sulfide was not detectable during the 70 h period. This study shows that ammonia and amine from pig excreta can be reduced and the growth performance can be improved by dietary supplementation of a probiotic with *Lactobacillus plantarum* and *Lactobacillus salivarius*.

Key Words: Lactobacillus, Odor, Growth performance

102 The effect of salmon protein hydrolysate and spray-dried porcine plasma on growth performance of nursery pigs. J. Tucker*, B. Perkins, S. Johnston, T. Bidner, and L. Southern, *LSU Agricultural Center, Baton Rouge*.

The objective of this research was to evaluate the effects of salmon protein hydrolysate (SPH) and spray-dried porcine plasma (SDPP) on growth performance of nursery pigs (17 to 21 d weaning age; 5.86 kg initial BW; Phase 1, 7 or 8 d; Phase 2, 14 d; and Phase 3, 7 or 8 d). The SPH is a protein source enzymatically-produced from Atlantic salmon and Rainbow trout tissues; it consists of free AA, peptides, and protein. A total of 644 nursery pigs (10 to 14 replicates per treatment with 5 to 6 pigs per pen) were used in a series of 2 experiments with 2 trials each. In Exp. 1, pigs were fed a conventional complex Phase 1 nursery diet containing: 1) no SPH or SDPP; 2) 1.5% SPH; 3) 1.5% SDPP; 4) 3.0% SPH; 5) 3.0% SDPP; or 6) 1.5% SPH and 1.5% SDPP. Pigs were then fed the same Phase 2 and 3 diets with no experimental ingredient. In Exp. 2, pigs were fed a conventional complex Phase 1 nursery diet (no mammalian protein source) containing: 1) no SPH or SDPP; 2) 1.5% SPH; 3) 1.5% SDPP; or 4) 1.5% SPH and 1.5% SDPP. Pigs were then fed the same Phase 2 and 3 diets with no experimental ingredient. Dietary Lys levels were the same in all diets within each phase. In Exp. 1, ADG, ADFI, and G:F were not affected by source or

level of protein source during any growth phase ($P > 0.10$). Overall G:F was greater ($P = 0.08$) for pigs fed the 1.5% level of protein source than for those fed the 3.0% level of protein source, but there was no difference between protein source. In Exp. 2 during Phase 1, G:F was greater ($P < 0.05$) for pigs fed SDPP than for those fed SPH. During Phase 2, ADFI was greater ($P < 0.05$) for pigs fed SPH than for those fed the control diet. During Phase 3, ADG was greater ($P = 0.08$) for pigs fed SDPP than for those fed SPH. Overall, ADG, ADFI, and G:F were not affected by protein source ($P > 0.10$). The results of these experiments indicate that SPH or SDPP are excellent protein sources for nursery pigs. We acknowledge partial financial support and SPH from Green Earth Industries, Washington, DC.

Key Words: Nursery pigs, Marine protein, Plasma protein

103 Prediction of the proximate content of homogenized whole Pacific Herring (*Clupea pallasii*) using near-infrared reflectance spectroscopy (NIRs). C. Morishige¹, J. R. Carpenter*¹, and B. Rasco², ¹University of Hawaii at Manoa, Honolulu, ²Washington State University, Pullman.

Numerous marine parks in the United States house and exhibit marine mammals. One of the main components of the diets of these animals is herring. In most marine mammal facilities, diet assessment is a key part of daily husbandry. In a facility that houses an endangered or threatened species of marine mammal, diet analysis is more critical. Traditional methods of diet analysis are time consuming and costly. The objective of this project was to use visible and short-wavelength near-infrared reflectance spectroscopy (SW-NIRs), because of its speed, efficiency and cost effectiveness, to develop chemometric calibration models for the prediction of fat, protein, moisture and mineral content of whole homogenized Pacific herring (*Clupea pallasii*). Eighty-six random samples from four different lots and two fisheries – North Bay Meat Company in British Columbia, Canada, and Petersburg Fisheries in Alaska – were homogenized and sub-samples were both analyzed with standard methods of proximate analysis and scanned by SW-NIRs using wavelengths from 600 to 1100nm. There were differences ($P < 0.001$) between all analytes for both lots and location of catch. The prediction equations (R^2) for the calibrations for lots ranged from .27-.88, .66-.93, .48-.87, and .24-.91 for moisture, fat, protein and ash, respectively. Calibration models for each location were fairly comparable: Alaska (Lot D) $R^2 = 0.66-0.91$ and Canada (Lots A through C) $R^2 = 0.47-0.81$. Using the leave one out cross validation technique the NIRs equations were extremely repeatable and accurate in predicting nutrient composition of Pacific herring.

Key Words: Proximate analysis, NIRs, Pacific herring

104 Catabolism of essential amino acids in enterocytes of growing pigs. L. X. Chen*^{1,2}, Y. L. Yin¹, W. S. Jobgen², D. A. Knabe², and G. Wu^{1,2}, ¹The Chinese Academy of Sciences, Changsha, Hunan, P.R. China, ²Texas A&M University, College Station.

Recent in vivo work with growing pigs suggests that the small intestinal mucosa plays an important role in degrading dietary essential amino acids (EAA). This study was conducted to test the hypothesis that EAA are extensively catabolized by pig enterocytes. Jejunal enterocytes were isolated from ten 50-d-old pigs weaned at 21 d of age (5 barrows and 5 gilts). Cells were incubated at 37 °C for 45 min in 2-ml oxygenated (95% O₂/5% CO₂) Krebs-bicarbonate buffer (pH 7.4) containing 1% BSA, 5 mM glucose, and plasma concentrations of amino acids (Wu et al. J Nutr 127: 2342, 1997). The medium also contained one of the

following L-amino acids at 0.5, 2, or 5 mM plus their L-[1-¹⁴C]- or L-[U-¹⁴C]-labeled tracers: His, Ile, Leu, Met, Phe, Lys, Thr, Trp, and Val, as well as 0 or 5 mM L-cycloserine (an inhibitor of transaminase). The use of [1-¹⁴C]- and [U-¹⁴C]-labeled amino acids allowed for quantification of the oxidation of their carboxyl carbons and remaining carbon skeletons (Wu et al. *Int J Biochem* 19: 937, 1987). Results indicate extensive transamination of all the three branched-chain amino acids (BCAA) in enterocytes, with their α -ketoacids undergoing limited oxidation by branched-chain α -ketoacid dehydrogenase or the Krebs cycle. BCAA degradation was markedly inhibited by L-cycloserine

($P < 0.01$). Rates of enterocyte BCAA catabolism did not differ ($P > 0.05$) between barrows and gilts. Oxidation of all other EAA was negligible in the cells from barrows or gilts. The lack of degradation of His, Met, Phe, Lys, Thr, and Trp was confirmed by HPLC analysis of amino acids in medium plus incubated cells. Collectively, our results demonstrate that BCAA are degraded substantially in pig enterocytes and that these cells are not the site for the extensive catabolism of His, Lys, Met, Phe, Thr, and Trp in the pig small intestine. Supported by funds from the Chinese Academy of Sciences, China NSF, and TAES.

Key Words: Amino acids, Catabolism, Small intestine

Physiology and Endocrinology: Metabolic Regulation of Food Intake

105 Hepatic energy status as a stimulus for hunger and satiety. M. Friedman*, *Monell Chemical Senses Center, Philadelphia, PA.*

Eating requires at least two basic decisions: what to eat, which is a decision about food choice, and how much to eat, which is a decision about food intake. Feeding behavior is controlled by a variety of signals, including those generated by the supply and utilization of metabolic fuels, which influence food intake in the short and long-term. Traditionally, it has been thought that separate metabolic signals associated with glucose and fat metabolism control food intake. More recently, evidence is accumulating that metabolic processes and events common to the metabolism of both glucose and fat, at the level of ATP production, are involved. Many studies point to a role of the liver in controlling feeding behavior, and a variety of evidence indicates an inverse relationship between hepatocyte ATP concentration and food intake. Experiments using metabolic inhibitors have shown that a reduction in hepatic energy status can trigger feeding behavior and have also elucidated how changes in fatty acid oxidation influence food intake by affecting energy metabolism in the liver. Other studies have demonstrated a relationship between food intake and liver energy in experimental diabetes and under fasting/refeeding conditions. Currently, we are studying the role of hepatic metabolism in obesity and have found that hyperphagia in several animal models of obesity is associated with reduced liver energy status. Very little is known about how changes in hepatocyte energy metabolism are transduced into a signal the nervous system can interpret. To date, evidence suggests that transduction could be mediated via changes in intracellular calcium concentrations and by alterations in hepatocyte sodium pump activity. Theoretically, changes in hepatic energy status could be transmitted to the brain via a neural or humoral route; at present, however, there is evidence only for a neural connection, specifically via vagal afferent neurons. Recent electrophysiological experiments suggest that a relatively small population of afferents in the hepatic branch of the vagus carry metabolic signals from the liver to the brain.

Key Words: Liver, Appetite, ATP

106 The role of ghrelin in the regulation of energy balance in the sheep. I. Clarke*, *Monash University, Melbourne, Australia.*

Ghrelin mainly secreted by the stomach is an endogenous ligand for the growth hormone secretagogue receptor/s (GHS-R) and stimulates growth hormone (GH) secretion in a variety of species including sheep. In monogastric species examined, ghrelin also stimulates food intake. The ruminant presents an interesting model to study in this regard,

since the gastrointestinal tract is never completely emptied. The ghrelin producing cells are found in the abomasum of this species. Ghrelin levels transiently increase pre-prandially and fall post-prandially, indicating a conditioned response to feeding. The preprandial rise occurs in animals of all body weights and this stimulates a post-prandial rise in plasma GH levels. Such a relationship is maintained with increasing adiposity, but is lost in diet-induced reduction in body weight. Since GH is an important metabolic regulator, the pre-prandial rise in ghrelin secretion is probably important in relation to partitioning of energy. In sheep, either central or peripheral administration of ghrelin fails to stimulate food intake, in spite of changes in plasma GH levels. Since the central administration of ghrelin stimulates GH secretion, this demonstrates action via growth hormone releasing hormone and somatostatin neurons that is relayed to the pituitary somatotropes. Whereas ghrelin does not affect food intake in this species, it remains possible that central action affects energy expenditure, as in other species. Ghrelin receptor levels are higher in the arcuate nucleus of lean ewes, but the functional significance of this is unknown; if ghrelin reduces energy expenditure in this species, this may be one salient mechanism. The ghrelin system may present a means of regulating GH without affecting food intake in ruminants. Supported by NH&MRC, Australia.

Key Words: Ghrelin, GH, Appetite

107 Metabolic regulation of food intake in ruminants. M. S. Allen* and B. J. Bradford, *Michigan State University, East Lansing.*

Food and energy intake of ruminant animals can change dramatically in response to changes in diet composition or metabolic state, and such changes are poorly predicted by traditional models of food intake regulation. Recent work suggests that temporal patterns of fuel absorption, mobilization, and metabolism affect food intake in ruminants by altering meal size and frequency. Research with non-ruminants suggests that meals can be terminated by a signal carried from the liver to the brain via afferents in the vagus nerve that are affected by hepatic oxidation of fuels and generation of ATP. Of fuels metabolized by the ruminant liver, propionate is likely a primary satiety signal because its flux to the liver increases greatly during meals. Propionate is utilized for gluconeogenesis or oxidized in the liver and stimulates oxidation of acetyl CoA. While propionate is extensively metabolized by the ruminant liver, there is little net metabolism of acetate or glucose, which may explain why these fuels do not consistently induce hypophagia in ruminants. Lactate is metabolized in the liver but has less effect on satiety probably because hepatic uptake

during meals is low. Hypophagic effects of fatty acid oxidation in the liver are likely from delaying hunger rather than promoting satiety because beta-oxidation is inhibited during meals by rapid uptake of propionate. A shortage of glucose precursors and increased fatty acid oxidation in the liver for early lactation cows leads to an abundance of NADH and a lack of TCA cycle intermediates, resulting in a buildup of the intracellular acetyl-CoA pool and export of ketone bodies. In this situation, hypophagic effects of propionate may be enhanced, because propionate entry into the liver provides TCA cycle intermediates that allow oxidation of acetyl-CoA. Oxidizing the pool of acetyl-CoA rather than exporting it dramatically increases ATP production and causes satiety, despite the use of propionate for glucose synthesis. A better understanding of metabolic regulation of food intake will allow diets to be formulated to increase the health and productivity of ruminants.

Key Words: Hepatic oxidation, Satiety, ATP

108 Effect of body composition on feed intake and macronutrient selection in growing pigs. M. J. Azain*, *University of Georgia, Athens.*

Numerous factors are involved in the regulation of feed intake in growing animals. The focus of this presentation is on the roles that body composition or composition of gain play in energy and amino acid requirements in nonruminants. When fed a single diet, energy is

the primary determinant of intake. However, when animals are allowed to select between diets that vary in macronutrient nutrient content, they are able to self-select a diet that optimizes growth. This has been observed with diets that vary not only in crude protein, but in individual essential amino acids. Examples of this ability include studies that examine differences in selection patterns in response to 1) age-associated, 2) repartitioning agent induced or 3) genetic changes in composition of gain. In the case of repartitioning agents, growing pigs treated with somatotropin have changes in the rates of protein and lipid accretion that alter the energy and protein (amino acid) requirements and ultimately affect selection patterns and total feed intake. Similarly, the selection pattern between high and low protein diets differs in pigs with different levels of fatness. The mechanisms involved in the ability to monitor lipid and protein accretion rates in the periphery and to distinguish subtle differences between diets are not clear, particularly in livestock. Research in rodent models suggests that protein accretion likely affects circulating amino acid levels which in turn alter neurotransmitters that are monitored centrally. Leptin or other factors from adipose tissue may be the signal used to monitor rates of lipid accretion. The ability to distinguish differences in incoming nutrients, particularly amino acids is likely through the liver. A better understanding of the mechanisms that tie composition of gain to diet selection would contribute to design of feeding systems that meet the nutrient requirements of individual animals under group housing conditions.

Key Words: Feed intake regulation, Composition of gain, Macronutrients

Ruminant Nutrition: Growing/Finishing Nutrition – Beef

109 Performance evaluation of calf- and yearling-finishing. W. A. Griffin*, T. J. Klopfenstein, G. E. Erickson, D. M. Feuz, and J. C. MacDonald, *University of Nebraska, Lincoln.*

The objective of this study was to compare performance of calf (calf-fed) and yearling finishing systems conducted in Nebraska from 1995-2003. Calves were born in April and weaned in October. During the receiving procedure cattle were sorted by weight into two groups. Heavy calves were placed directly into the feedlot and fed an average of 168 d, while lighter calves were placed into a long yearling system. The yearling system consisted of a corn residue grazing period (supplemented wet corn gluten feed (WCGF) at 2.27 kg/hd/d) followed by a summer grazing period. Following summer grazing, yearlings were placed in the feedlot and fed an average of 90 d. Trials included in the data set were selected based on finishing diet composition. Calf-feds were fed a basal diet of either dry-rolled (DRC) or high-moisture corn (HMC) with WCGF (targeted inclusion of 25-40% of the diet). The yearling finishing diet consisted of either DRC or HMC fed with WCGF at an inclusion level of 35-45%. At receiving, calf-feds were heavier than cattle entering the yearling system (292 kg vs. 239 kg; $P < 0.01$) by design. However, when comparing BW at the beginning of the finishing period, yearling cattle were 143 kg heavier than calf-feds ($P < 0.01$). Yearlings had greater ($P < 0.01$) DMI than calf-feds (13.89 kg/d vs. 9.71 kg/d); however, due to the difference in days fed, yearling cattle consumed less DM over the entire finishing period (1252 kg vs. 1633 kg; $P < 0.01$). Daily gain was 0.33 kg higher during the finishing period for yearling cattle ($P < 0.01$); however, calf-feds were 16.7% more efficient ($P < 0.01$) than yearlings (5.63 vs. 6.76). Final BW was 37.7 kg heavier ($P < 0.01$) for yearlings relative to calf-feds, due to a 23.6 kg ($P < 0.01$) heavier HCW. Marbling score was not affected by production system ($P > 0.10$); however, calf-feds had 0.15 cm

greater fat thickness. Overall, yearling cattle had fewer days on feed, gained more rapidly, consumed less total DM, and were heavier at slaughter than calf-feds, while calf-feds were more efficient relative to yearling cattle.

Key Words: Calf, System, Yearling

110 Effect of phase feeding protein on cattle performance and nitrogen mass balance in the summer. S. Quinn*, G. Erickson, T. Klopfenstein, R. Stowell, and K. Vander-Pol, *University of Nebraska, Lincoln.*

A summer feedlot trial was conducted using 96 yearling steers (374 ± 0.12 kg) to compare conventional CP levels to phase-fed diets balanced for degradable intake protein (DIP) and undegradable intake protein (UIP) on performance and N volatilization. Steers were stratified by BW and assigned randomly to 12 pens and one of two treatments. Treatments were 1) control diet formulated for 14% CP (CON) or 2) a phase-fed diet using the NRC model to balance DIP and UIP requirements over the finishing period and encourage N recycling over the feeding period (PHASE; CP = 14 to 11%). Diets consisted of 83% dry rolled corn, 7% alfalfa hay, 5% molasses and 5% supplement. Nitrogen excretion was determined by the difference between N intake and individual steer N retention. Total N lost was calculated by subtracting manure and runoff N from excreted N. Ammonia emissions were measured weekly during the last six weeks of the feeding period using forced air wind tunnels and a sulfuric acid trap for 30 minutes in each pen. DMI for PHASE was greater ($P = 0.08$) than CON with 10.5 and 10 kg/hd for CON and PHASE, respectively. There was no difference ($P = 0.38$) in ADG between CON and PHASE (1.71

and 1.70 kg, respectively). Steers fed PHASE had similar ($P = 0.18$) G:F than CON steers (0.170 and 0.163, respectively). There were no significant carcass differences between CON and PHASE. As designed, cattle fed PHASE consumed less ($P < 0.01$) N and excreted less ($P < 0.01$) N than steers fed CON with N excretion of 24.9 and 19.3 kg/steer for CON and PHASE, respectively. The amount of manure N was similar ($P = 0.35$) and runoff losses were similar ($P = 0.81$) between PHASE and CON. Nitrogen volatilization was lower ($P = 0.02$) for PHASE fed steers compared to CON with 12.85 and 17.55 kg of N excreted lost for PHASE and CON, respectively. Ammonia emissions were not different ($P = 0.95$) between the CON and PHASE pens (19.41 and 19.84 g/hd/d) as measured by forced air wind tunnel. Phase feeding gave similar performance and reduced N volatilization without impacting N removed in manure.

Key Words: Cattle, Mass balance, Phase feeding

111 Withdrawn by author.

112 Withdrawn by author.

113 Evaluation of cotton gin trash as a low-cost feedstuff for growing cattle. J. B. Kennedy* and D. L. Rankins, Jr., *Auburn University, Auburn, AL.*

Two trials were conducted to evaluate the feeding value of cotton gin trash for beef cattle. In trial 1, 40 Angus x Continental steers were allotted randomly to one of the following 4 diets: 1) 45% peanut hulls + 55% cracked corn, 2) 45% peanut hulls + 47% cracked corn + 8% cottonseed meal, 3) 45% gin trash + 55% cracked corn, and 4) 45% gin trash + 47% cracked corn + 8% cottonseed meal. Each pen contained 5 steers with 2 pens/diet. All diets were fed ad libitum and bermudagrass hay was offered free choice in each pen. Steers were weighed initially and every 28 d throughout the 112-day trial. Data were analyzed as a 2 x 2 factorial, with factors being 2 roughage sources with or without cottonseed meal. Steers fed gin trash gained faster than those fed peanut hulls ($P < 0.02$; 1.19 vs 0.94 kg/d) and had greater DMI ($P < 0.01$; 10.3 vs 7.6 kg/d). Diets containing cottonseed meal produced faster ADG ($P < 0.02$) than those containing no cottonseed meal (1.14 vs 0.99 kg/d) and greater DMI ($P < 0.01$; 9.7 vs 8.3 kg/d). Hay intake was not different among diets. In trial 2, 16 steers were assigned randomly to one of the 4 diets used in trial 1 (4 steers/diet). Steers were fed their assigned diet for 14 d and then placed in individual metabolism stalls for 8 d of collection. Dry matter intake did not differ among diets and averaged 6.0 kg/d or 2.0% of BW. Fiber digestibility (NDF or ADF) was not different among diets. A significant cottonseed meal by roughage source interaction was detected for DM, OM and CP digestibilities. Dry matter and OM digestibility was greater for diet 3 compared to the other three diets ($P < 0.07$). Digestibilities for the 4 diets were as follows: 73, 73, 80 and 69% for DM, respectively and 73, 72, 80 and 72% for OM, respectively. Crude protein digestibility was lowest ($P < 0.07$) for diet 1 (60%) and highest for diet 2 (70%) with diets 3 and 4 being intermediate (66% and 63%). Cotton gin trash was more digestible and resulted in faster ADG than peanut hulls when fed to growing cattle. Protein supplementation increased intake of the gin trash and resulted in better cattle performance.

Key Words: Gin trash, Beef cattle, By-products

114 Digestibility of cottonseed and Tifton 85 hay fed to growing beef steers. G. M. Hill*, B. C. Hand, and B. G. Mullinix, Jr., *University of Georgia, Tifton.*

Whole cottonseed (CS) often forms integral parts of dairy and beef cow diets, but less research has focused on younger growing cattle fed CS. Steers ($n=28$; 334.2 ± 15.4 kg initial BW) were blocked by BW class, and randomly assigned to four treatments (7 steers each), and individually-fed diets for 21 d. Tifton 85 bermudagrass hay (11.9% CP, 37.0% ADF, 77.8% NDF) and minerals were fed free-choice. Dietary treatments included hay with Control supplement [C; 90% ground corn, 10% cottonseed meal (13.7% CP, 12.1% NDF), fed at 2.0 kg/steer daily], or CS (26.1% CP, 37.3% ADF, 52.2% NDF, 17.4% crude fat) as-fed at three levels (LowCS=1.5 kg/d; MedCS=2.5 kg/d; HighCS=3.5 kg/d; or DM at 1.34, 2.23, 3.12 kg/d, respectively). Chromic oxide (10 g/steer daily; d 12 to d 21) was fed as an indigestible marker, mixed with C supplement, or fed in a corn carrier (corn=0.25 kg/steer daily) for CS treatments. Fecal samples (11/steer, d17 to d 21) were analyzed to determine apparent digestion of major dietary nutrients. Hay DMI (Table) was similar for C and LowCS, but significantly lower for MedCS and HighCS. Total DMI and OM digestibility had similar response patterns, including similar Total DMI and OM digestion for C and HighCS, with higher values for these treatments than for LowCS and MedCS. Dietary CP (12.4, 15.0, 16.8, 18.6 % in DM, respectively, for C, LowCS, MedCS and HighCS) and CP digestion increased with dietary level of CS. Dietary ADF and NDF increased with CS additions, but digestibility of ADF and NDF was similar for all diets. Growing steers had depressed dietary DMI and OM digestibility with low and medium levels of CS intake on hay-based diets, but dietary DMI and OM digestibility may not be affected when CS is more than 50% of the diet DM.

Table 1.

Item	Control	LowCS	MedCS	HighCS	SE	$P <$
Hay DMI, kg	4.50	4.25	3.36	3.05	0.13	0.01
Total diet DMI, kg	6.27	5.78	5.57	6.19	0.14	0.01
DM digestion, %	67.36	64.00	63.80	66.78	0.85	0.02
OM digestion, %	68.86	65.84	66.07	68.82	0.89	0.05
CP digestion, %	61.06	66.03	70.93	75.49	0.74	0.01
ADF digestion, %	54.08	56.53	52.04	54.66	1.55	0.26
NDF digestion, %	66.34	64.94	62.25	64.4	1.15	0.15

Key Words: Steer, Cottonseed, Digestion

115 Assessment of energy enhanced roughage (EER) based diets for growing/finishing cattle. J. R. Carpenter*¹ and B. Sporleder², ¹*University of Hawaii at Manoa, Honolulu,* ²*Byproducts Enhancement Technologies Corporation (BETC), Fort Collins, CO.*

Forages and energy feeds are key components in the diets of growing and finishing cattle. Both escalating feed costs and ecological considerations prompt investigations into the use of agricultural by-products and processed tropical forages (Energy Enhanced Roughage) in beef production systems. The objectives of this trial were to determine: 1) the variation in nutrient composition and in situ DM, protein and fiber digestibility of fresh Guinea grass (*Panicum maximum*) and processed EER diets, and 2) the production potential of EER in beef rations. Wrapped silage bales were transported to the processing facility, ground, and pretreated with one of two liquors. Treated grass was then cooked in an autoclave and air dried. The EER was then mixed

with a combination of vegetable oil (6% of DM), vitamin, mineral, and protein supplement (0.454 kg/hd/d), and molasses (20% of DM) to create the diet fed once daily. Cattle "(n = 24)" were obtained from three cooperating producers and were randomly assigned by BW and sex to one of 3 treatments (corn and alfalfa based control, and 2 different EER treatments). Each treatment consisted of 2 pens with 3 steers and 3 heifers each. Average BW of the steers and heifers were 295kg and 363kg, respectively. Feed and orts were recorded, animals were weighed by-weekly, and ADG and DM consumption calculated. Two *In situ* trials with 3 fistulated steers were conducted to test both EER mixed rations and individual raw and ensiled Guinea grass for digestibility. Dry matter digestibility of grass increased from 35% up to 85% after processing. Rates and extent of DM disappearance (%/hr) were similar to high energy feedstuffs [4.18% for DM, 4.55% for CP, 4.72% for NDF, and 4.65% for ADF]. During *in situ* runs, pH readings were taken at 1 hr intervals for the first 6 hours after feeding. The pH peaked at 0 h (6.81) and steadily declined to time 3 h (6.22), then the pH slowly increased till time 6 h (6.39). The results showed that the corn fed cattle had better rates of gain, DM consumption and feed conversion than the EER cattle (p<0.05).

Key Words: Enhanced energy roughage (EER), *In situ* digestibility, Guinea grass (*Panicum Maximum*)

116 Evaluation of feed efficiency traits in growing Brahman heifers and relationship with body composition ultrasound traits and feeding behavior. F. R. B. Ribeiro¹, G. E. Carstens¹, P. A. Lancaster¹, L. O. Tedeschi¹, and M. H. M. R. Fernandes², ¹Texas A&M University, College Station, ²Universidade Estadual Paulista-FCAV, Jaboticabal, SP, Brazil.

Objectives of this study were to characterize feed efficiency traits and examine phenotypic correlations with performance, body composition ultrasound, and feeding behavior traits in growing Brahman heifers. Individual DMI were measured in Brahman heifers (n = 70; mean (± SD) initial age 318 ± 25 d) fed a corn-silage based diet (ME = 2.78 Mcal/kg). Body weight were measured at 14-d intervals and daily DMI and feeding behavior traits recorded for 63 d using a GrowSafe™ feeding system. Ultrasound 12 to 13th rib fat thickness (UBF) and longissimus dorsi muscle area (ULMA) were measured on days 0 and 63. Residual feed intake (RFI) was computed as the residuals from the linear regression of DMI on mid-test BW^{0.75} (MBW) and ADG (R² = 0.22). Overall mean (± SD) ADG, DMI and RFI were 0.99 ± 0.16, 9.17 ± 1.19, and 0.0 ± 1.05 kg/d, respectively. Residual feed intake was correlated with DMI (0.88), feed conversion ratio (FCR; 0.61) but not ADG or MBW. Heifers with low RFI (< 0.5 SD; n = 18) consumed 24.5% less DMI and had 22% lower FCR than heifers with high RFI (> 0.5 SD; n = 25). Final UBF was not correlated with RFI, but tended (P = 0.09) to be correlated (0.21) with FCR. Initial age and BW were correlated with FCR (0.24 and 0.32), but not with RFI, suggesting that younger and lighter heifers at start of test had lower FCR, but similar RFI. Feeding duration (min/d) was correlated (P < 0.05) with DMI (0.29), and RFI (0.28), but not with FCR. Meal frequency (meals/d) was not correlated with either of the feed efficiency traits. Heifers with low RFI spent less time (P < 0.05) at the feed bunk (160 vs. 177 ± 5 min/d), but had similar meal frequencies compared to high RFI heifers. Results suggest that RFI was less influenced by rate and composition of growth, and initial age and BW of heifers compared to FCR.

Key Words: Heifers, Residual feed intake, Feed conversion ratio

117 Effects of sorting and supplementation of optaflexx on yearling feedlot performance. W. A. Griffin*, T. J. Klopfenstein, G. E. Erickson, K. J. Vander Pol, D. M. Feuz, and M. A. Greenquist, University of Nebraska, Lincoln.

A 2-yr study utilizing 400 yearling steers (436 ± 30 kg) was conducted to determine the effects of sorting by weight upon entry into the feedlot and feeding 200 mg/steer of Optaflexx (OPT) daily the last 28 d on feedlot performance and carcass characteristics. During the winter, steers grazed corn stalks and were supplemented daily with 2.27 kg/steer of wet corn gluten feed. Steers grazed during summer and were finished from September to January. Upon feedlot entry, steers were allotted into one of four treatments in a 2x2 factorial design: sorted with OPT, sorted without OPT, no sort with OPT, and no sort without OPT. Sorted steers were placed into one of three groups based on initial BW (heavy, medium, and light). Steers were sorted into groups of 32% heavy, 44% medium, and 24% light and were fed accordingly based on sort group, 97, 118, and 132 d, respectively. Initial BW for heavy, medium, and light steers averaged 468, 432, and 399 kg, respectively. Initial BW for unsorted steers averaged 436 kg and were fed 111 d. There were no SORT*OPT interactions (P > 0.10) and feeding OPT had no effect on steer live or carcass performance (P > 0.10). Daily gain, DMI, and feed efficiency were not different comparing sorted steers to unsorted steers (P > 0.10). Sorted steers were fed more days than unsorted steers (114 vs. 111; P < 0.01) and had a numerical increase in final BW of 4.4 kg (P = 0.15) due to a numerical increase in HCW of 2.8 kg (P = 0.14). Sorted steers were not different in USDA Yield Grade (YG), marbling score, and percent choice (P > 0.10) compared to unsorted steers. Sorted steers had a 5.23 cm² increase in LM area (P < 0.01), a 0.14 cm increase in 12th rib fat thickness (P = 0.04), and a 7.5 percentage unit increase in USDA YG 4 carcasses (P = 0.02) compared to unsorted steers. However, no difference (P = 0.75) was observed in percent heavy carcasses (> 432 kg) between sorted and unsorted steers. From this study we conclude no benefits to sorting yearling steers or feeding Optaflexx

Key Words: Optaflexx, Sorting, Yearling

118 Evaluation of feeding ractopamine (Optaflexx®) with various levels of dietary crude protein on growth performance in feedlot steers. S. Sachtleben¹, E. Thomas², W. Platter², and A. Schroeder^{*2}, ¹Kent Feeds, Inc., Muscatine, IA, ²Elanco Animal Health, Greenfield, IN.

Ractopamine HCl, (RAC), was recently approved by the US FDA CVM for feeding to cattle during the last 28 to 42 of the finishing period. The effects of feeding 200mg•hd⁻¹•d⁻¹ RAC and 10, 12 and 14% CP for the final 34 days of the finishing period was evaluated on growth performance characteristics in feedlot steers. A randomized complete block design was used with pens arranged in a 2x3 factorial design of 4 replicates per treatment. Each pen contained 6 steers. All steers received 260 mg•hd⁻¹•d⁻¹ Rumensin and were implanted with Synovex Choice®, 98 d before slaughter. Steers were slaughtered and graded at a commercial facility after a 24 hr chill. No RAC X CP interactions were detected (P>.05) thus least squares means for main effects of RAC are reported. Dietary protein concentration did not affect (P>.05) cattle feedlot performance. Average daily gain (kg) for each respective CP group (10, 12 or 14% CP) was 1.82, 1.98 and 1.98. Steers gained at a faster rate (P=.01) when fed RAC. Dry matter intake was not influenced by RAC treatment (P>.05). Steers fed RAC

converted feed to gain more efficiently ($P < .01$). Total weight gain of cattle fed $200 \text{ mg} \cdot \text{hd}^{-1} \cdot \text{d}^{-1}$ of Optaflexx for 34 days was 10.07 kg more than control steers (1.7%). Average daily gain was improved by 16.8% with the use RAC. These data demonstrate that RAC when fed with 10, 12 or 14% dietary CP for the last 34 d of the finishing period, improves growth performance in steers.

Table 1. Effect of RAC on Growth Performance in Steers

Item	RAC 0	mg 200	SEM	^P RAC Level
Initial wt, kg ^a	505.53	505.08	0.23	0.18
Final wt, kg ^a	566.04	575.66	2.48	0.01
DMI, kg	10.00	10.26	0.14	0.20
Total wt gain, kg	60.51	70.58		
ADG, kg	1.78	2.08	0.07	<0.01
Feed/Gain	5.72	4.98	0.17	<0.01
Gain/Feed	0.177	0.202	0.006	<0.01

^a4% pencil shrink

Key Words: Beef, Growth performance, Ractopamine

119 Evaluation of feeding ractopamine (Optaflexx[®]) with various levels of dietary crude protein on carcass characteristics in feedlot steers. S. Sachtleben¹, E. Thomas², W. Platter², and A. Schroeder^{*2}, ¹Kent Feeds, Inc., Muscatine, IA, ²Elanco Animal Health, Greenfield, IN.

Ractopamine HCl, (RAC), was recently approved by the US FDA CVM for feeding to cattle during the last 28 to 42 d of the finishing period. The effects of feeding $200 \text{ mg} \cdot \text{hd}^{-1} \cdot \text{d}^{-1}$ RAC and 10, 12 and 14% CP for the final 34 d of the finishing period was evaluated on carcass characteristics in feedlot steers. A randomized complete block design was used with pens arranged in a 2x3 factorial design of 4 replicates per treatment. Each pen contained 6 steers. All steers received $260 \text{ mg} \cdot \text{hd}^{-1} \cdot \text{d}^{-1}$ Rumensin and were implanted with Synovex Choice[®], 98 d prior to slaughter. Steers were slaughtered and graded at a commercial facility after a 24 hour chill. Least squares means for main effects of RAC on carcass characteristics are reported. Feeding RAC to steers increased HCW by 5.7 kg (1.63%, $P = .01$) compared to non-RAC fed cattle. Steers fed diets with 12% or 14% CP tended to exhibit heavier ($P = .10$) HCW (362.33 and 362.47 kg, respectively) than those fed the 10% CP ration (357.03 kg). Several RACxCP interactions were detected. Feeding RAC to cattle fed low protein (10% CP) diets tended to decrease KPH fat, however, 12% and 14% CP diets had little effect on carcass KPH fat (RACxCP $P = .11$). The use of RAC ($200 \text{ mg} \cdot \text{hd}^{-1} \cdot \text{d}^{-1}$) in cattle fed low protein (10%) diets suggested that marbling score decreased (630.1 vs 576.0) but increased marbling score in the presence of 12% (575.8 vs 585.8) or 14% (552.1 vs 578.3) rations (RACxCP $P = .10$). Other carcass traits were unaffected ($P > .05$) by RAC treatment. These data demonstrate that RAC when fed with 10, 12 or 14% dietary CP for the last 34 d of the finishing period, will increase HCW without other detrimental effects on carcass characteristics in steers.

Table 1. Effect of RAC on Carcass Characteristics in Steers

Item	RAC 0	mg 200	SEM	^P RAC Level
Final wt, kg ^a	566.04	575.66	2.48	0.01
HCW, kg	357.80	363.60	1.49	0.01
Dress Percent, %	63.2	63.2	0.22	0.87
REA, cm ²	86.90	86.13	0.023	0.58
12 th rib fat, cm	0.173	0.169	0.009	0.66
KPH, %	2.10	2.03	0.07	0.52
YG	2.72	2.76	0.09	0.75
Overall maturity ^b	157.8	157.5	0.89	0.79
Marbling score ^c	586.0	580.0	11.48	0.72
Conformation score	20.2	20.3	0.08	0.27

^a4% pencil shrink ^b100=A0 ^c500=small 0

Key Words: Beef, Carcass, Ractopamine

120 The effects of dose and duration of ractopamine-HCl administration on finishing performance and carcass traits of non-implanted beef heifers. M. J. Quinn^{*}, J. S. Drouillard, C. D. Reinhardt, A. S. Webb, J. M. Pozuelo, M. L. May, C. E. Walker, and S. J. Winterholler, Kansas State University, Manhattan.

Effects of dose and duration of ractopamine-HCl (RAC) administration were examined in non-implanted beef heifers ($n = 282$, 451 ± 4 kg). A control diet (CON; no ractopamine) was compared to diets providing 200 mg RAC per animal daily for periods of 28 or 42 d (200x28 and 200x42, respectively); 300 mg/d for 28 d (300x28); and a step-up regimen consisting of 14 d at 100 mg, followed by 14 d at 200 mg, and the final 14 d at 300 mg (Step-up). Heifers were fed diets of 83% steam-flaked corn, 7% alfalfa hay, 5% corn steep liquor, and 5% supplement. Diets contained 13% CP, and provided 90 mg tylosin and 300 mg monensin per animal daily. For calculation of carcass gain and gain efficiency, initial (42 d before harvest) and final (at harvest) dressed yields were assumed to be 62% and 64%, respectively, for all treatments. Performance measurements that appear in the table below reflect averages for the final 42 d on feed. Feeding RAC increased carcass gain and carcass gain efficiency compared to CON for 200x42 and Step-up. Administration of RAC had no effect on marbling score, yield grade, LMA, KPH, or percentages of carcasses grading USDA Choice ($P > 0.10$). Feeding ractopamine-HCl to non-implanted finishing heifers generally yielded modest improvements in carcass gain and gain efficiency with minimal impact on carcass characteristics. These effects were most pronounced in heifers fed ractopamine for 42 d.

Table 1. Finishing performance and carcass traits of non-implanted heifers fed ractopamine-HCl

Item	CON	200x28	300x28	200x42	Step-up	SEM
Carcass gain, Kg/d	0.58 ^a	0.67 ^{ab}	0.68 ^{ab}	0.77 ^b	0.75 ^b	0.13
DMI, Kg/d	8.2 ^a	8.2 ^a	7.7 ^b	8.2 ^a	7.9 ^a	0.27
Carcass efficiency	0.071 ^a	0.083 ^{ab}	0.089 ^{ab}	0.095 ^b	0.096 ^b	0.008
Marbling score	4.38	4.31	4.11	4.27	4.08	1.34
Yield grade	2.09	2.12	2.23	2.31	2.36	0.10
% USDA Choice	60.7	70.7	55.3	61.8	59.3	7.23

Means with different superscripts differ ($P < 0.05$). Marbling scores are slight=3.00 to 3.99, small=4.00 to 4.99, and modest=5.00 to 5.99.

Key Words: Ractopamine-HCl, Heifers, Cattle

Ruminant Nutrition: Rumen Fermentation Modifiers

121 A modified glucomannan as a method for mitigating fescue toxicosis. I. Cattle performance. S. A. Gunter*, J. D. Shockey, P. A. Beck, and C. A. Masino, *University of Arkansas, Hope*.

To evaluate the efficacy of a modified glucomannan to mitigate fescue toxicosis, 60 Angus cross (281 ± 7.0 kg) steer calves were randomly assigned to 1 of 12 2-ha pastures of endemically-infected tall fescue in April of 2004 and 2005 and allowed to graze for 133 d. The treatments were 1 of the 3 following: 1) non supplemented (CTL), 2) a self-fed liquid supplement (Pasture Plus 34/6; QLF, Inc., Dodgeville, WI; SUP), or 3) the liquid supplement containing a modified glucomannan (FEB-200; Alltech, Inc., Nicholasville, KY; FEB). Target intake for the supplements was 0.91 to 1.40 kg/d with FEB delivering 10 to 20 g/d of the modified glucomannan. Steers were weighed every 28 d and feed intake was monitored weekly. Data were analyzed by period (28 d for Periods 1, 2, 3, and 4; 20 d for Period 5) with Proc Mixed using treatment and year as the fixed and random effects, respectively. Least-square means were separated using contrasts: 1) CNL vs the average of SUP and FEB, 2) SUP vs FEB, and 3) CNL vs FEB. Supplement intake in Periods 1 and 2 did not differ ($P \geq 0.36$) between SUP and FEB, in Period 3 intake (kg/d) tended to be greater ($P = 0.08$) FEB (1.7) compared to SUP (1.1), and in Periods 4 and 5 intake did not differ ($P \geq 0.22$). Average daily gain (kg) was greater ($P = 0.04$) for supplemented cattle than CTL in the Period 2, but did not differ ($P \geq 0.11$) in any other period. Across all Periods (133 d), FEB steers (0.54 kg/d) gained BW more quickly ($P = 0.03$) than SUP steers (0.41 kg/d); however, FEB steers did not gain BW more quickly ($P = 0.21$) than CNL steers (0.50 kg/d). Beginning BW did not differ ($P \leq 0.62$) among treatments and by the end of Period 5 the BW (kg) of the average of the supplement cattle (348) did not differ ($P = 0.96$) from CTL steers (348). However, the BW (kg) of FEB steers at the end of Periods 4 (348) and 5 (358) were 5 and 6% heavier ($P \leq 0.03$), respectively, than SUP steers (333 and 338, respectively). Overall, there was no beneficial effect noted for supplementation with these steers grazing infected tall fescue, but there seems to be some beneficial effects of modified glucomannan.

Key Words: Beef, Glucomannan, Fescue toxicosis

122 A modified glucomannan as a method for mitigating fescue toxicosis. II. Cattle behavior. J. D. Shockey*, S. A. Gunter, P. A. Beck, and C. A. Masino, *University of Arkansas, Hope*.

This study was conducted from April to August in 2004 and 2005 to examine the effect of supplementation and modified glucomannan on animal behavior. Sixty Angus cross steers (281 ± 7.0 kg) assigned to 1 of 12 pastures of K-31 tall fescue infected with the endemic endophyte at a stocking rate of 2.5 steers/ha. Pastures of steers ($n = 5$) were randomly assigned to 1 of the 3 following treatments: 1) non supplemented controls (CTL), 2) a self-fed liquid supplement (Pasture Plus 34/6; QLF, Inc., Dodgeville, WI; SUP), 3) or the same liquid supplement containing a modified glucomannan (FEB-200; Alltech, Inc., Nicholasville, KY; FEB) intended to supply 10 to 20 g/animal daily. All groups received a free-choice mineral in weathervane mineral feeders. Behavioral observations were collected bimonthly every 60 min (2004) or every 30 min (2005) between 0630 and 2030. Observations were classified into six activities: consuming supplement, grazing, eating mineral, drinking, lying, or standing. Data were

analyzed by month with Proc Mixed with treatment (fixed), and year and sampling day (random) as effects. Least-square means were separated using contrasts: 1) CNL vs supplemented steer (average of SUP and FEB), 2) SUP vs FEB, and 3) CNL vs FEB. There was no difference ($P > 0.05$) noted between groups in percentage of time spent standing, lying, drinking or at the mineral feeder. Across months, CNL and FEB steers spent an average of 4 and 5%, respectively, of their time consuming supplements. However, the CNL steers spent a greater ($P < 0.05$) percentage of time grazing (51%) than the SUP steers (41%) and FEB steers were intermediate (46%) to the SUP and CNL steers. Supplemented steers spent 17% less time grazing than the CNL steers and the majority of this reduction in grazing time seems to be accounted for by time at supplement feeders. The differences noted in grazing times reflected differences reported in cattle performance (Abstract I; Gunter et al., 2006). Perhaps the additional time spent grazing for FEB steers led to the increased performance associated with the modified glucomannan addition to the liquid supplement.

Key Words: Beef, Glucomannan, Fescue toxicosis

123 Effects of *Saccharomyces cerevisiae* (Sc47) on the rumen digestion, fermentation and protozoa population of bulls fed either alfalfa hay or corn silage diet. A. Nikkhab* and E. Ghasemi, *Tehran University, Karaj, Tehran, Iran*.

The objective of this study was to determine the effect of Sc (47.8×10^9 cfu/g) on alfalfa hay (AH) and corn silage (Cs) fed to bulls. Four ruminally fistulated bulls (two Holstein and two Sistani) were used in a Latin Square design with factorial arrangement of treatments (two forage sources and two level of Sc (Makian Daroo, Iran)) and four periods. Bulls were fed individually twice a day as total mixed ration (TMR) at maintenance level and Sc was top-dressed once per day. The diet consisted of either 46.15% AH or 48.84% Cs, 24% straw and 28% concentrate (DM basis). Rumen degradability of DM, CP, NDF and ODM was measured by Dacron bag at 0, 3, 6, 12, 24, 48 and 72h. Rumenal fluid samples were collected from carnial-ventral site of rumen at 0, 3, 6 and 12h to determine rumen pH and concentration of VFA and N-NH₃. Samples for counting rumen protozoa were also drawn from rumen fluids. DM degradation of AH and Cs was increased at 3h incubation by Sc (46.5% vs. 48.53%, $P < 0.1$). In situ DM degradation of TMR was also increased at 72 h incubation. CP disappearance of AH, Cs and TMR were unaffected by the addition of Sc. Addition of Sc caused an increment in degradability of ODM at 3h (38.86% vs. 40.52%, $P < 0.1$), 72h (75.18% vs. 76.28%, $P < 0.05$) and forage NDF degradability at 3h (1.29% vs. 4.39%, $P < 0.05$). Mean daily N-NH₃ (mg/dL) concentration was decreased by Sc but no effect was observed at 0, 3, 6 and 12h. Concentration of total VFAs and percentage of propionate were higher and acetate to propionate ratio was lower in diet supplemented with Sc. However there were interactions between Sc and forage source at 3 and 12h post feeding. For AH based diet, acetate to propionate was reduced and for Cs based diet was increased by Sc. Protozoa population was reduced at 3h (183.63×10^3 vs. 148.06×10^3 per mL) and 12h (161.69×10^3 vs. 146.68×10^3) and entodiniomorph was also reduced at 12h (155.50×10^3 vs. 140.54×10^3). Holotrich was unaffected by Sc. The results of this investigation indicate that Sc can slightly affect most rumen parameters and can improve efficiency of digestion.

Key Words: S. Cerevisiae, Fermentation, Bull

124 Effects of essential oils on rumen microbial fermentation evaluated in vitro. L. Castillejos^{*1}, S. Calsamiglia¹, J. Martin-Tereso², and H. ter Wijlen², ¹*Universitat Autònoma de Barcelona, Bellaterra, Spain*, ²*Nutreco Ruminant Research Center, Boxmeer, The Netherlands*.

The effects of ten essential oils (clove, hyssop, lavender, thyme, oregano, rosemary, sage, savory and tea tree) were evaluated in an in vitro 24 h batch culture of diluted rumen fluid (Tilley and Terry, 1963) at pH 6.50. A 10 to 90 forage to concentrate diet (16% CP; 32% NDF; 38% starch) typically fed to beef cattle in a barley-beef system was used as substrate. Treatments were: negative control (CTR), positive control (10 mg/L of monensin), and three different doses of each essential oil (5, 50, and 500 mg/L). After 24 h, the pH was determined in culture fluid and samples were collected to analyze ammonia N and volatile fatty acid (VFA) concentration. Data were analyzed using PROC MIXED of SAS (1996) and differences declared at $P < 0.05$. Monensin increased total VFA concentration, propionate and valerate proportion, and decreased acetate and butyrate proportion, the acetate to propionate ratio and ammonia N concentration. Lavender did not modify rumen microbial fermentation and lavender and oregano (500 mg/L) inhibited rumen microbial fermentation decreasing total VFA concentration, which suggests that these essential oils may not be nutritionally beneficial to beef cattle. However, the lowest dose of oregano increased total VFA concentration by 39-56%. Thyme and savory increased total VFA concentration and decreased ammonia N concentration, but also reduced final rumen pH. The 500 mg/L doses of rosemary, hyssop, sage, tea tree and clove acted as monensin increasing propionate and valerate proportion, and reducing acetate proportion, butyrate proportion and the acetate to propionate ratio without reducing total VFA concentration. Clove at 500 mg/L was the only essential oil that increased rumen pH without reducing total VFA concentration. Most of essential oils demonstrated an important activity modifying rumen fermentation. Careful selection and combination of these essential oils may allow the manipulation of rumen fermentation.

Key Words: Essential oils, Rumen fermentation

125 Effect of CRINA RUMINANTS AF, a mixture of essential oil compounds, on finishing beef steer performance. N. Meyer^{*1}, G. Erickson¹, T. Klopfenstein¹, P. Williams², and R. Losa², ¹*University of Nebraska, Lincoln*, ²*Intervet, Millsboro, DE*.

The objective of this study was to determine the potential of an essential oil additive to improve steer growth performance and carcass characteristics. Three hundred seventy six yearling beef steers (398 + 35 kg) were blocked by initial BW (3 blocks for light, middle, and heavy), and assigned randomly to one of four treatments (10 pens per treatment). Treatments were 1) Control (CON) with no active dietary ingredients, 2) CRINA RUMINANTS AF (CR) added at a target consumption of 1.0 g/hd/d, 3) CRINA RUMINANTS AF plus tylosin (CR+T), and 4) monensin plus tylosin (M+T). Diets consisted of 66.0% high moisture corn, 16.5% dry rolled corn, 7.5% alfalfa hay, 5% molasses, and 5% supplement. There were no significant differences ($P > 0.05$) for initial BW, final BW, and ADG. Steers fed M+T had lesser ($P < 0.05$) DMI than other treatments (Table 1). Feed efficiency was significantly greater ($P < 0.05$) for the CR+T and M+T fed steers compared with CON steers. Hot carcass weight, 12th rib fat thickness, LM area, and marbling score were not significantly different ($P > 0.05$) among treatments. Treatments containing tylosin had significantly fewer ($P < 0.01$) liver abscesses as compared to the other treatments with values of 26.25, 15.65, 7.75, and 5.55% (% total abscesses) for CON, CR, CR+T, and M+T, respectively. The

results of this study suggest that addition of CRINA RUMINANTS AF plus tylosin or monensin plus tylosin improved feed efficiency and decreased liver abscesses compared to no additives.

Table 1.

	CON	CR	CR+T	M+T	SE	P-Value
DMI (kg/d)	12.2 ^b	12.1 ^b	12.0 ^b	11.5 ^c	0.23	<0.01
ADG (kg/d)	1.77	1.81	1.83	1.79	0.08	0.52
G:F	0.145 ^b	0.151 ^{bc}	0.153 ^c	0.156 ^c	0.002	0.03

Key Words: Cattle, Essential oils, Feed additives

126 Effects of concentration and duration of Rumensin application on milk production efficiency in multiparous Holstein cows.

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Six multiparous Holstein cows (initial DIM = 135, BW = 653 kg) were used in a replicated 3 X 3 Latin square design experiment with 21d periods to evaluate the effects of Rumensin dose and duration of application period on milk production, feed intake and metabolic traits. Treatments were TMR top-dressed with 0 (C, control), and two levels (L) of Rumensin at 300 (L1) or 600 (L2) mg/day. Diet contained 16.2% CP, 31% NDF and 1.72 Mcal NEL/kg of DM. Milk production and feed intake were monitored daily. Milk composition and rumen and blood metabolites concentrations, were assessed on 10d and 21d. Blood and rumen samples were obtained 3 hours after morning feeding. Milk production averaged 41.6 kg/d (SEM 1.0). Intake of DM was less for L2, (22.6 kg/d) than for L1 and C (24.6 kg/d, $P = 0.006$), resulting in a numerically higher milk production efficiency for L2 than for the C (1.80 vs. 1.68 kg milk/kg DM, $P = 0.08$). Blood NEFA, glucose and N-urea concentrations for all treatments were in the normal ranges (treatments means of 113 to 128 meq/l, 62.4 to 65.3 mg/dl and 13.7 to 14.1 mg/dl, respectively). Ruminal propionate molar proportions were higher for L2 than for C (274 vs. 241 mmol/mol, respectively, $P = 0.004$). Ruminal acetate to propionate ratio was lower for cows provided L2 than C (2.2 vs. 2.7, $P = 0.001$). Milk fat and protein percentage were similar among treatments, averaging 3.4% and 3.0%, respectively. For metabolic and production traits, at each Rumensin dose, there was no difference between 10 and 21 d of application ($P > 0.1$). Results from this study indicate that in cows at peak lactation Rumensin effects on ruminal fermentation may be achieved already after 10d of application. Short term application of 600 mg/g Rumensin dose to high yielding cows may support milk production with a concomitant reduction in intake, without an apparent utilization of body energy stores. The correlation ($r = -0.66$, $P = 0.001$) between milk production efficiency and acetate to propionate ratio indicate an involvement of ruminal fermentation in the improved feed utilization of Rumensin supplemented cows.

Key Words: Rumensin dose, Lactation, Duration of application

127 Effects of monensin on dairy cows fed diets differing in fiber source and starch concentration.

A. M. Gehman^{*1}, P. J. Kononoff¹, B. N. Janicek¹, and F. Bargo², ¹*University of Nebraska, Lincoln*, ²*University of Buenos Aires, Argentina*.

The objective of this experiment was to determine the effects of monensin when dairy cows were fed rations differing in fiber source

and starch content. Twenty Holstein cows (163 ± 26 DIM) were used in a replicated 4 x 4 Latin square with treatments arranged in a factorial manner. The experiment was composed of four 28-d periods, during which the cows were offered one of four rations: 1) 0% DM wet corn gluten feed (CGF), 0 mg/d monensin, 2) 0% DM CGF, 300 mg/d monensin, 3) 38% DM CGF, 0 mg/d monensin, and 4) 38% DM CGF, 300 mg/d monensin. Corn gluten feed replaced a portion of the corn silage, alfalfa haylage, soybean meal, and ground corn contained in the control diet. Diets were formulated to be similar in NDF (34% DM), but diets containing CGF had a lower concentration of starch (21 vs. 25% DM). Data were analyzed using PROC MIXED with period, CGF, monensin, and CGF x monensin as fixed effects and square and cow within square as random effects. Cows consuming the ration containing CGF consumed more DM ($P < 0.01$) than cows not consuming CGF (22.7 vs. 20.2 kg/d). There was a tendency ($P < 0.10$) for a CGF x monensin interaction on DMI. Monensin tended to increase DMI for cows on CGF (23.2 vs. 22.2 kg/d), while it tended to decrease DMI for cows not consuming CGF (19.6 vs. 20.8 kg/d). Cows consuming CGF also tended ($P < 0.10$) to produce more milk than cows not consuming CGF (33.4 vs. 30.6 kg/d), but milk fat percent tended ($P = 0.10$) to be lower (3.91 vs. 4.10%). Cows consuming CGF tended ($P < 0.10$) to produce more milk protein than cows not consuming CGF (1.03 vs. 0.94 kg/d). There were no differences ($P > 0.05$) among treatments in 3.5% fat-corrected milk, milk protein or lactose percentages, milk urea N, milk fat yield, feed conversion, body weight, or body condition score. In this experiment, the inclusion of CGF in the ration increased DMI and tended to increase milk production and protein yield while tending to decrease fat percentage. However, monensin did not affect milk production or other measurements nor did it appear to interact with ration fiber source or starch concentration.

Key Words: Dairy cow, Monensin, Corn gluten feed

128 Effects of molasses and monensin in alfalfa hay or corn silage diets on rumen fermentation, total digestibility and milk production in holstein cows. E. R. Oelker*, C. Reveneau, and J. L. Firkins, *The Ohio State University, Columbus.*

Sugar supplementation can stimulate rumen microbial growth and possibly fiber digestibility, however, increasing ruminal carbohydrate availability relative to RDP can promote energy spilling by microbes or decrease rumen pH. RDP supply and rumen pH might be altered by forage source and monensin. Therefore, 7 ruminally cannulated lactating Holstein cows were used in five 28-day periods in a 5x7 incomplete Latin square design to determine the effects of matching molasses supplementation with urea and monensin supplementation on two types of forage-based diets. Four corn silage diets consisted of control (CS), CS + 2% DMB molasses (MOL), CS + MOL + 0.5% urea and CS + MOL + urea + monensin (16g/ton DM). Three alfalfa hay diets consisted of control (AH), AH + MOL and AH + MOL + monensin. Urea was added to CS diets to provide RDP comparable to AH diets with no urea. All diets were balanced to have 16.2% CP, 18.0% forage NDF and 41.0% NFC. The model included the fixed effects of period and treatment, and the random effect of cow. Treatment means were compared by protected LSD. Treatments had no effect on milk or protein yield, but monensin decreased ($P=0.04$) milk fat from 3.25 to 2.72 % in CS diets but not in AH diets. Total tract OM digestibility (using Cr₂O₃ as a marker) was lower ($P=0.03$) in AH (63.4%) than CS (73.9%) diets. Treatments had no effect ($P>0.12$) on NDF digestibility. Rumen ammonia concentration decreased ($P=0.02$) with MOL but increased with MOL and urea in the CS diets.

Additionally, MOL with urea increased MUN in the CS diets (7.6 vs 12.0 mg/dl for MOL vs MOL + U). Ammonia and MUN remained unchanged in the AH diets. Acetate:propionate ratio was higher ($P=0.004$) in AH (3.03) than CS diets (2.36). Diets did not affect ($P>0.21$) ruminal pH or DMI. Sugar supplementation might require urea to support microbial protein synthesis in corn silage diets balanced for moderate CP and perhaps especially if monensin is fed.

Key Words: Molasses, Monensin, NDF digestibility

129 Effect of inhibition of methane synthesis on biohydrogenation in the presence or absence of protozoa in continuous culture. S. K. R. Karnati*, C. V. D. M. Ribeiro, J. T. Sylvester, and J. L. Firkins, *The Ohio State University, Columbus.*

Ruminal methanogenesis disposes reducing equivalents generated from anaerobic metabolism of sugars. Our objectives were to assess the role of protozoa in biohydrogenation (BH) of dietary unsaturated FA, and to determine if inhibition of methanogenesis increased BH. Four dual-flow continuous culture vessels were modified to retain protozoa and used in a 4 x 4 Latin square design; each experimental period was split into 10-d faunated or defaunated (DEF) sub-periods, each with 7 d of adaptation and 3 d of sampling. Once daily, the fermenters were fed 40 g of a 30:70 concentrate:forage diet containing either no additive, 4% animal-vegetable fat, bromoethanesulfonate (BES 250 µM, methane inhibitor), or monensin (MON 2.5 µM). pH in the fermenters was not controlled and ranged between 6.2 and 6.7. The model included the fixed effects of period, treatment, and filter, and the random effect of fermenter. Means were compared using protected LSD. Digestibilities of OM and NDF were increased ($P<0.05$), whereas total VFA production decreased ($P=0.05$) by DEF. Methanogenesis was not affected by DEF, but acetate:propionate decreased ($P<0.01$) from 3.53 to 3.29 and molar proportions of butyrate ($P=0.09$), isobutyrate and isovalerate ($P<0.01$) increased by DEF. Dietary fat increased the flow (mg/day) of the trans (t) BH intermediates t10 and t11, and the effect was more pronounced by DEF (DEF x treatment interaction $P<0.01$). Because the same interaction persisted for the ratio of total t18:1/18:0, but there was no interaction for total t18:1/total unsaturated FA, DEF probably decreased the rate of the second step of BH. DEF increased VA more than it increased t10 18:1 in fat diets (interaction of VA/t10 ratio). The flow of CLA was unaffected by DEF or by treatments other than added fat. MON tended ($P=0.07$) to decrease methanogenesis, but increased isovalerate. MON did not affect flows of t10, t11, or total t18:1 FA. Protozoa increased BH intermediates possibly by stimulating lipolysis or the first step of BH or by inhibiting the second step of BH by influencing the bacterial community structure by selective predation.

Key Words: Methane, Protozoa, Biohydrogenation

130 Manipulation of fermentation profile and methane production with microbial inhibitors and protozoal retention in continuous culture. S. K. R. Karnati*, J. T. Sylvester, L. E. Gilligan, and J. L. Firkins, *The Ohio State University, Columbus.*

Protozoa profoundly impact ruminal carbohydrate and N metabolism. We modified 4 continuous culture vessels to determine interactions between ruminal protozoa, methanogens and eubacteria. The 4 vessels were incubated in 4 periods in a 4 x 4 Latin square design split into 2 sub-periods. In sub-period 1, a multi-stage filter system (50 µm smallest pore size) retained most protozoa so that they passed with the overflow (50 h retention time). At the start of sub-period 2, conventional

filters (300 µm pore size) were used to also remove protozoa via filtrate pumps over 3 d; after further 7 d of adaptation, the fermenters were sampled for 3 d. Throughout, the fermenters were fed 40 g/d of a 30:70 concentrate:forage diet (1 meal) containing either no additive, 4% animal-vegetable fat, bromoethanesulfonate (BES, 250 µM; a methane inhibitor), or monensin (2.5 µM). Protozoal counts were used to calculate generation times (total pool size of cells in the fermenter /flow of cells in the effluent). The model included the fixed effects of period, treatment, and filter, and the random effect of fermenter. Means were compared using protected LSD. Flow of total N and digestibilities of NDF and OM were 18%, 16% and 9% higher, respectively, for the defaunated sub-period but were not different between treatments. Methanogenesis was unaffected by defaunation but tended ($P=0.07$) to be decreased by monensin. Protozoal counts were not different between treatments, but BES increased the generation time from 43.2 to 55.6 h. Ammonia concentration was 33% higher in the faunated fermenters but not affected by treatment. Defaunation did not affect total VFA production but decreased the acetate: propionate ratio; monensin increased isovalerate production in both sub-periods, but more in faunated. Monensin selects for Gram negative bacteria such as *Megasphaera*, *Fibrobacter*, and *Prevotella*, which can produce isovalerate and might increase deamination of AA from protozoal proteolysis. Because of challenges in defaunation in vivo, our modified system should advance our understanding of protozoal ecology.

Key Words: Methane, Protozoa, Monensin

131 Gastrointestinal metabolism and plasma concentrations of the methane-inhibitor, nitroethane, in fed steers. R. Anderson^{*1}, N. Ramlachan¹, H. Gutiérrez-Bañuelos², G. Carstens², W. Majak³, R. McDiarmid³, T. Callaway¹, R. Harvey¹, S. Horrocks¹, T. Edrington¹, and D. Nisbet¹, ¹USDA/ARS, Food & Feed Safety Research Unit, College Station, TX, ²Texas A&M University, College Station, ³Agriculture & Agri-Food Canada, Kamloops Range Research Unit, Kamloops, BC, Canada.

To investigate the metabolism and absorption of the methane-inhibitor, nitroethane (NE), we fed 18 steers (403±26 kg BW; mean±SD) a 50% concentrate diet and administered 0, 80 or 160 mg NE/kg BW per day (6 steers/treatment) for 14 d. Treatments were administered orally 2X daily. Ruminal fluid and feces were collected on d -1, 1, 2, 7 and 14 of treatment; blood samples were collected at 0 and 6 h and at 1, 2 and 7 d of treatment. Rates of NE degradation (dNE/dt) were determined by in vitro incubation. Concentrations of NE were determined colorimetrically. Mean (±SD) NE concentrations in plasma 6 h after start of NE treatments were 0.12±0.1 and 0.41±0.1 µmol/ml for steers administered 80 or 160 mg NE/kg BW per day, respectively, indicating rapid absorption of NE. Plasma NE concentrations peaked 1 d after initiation of the 80 or 160 mg NE/kg BW per day treatments (0.38±0.1 and 1.14±0.1 µmol/ml, respectively). Plasma NE concentrations declined thereafter to 0.25±0.1 and 0.78±0.3 and to 0.18±0.1 and

0.44±0.3 µmol/ml on days 2 and 7 for the 80 or 160 mg NE/kg BW per day treatment groups, respectively, indicating decreased absorption or more rapid excretion or metabolism of the compound. An analysis of variance revealed that ruminal dNE/dt from steers administered NE were >2.5-fold higher ($P<0.05$) than the mean (±SD) rate observed in steers administered no NE (0.05±0.1 µmol NE/ml ruminal fluid per h). This observation suggests an enrichment of NE-degrading bacteria in the rumen of both groups of NE-treated steers. Fecal dNE/dt (0.07±0.1 µmol NE/g feces per h) were unaffected ($P>0.05$) by treatment indicating that NE was not present at high enough concentrations in the lower gut to affect a similar enrichment of NE-degrading bacteria in these steers.

Key Words: Methane, Nitroethane, Rumen

132 Effects of feeding a polyclonal antibody preparation against *Streptococcus bovis* on rumen fermentation of heifers switched from a high forage to a high concentrate diet. M. Blanch^{*1}, S. Calsamiglia¹, N. DiLorenzo², and A. DiCostanzo², ¹Universitat Autònoma de Barcelona, Bellaterra, Spain, ²University of Minnesota, St. Paul.

The effects of feeding a polyclonal antibody preparation against *Streptococcus bovis* (PAPSb) were studied in a completely randomized experiment using 12 crossbred heifers (452±20 kg BW) with two groups (6 animals each): control (CTR) and polyclonal antibody treatment (PAPSb, CAMAS Inc., MN). The acidosis induction protocol included 3 periods: 3 months of baseline (100% fescue ad libitum), 10 d adaptation (d 1-10 of the experiment, fed 100% forage + 10mL of PAPSb top-dressed in treatment group) and 12 d of challenge feeding (d 11-22 of the experiment). The challenge consisted in increasing the concentrate (16% CP) intake 2.5 kg DM per day until 12.5 kg (achieved in 5 days) plus fescue ad libitum. The treatment group received 10 mL of PAPSb daily. Acidosis was declared when pH reached 5.5 or when concentrate intake was reduced more than 50% compared with the previous day. When an animal was considered acidotic it was taken out of the experiment. Samples of ruminal contents were collected at 0h and 6h post feeding to determine pH, and volatile fatty acid and ammonia-N concentrations. Data were analysed using PROC MIXED of SAS (version 8.2). Differences were declared at $P<0.05$. PAPSb had higher pH values at 0h post feeding in days 16 (6.70 vs 6.11), 18 (6.54 vs 5.95) and 19 (7.26 vs 6.59) compared with CTR. PAPSb had higher concentration of acetic acid at 6h post feeding (81.8 vs 90.3 mM for CTR and PAPSb, respectively) and higher total volatile fatty acid concentration (132.9 vs 147.1 mM for CTR and PAPSb, respectively). These results indicate that PAPSb may be effective in reducing acidosis when heifers are abruptly adapted from a high forage to a high concentrate diet.

Key Words: *Streptococcus bovis*, Antibody, Rumen fermentation

Graduate Student Paper Competition: ADSA Southern Branch

133 Waste milk supply and pasteurizer performance on three North Carolina dairy farms. M. C. Scott^{*1}, R. E. James¹, M. L. McGilliard¹, and B. A. Hopkins², ¹Virginia Polytechnic Institute and State University, Blacksburg, ²North Carolina State University, Raleigh.

Feeding saleable milk or milk replacer to the pre-weaned calf results in high daily feed cost. All dairy farms generate waste milk (WM) that

cannot be sold. Waste milk includes, but is not limited to, transition milk and milk from cows treated with antibiotics. Feeding WM to calves reduced feed cost, but raises bio-security concerns. Pasteurization effectively lessens health risk associated with feeding WM. The objective of this study was to determine amount and composition of WM generated by three dairy farms and to track effectiveness of on-farm high-temperature short-time (HTST) pasteurizers. Bacteriological

activity and components of the pasteurized WM were measured until it was fed to calves on two of the farms. Pasteurizer function was measured by alkaline phosphatase deactivation (AP) and aerobic plate count (APC). Farm 1, 2 and 3 milked 1100, 2500 and 800 cows, and all used commercial HTST pasteurizers. Farms were visited every 2 wk for 28 wk during the spring and summer of 2005. Waste milk generated per calf on farm 1, 2 and 3 was 2.8, 10.3, and 4.4 kg/d. Post pasteurization (PostPast) samples were AP positive 18%, 15%, and 0% on farm 1, 2, and 3. Mean APC pre-pasteurization (PrePast) and PostPast for all farms was 1.73×10^7 cfu/ml and 4.5×10^5 cfu/ml. When AP was positive, APC averaged 348,000 cfu/ml and 5.3×10^6 cfu/ml for farm 1 and 2. When AP was negative, APC averaged 64,000 cfu/ml and 367,000 cfu/ml for farms 1 and 2. The APC of PostPast WM increased over time as calves were fed. The LSM, adjusted for farm and season, ranged from 2.4×10^6 cfu/ml at initiation of feeding to more than 1×10^7 cfu/ml at the end of feeding one hr later. Commercial HTST pasteurizers require proper operation in order to assure successful pasteurization. The supply of WM was inadequate to feed all calves on two farms. Improper handling of PostPast WM increased APC almost to PrePast levels, indicating poor sanitation of feeding equipment.

Key Words: Pasteurization, Calf, Waste milk

134 Breed differences in postpartum cyclicity of pasture-based dairy cows. C. M. Williams*, S. P. Washburn, A. N. Elias, and C. S. Whisnant, *North Carolina State University, Raleigh.*

The purpose of this study was to examine potential breed differences in postpartum cyclicity of fall calving pasture-based dairy cows. Milk samples from sixty-five post-partum dairy cows of three breeds (Holstein, n=16, Jersey, n=23, and various Holstein and Jersey crosses, n=26) were collected twice weekly. Collections were done during the PM milking at the Center for Environmental Farming Systems (CEFS) Dairy Unit, Goldsboro, NC and measured approximately 100mL. Milk production averages for each breed were obtained and are as follows: 29.6 ± 2.3 kg/d for Holsteins, 21.3 ± 1.7 kg/d for Jerseys, and 21.7 ± 1.5 kg/d for crossbreds. Milk was centrifuged to obtain skim milk for a radioimmunoassay for progesterone (P4) with a sensitivity of 0.02 ng/mL. Return to cyclicity was defined as the first day progesterone levels were ≥ 1 ng/mL for two consecutive samples or ≥ 2 ng/mL for one sample. For cyclic cows, anestrus length was calculated from calving date until the first day P4 was ≥ 1 ng/mL. By thirty days postpartum, more crossbred cows had initiated estrous cycles than purebred Jersey or Holstein cows (70% versus 52% and 47% respectively, $P < 0.05$). However, by sixty days postpartum, 100% of the Jersey and crossbred cows had initiated estrous cycles whereas only 12 of 16 (75%) of Holsteins were cyclic ($P < 0.001$). Although intervals to calving until first P4 rise among cyclic cows did not differ (34.3 ± 3.0 days for Holsteins, 31.1 ± 2.2 days for Jerseys, and 32.1 ± 2.0 days for crossbreds), it is expected that Holsteins will have significantly longer intervals once all cows are cyclic. Breed differences in postpartum cyclicity were evident in that fewer Holsteins initiated early postpartum estrous cycles compared to either Jerseys or crossbred cows.

Key Words: Dairy, Crossbreeding, Progesterone

135 Effect of feed additives on aflatoxin in milk of dairy cows fed aflatoxin-contaminated diets. J. Stroud*¹, E. English¹, S. Davidson¹, B. Hopkins¹, G. Latimer², W. Hagler¹, C. Brownie¹, and L. Whitlow¹, ¹*North Carolina State University, Raleigh,* ²*Texas A&M University, College Station.*

Sixty lactating Holstein cows were used in a replicated block experiment to determine the efficacy of eight feed additives to reduce the transfer of aflatoxin from feed to milk. Six cows were allocated to each treatment group and 12 to a control group. All cows were fed the same aflatoxin-contaminated total mixed ration (TMR) (≈ 170 ppb, provided by naturally contaminated corn grain) and then either no additive (control) or one of eight additives at 0.5% of the TMR dry matter. Milk samples were collected twice daily on day five after initiating aflatoxin feeding and on days five and six after including additives. Milk aflatoxin concentration [$\mu\text{g/L}$] was measured by HPLC. Changes in milk aflatoxin concentration, milk aflatoxin excretion (milk aflatoxin concentration \times milk yield); and aflatoxin transfer from feed to milk (aflatoxin excretion as a percentage of aflatoxin intake) were evaluated. All changes were expressed as percentages and calculated relative to the control group which defined zero change. Changes were considered significantly different from zero when $P < 0.05$. Additives are described by their analyzed composition of organic carbon and ammonium acetate extractable amounts of calcium, magnesium, sodium and potassium. The organic carbon percentage was 48,14,<1,<1,19,<1,<1,<1 for the additives 1 through 8, respectively. The ammonium acetate extractable Ca, Mg, Na and K contents (cmol_c/kg) were 7,18,19,30; 28,12,18,11; 59,12,2,9; 92,13,<1,2; 74,15,27,9; 10,11,<1,2; 52,15,44,<1 and 43,15,12,<1 for the additives one to eight, respectively. Inclusion of the additives resulted in percentage changes in aflatoxin transfer from feed to milk of 3,-8,-7,-42,-34,-13,-48 and -44 for the additives one to eight, respectively. Four of the eight additives added at 0.5% of DMI significantly reduced milk aflatoxin concentration, excretion and transfer from feed to milk of dairy cows fed approximately 170 ppb aflatoxin.

Key Words: Adsorption, Aflatoxin, Dairy

136 Using dietary heat increment to alter energy use in dairy cows during hot weather. L. M. Pacetti*, J. W. West, J. K. Bernard, and C. D. Wildman, *The University of Georgia, Tifton.*

Thirty-two lactating Holstein cows averaging 169 DIM (± 35 d) were used to determine changes in energy use due to ration heat increment (HI). The study was conducted from June 15 through August 24, 2005. Mean maximum and minimum temperature, relative humidity, and temperature-humidity index during the treatment period were 31.2 and 22.7°C; 99 and 61%; and 82.2 and 72.8, respectively. Dietary treatments were high HI offered ad libitum (HA), low HI offered ad libitum (LA), and low HI offered at restricted caloric intake (LR). The LR cows were paired individually with HA cows to achieve similar NE_L intake (Mcal/100 kg BW). High heat increment diets were formulated using greater concentrations of forage and fibrous byproducts. Low heat increment treatments were formulated using lower forage concentration, no fibrous byproducts, and increased quantities of grain and fat. For DMI, HA (24.6 kg) was greater than both LA (22.8 kg) and LR (20.5 kg) [$P < 0.0001$]. Increased DMI/100 kg BW was also noted for HA (3.7 kg) compared with LA (3.6 kg) and LR (3.3 kg) [$P < 0.05$]. No differences were observed among treatments for NE_L intake ($P < 0.07$) with mean values of 6.4, 6.5, and 6.0 Mcal/100 kg BW for HA, LA, and LR, respectively. Milk yield (34.5, 34.6, and 33.0 kg/d) and energy-corrected milk yield (34.2, 31.6, and 31.5

kg/d) for HA, LA, and LR, respectively, were similar across dietary treatments. Milk yield ($P < 0.002$) and energy-corrected milk yield ($P < 0.03$) [kg/kg DMI] were greater for LR (1.5 and 1.6) compared with HA (1.3 and 1.4). Milk net energy secretion (Mcal/100 kg BW) was similar across treatments. Yield and concentration of fat, protein, and total solids were similar across dietary treatments. A trend for NE balance ($NE_{L\text{balance}} = NE_{L\text{intake}} - NE_{L\text{milk}} \pm NE_{L\text{tissue}}$) was

observed; NE balance was lower for LR (0.01 Mcal/d) compared with HA (3.9 Mcal/d) and LA (5.7 Mcal/d). There was a minor trend for improved efficiency of energy use for the low heat increment diet. Additional research is needed to elucidate differences in energy efficiency in relation to HI during heat stress.

Key Words: Dairy nutrition, Heat stress, Heat increment

ADSA-SAD – Undergraduate Competition: Dairy Production

137 The use of copper sulfate to improve hoof health in dairy cattle. M. Konzelman*, *Louisiana State University, Baton Rouge.*

One of the most important parts of a dairy cow is her feet. If a herd is experiencing hoof health problems, then the producer will have more than sore feet when the milk check arrives. Diseases such as foot rot and hairy heel warts should not be taken lightly as they can have a major impact on a herd's overall performance. Decreased production occurs as a result of the cows' unwillingness to walk to the feed, and consequently they do not obtain the proper nutrition to maximize milk production. Poor hoof health may also result in decreased reproductive efficiency because sore feet lead to reduced signs of estrus. One way to improve hoof health is by using copper sulfate. Copper sulfate is a compound formed when sulfuric acid reacts with copper oxide. It is used on dairy farms in foot baths to form a solution that works wonders on diseases such as foot rot and hairy heel warts. Although copper sulfate is effective in improving hoof health, producers must be careful with the amount used as it can cause copper toxicity in soil. The waste from the foot bath is generally washed out with the manure into lagoons or some form of waste management system. When water from the lagoons is pumped out, the waste copper pumped with it onto the field. Over time this can cause a copper buildup that could be toxic to some crops. If a digester type manure system is used, the copper could actually kill the bacteria that digest the manure. When used properly, copper sulfate is a relatively inexpensive management tool for improving hoof health. In the long run, this expense will bring savings to the producer through increased milk production.

Key Words: Copper sulfate, Hoof health

138 The agricultural workforce: Changing times and issues. K. Connelly*, *Pennsylvania State University, University Park.*

One of the most challenging obstacles facing animal agriculture is finding skilled and qualified labor. The sustainability and productivity of the industry is closely related to the strengths and abilities of its workers. The U.S. Census of Agriculture reported that more than 550,000 farms hired laborers in 2002, with the workforce accounting for one in every eight dollars spent on farm production. The dependence upon international workers has increased significantly in the U.S. in recent years. This influx of new workers has significantly altered the demographics of rural communities. For example, New York's farm worker population shifted from mainly African-American to Hispanic over an eleven year period. Farm employers must now give greater consideration to the health and safety of workers, as well as to employer/employee communication. According to The Bureau of Labor Statistics, Hispanic workers have a 25% higher fatality rate than non-Hispanic workers. Cornell University's Agriculture Health & Safety Worker Training Program is an example of recent initiatives devoted to the issue of the evolving animal agriculture workforce.

Much can be learned from the western farms that first began hiring Hispanic workers from Mexico. The University of California, Berkeley, created the Agricultural Personnel Management Program, which is used as a resource by producers dealing with common problems such as a migrant workforce. Dairy producers throughout the rest of the country are beginning to realize the significance of dealing effectively with international labor force. The number of programs and publications for dairy employees available in Spanish and other languages has increased dramatically. With constant changes in agricultural industry demographics, attention devoted to workforce development will continue to influence U.S. productivity.

Key Words: Laborers, Workforce development, Safety

139 Dairy production in south China: Challenges and opportunities. L. Schultz¹, and B. Moss³, ¹*Iowa State University, Ames,* ²*Agricultural Trade Office, U.S. Consulate General, Guangzhou, China,* ³*Auburn University, Auburn, AL.*

The Chinese dairy industry is developing rapidly as domestic demand skyrockets. Per-capita consumption of dairy products has more than doubled over the last five years, and producers in South China are struggling to keep up. Average annual production in the six-province region hovers at 4 MT per cow, much lower than in the developed world. Although a large percentage of cattle in the region are imported from New Zealand, Australia and the U.S., management challenges limit the genetic potential of these animals. Specific problems in the region include a lack of high-quality forages, poor cow comfort and inadequate heifer raising programs. Milk quality also remains a key issue as several food safety scares have shaken consumer confidence in the industry. Education plays a key role in addressing these concerns and ensuring the future success of China's dairy sector. Improving domestic production also has many global implications, creating an opportunity for more international cooperation and trade.

Key Words: China, Education, Forage quality

140 Methane digestion- same manure- more energy and nutrients- less odor. A. Offenheiser*, *University of Kentucky, Lexington.*

A new light is shining on the dairy industry, or shall we say, because of it. With the opportunity to produce most, if not all of the electricity needed to run the farm, many dairies are investing in methane digesters. The use of a digester allows farmers to turn manure into a versatile source of energy. In absence of oxygen, bacteria transform volatile solids into biogas which is 50-70% methane. Methane gas can be used, like any other flammable gas, to generate electricity, heat, or even as a fuel on which to run motors. Not only have dairies been able to sufficiently power their operations and save considerable amounts of

money each year, many have found a second income by selling the excess power they produce. But the production of electricity is by no means the only benefit of using a methane digester. Along with making dairy farms self-sufficient on energy, it also solves one of the industry's biggest problems- odor. Because of this problem, many restrictions are placed on the location and size of a dairy. Since manure placed into the digester is sealed off from the outside air, it reduces odor by an incredible 97% and prevents the release of methane gas into the atmosphere. The high temperature in which the digester is held also kills many pathogens and weed seeds and any digested manure applied as fertilizer will be less hazardous to water sources and retains more nitrogen than typical manure. Although installation of the system is rather expensive, state and federal grants as well as possible tax credits provide help in initial set-up costs allowing for a 3-10 year payoff. With such benefits available, methane digestion should be strongly considered by the dairy industry as both a manure management system as well as a secondary source of income.

Key Words: Digester, Manure, Energy

141 Why crossbreed dairy cattle? J. Yoder*, *Virginia Polytechnic Institute and State University, Blacksburg.*

In the last several years crossbreeding has reappeared as a management tool for dairy farmers. Historically, crossbreeding dairy cattle has not been as popular as it is in other species, because it did not appear to be economically useful. Producers have focused on increased production as the primary economic factor in breeding programs. In most cases this focus favors pure Holsteins. Recently, producers have begun to expand their focus to add management traits (such as health and fertility traits), to breeding programs to control costs. Purebred breeds are growing increasingly inbred, as producers heavily use a small number of elite bulls. Inbreeding impacts many traits negatively, especially the management traits. Crossbreeding seeks to form beneficial heterozygous gene combinations, along with the benefit of heterosis. Heterosis raises performance above the average of the two parents. Three studies have looked at performance of crossbreds in commercial herds. A Wisconsin study surveyed producers who had crossbreds in their herds. The producers gave high scores to crossbreds for traits such as components, survivability and fertility compared to Holsteins, while citing conformation to facilities, value of selling stock and production as negatives. A USDA study found that while Holsteins produce more fluid milk, crossbreds are competitive on a Net Merit or Cheese Merit basis. A University of Minnesota study compared

purebred Holsteins to crosses of Scandinavian Red, Montebeliarde, and Normande sires on Holstein dams. The study shows that crossbreds may be competitive with Holsteins for production, particularly combined fat and protein, while improving fertility, calving ease and survival rates. Crossbreeding could be an effective tool for dairy managers. The trade-off in many cases will be giving up some production while cutting the costs of managing the herd. Crossbreds will be most beneficial in high stress climates and in areas that favor higher components. Crossbreeding programs do not eliminate the need for good management. It is critical to use high quality breeds and to select intensely within the breeds utilized. It will also be important to have accurate record-keeping to insure the success of the program.

Key Words: Crossbreeding

142 The effect of selenium source on the health and performance of dairy cattle. R. J. Mast* and E. H. Jaster, *California Polytechnic State University, San Luis Obispo.*

One of the trace minerals that has gained recognition in animal nutrition, specifically dairy cattle, is selenium because of the role that it plays in immune, reproductive, and cellular function. Research has indicated that the source of selenium can have an affect on the health and performance of dairy cattle. Recent studies have demonstrated that there are increased benefits to feeding organic forms of selenium compared to inorganic forms. These studies have focused on the concentrations of selenium in whole blood, milk, and colostrum, as well as whole blood glutathione peroxidase (GSH-PX) activity that can be achieved by feeding various forms and amounts of selenium. Selenium status is determined by the level of selenium in blood, milk, and tissue, and by enzyme activity of glutathione peroxidase. The bio-ability of the cow to transfer selenium to the calf is essential for calf health and reduced mortality. The majority of this research points to the conclusion that organic sources of selenium are more easily absorbed and able to be utilized more fully than inorganic sources by the dairy cow. Such findings make this topic important for further study in order to determine how to achieve the highest level of herd health and productivity. Comparison of the results from studies that have measured the effects of supplementing organic versus inorganic selenium to dairy cattle is important in evaluating the feeding value of this mineral in dairy cattle rations.

Key Words: Selenium, Dairy cattle

Women and Minority Issues in Animal Agriculture Luncheon

143 Mutual mentoring: A strategy for success in academia and industry. M. Lederman*, *Virginia Tech, Blacksburg.*

Those who attend this session will have the opportunity to hear about mutual mentoring, a strategy by which individuals come together to support each others efforts to succeed in the academy and in industry. We will present several examples of mutual mentoring groups whose members have been successful in achieving the goals they set for themselves. The strengths and weakness of these groups and the mechanics of how they operated will be discussed. During this meeting, we will offer the opportunity for those present to form new mutual

mentoring groups, based on whatever criteria (discipline, geographical proximity, seniority) the participants deem appropriate. We ask the participants to articulate their personal and professional goals for a time period they select, define the topics appropriate for group discussion, set up the procedure(s) by which they are accountable to each other, and decide how they will communicate. The sub-groups will report back to the whole and develop strategies by which they will continue to be in contact with each other.

Key Words: Women in agriculture, Minorities in agriculture, Mentoring

Animal Health: Johne's Disease

144 Johne's Disease integrated program – An overview. V. Kapur*, *University of Minnesota, Minneapolis.*

The Johne's Disease Integrated Program (JDIP) is a consortium of scientists from leading academic and government institutions. This consortium includes the diverse disciplines of microbiology, immunology, pathology, molecular and cellular biology, genomics, proteomics, epidemiology, clinical veterinary medicine, public health, extension, and public policy. All of the researchers are committed to finding solutions to better diagnose, treat, prevent and control Johne's Disease (JD). JDIP's mission is to promote animal biosecurity by developing and supporting projects to enhance knowledge, promote education, develop real-world solutions and mitigate losses associated with JD. JDIP promotes efficiencies through collaborative research and by sharing the intellectual and physical resources that are critical to overall success.

JDIP's strategic objectives include:

- Support and facilitate investigator-directed research on JD;
- Create and maintain scientific core facilities to support JD research and training activities;
- Establish translational research capacity for developing and validating diagnostic tests, vaccines, and disease management concepts for JD; and,
- Provide scientific information and support for the development of JD education, prevention, and control programs.

JDIP has four major research thematic areas, each led by a team of scientists working towards a common goal. Themes are organized as four interacting projects: JD epidemiology and disease transmission; diagnostic testing and strain differentiation; *Map* biology and pathogenesis; and, *Map* immunology and vaccine development.

Key Words: Johne's disease, JDIP

145 JEI – Producer focused Johne's information. K. E. Olson*, *National Institute for Animal Agriculture, Bowling Green, KY.*

Johne's disease is a wasting disease that affects cattle and other ruminants in almost every nation. It is estimated to cost the US dairy industry in excess of \$200m per year. Beef costs have not been as completely quantified. In addition to producer costs, there is a lingering concern over possible links between Johne's and human health. A substantial portion of the beef and dairy herds in the US are infected with Johne's and the proportion appears to be increasing. Surveys indicate that producer awareness of Johne's disease has increased in recent years; however, participation in state and national Johne's programs is limited. The Johne's Education Initiative (JEI) is part of a cooperative agreement between USDA-APHIS-VS and the National Institute for Animal Agriculture (NIAA) to make 'producer-friendly' information on Johne's disease easily available to producers and those who work with them. Objectives include providing information to help producers:

1. Reduce the likelihood of introduction of *M. paratuberculosis* into currently uninfected herds or flocks;
2. Minimize impact of the disease in herds or flocks where it is already present, and

3. Control existing cases of the disease and while working to reduce the incidence in susceptible species.

An initial step in this effort has been development of www.johnesdisease.org. The website provides specific information as well as links to programs and people working with Johne's in each state. The JEI is working with other groups such as the National Johne's Work Group (NJWG), the Johne's Disease Integrated Program (JDIP), state program coordinators, extension and USDA agencies to gather and develop information for use with producers that can be made available through the web and by other means. Other nations including Canada, Australia, New Zealand, Japan and the EU are also increasing efforts to educate producers and may offer future collaboration opportunities. Partnerships are being developed with milk marketing organization, livestock markets and other producer groups to define information needs and deliver information directly to producers that will help them address the disease in the future.

Key Words: Johne's, JEI

146 Johne's demonstration project in Texas. M. A. Villarino¹, H. M. Scott², and E. R. Jordan*¹, ¹*Texas Cooperative Extension, Texas A & M University, Dallas,* ²*Texas A & M University, College Station.*

Bovine paratuberculosis (Johne's Disease) is a chronic debilitating disease of cattle. Recently, dairy veterinary practitioners and producers have become more aware of the benefits of establishing Johne's Disease control measures. The objective of this investigation was to evaluate the effect on milk production and culling patterns of subclinical manifestation of Johne's Disease. Initially a retrospective cohort study in a commercial dairy located in northwest Texas was conducted. Production data were collected starting in April, 2001 using a paired comparison scheme. The cohort consisted of cows of similar age (+/- 30 days), lactation, and origin (purchased or home raised). Production parameters (lifetime milk production, milk per lactation) and individual performance parameters (days in milk, days in dairy, cull date and reasons for culling) were collected from 120 ELISA positive and 120 ELISA negative for Johne's Disease cows, for as long as the animals were maintained on the premise. Statistical comparison (t-test) and linear regression analysis on the cohort data collected to date indicate a significant reduction in milk production from ELISA positive cows when compared to ELISA negative cows (-4,105 kg lifetime). Currently, 28.33 % of the ELISA positive and 60.34 % of the ELISA negative animals remain in the herd. The reduction of milk production in the ELISA positive cows started in the second lactation and continued for the remainder of the cow's productive life, regardless of when the cow was detected as ELISA positive. Seropositive cases of JD have higher likelihood of developing concurrent conditions and were more apt to be culled earlier.

Key Words: Johne's disease

147 Georgia Johne's Disease demonstration herd. M. Pence*, *University of Georgia, Athens.*

The Georgia Johne's disease demonstration herd project is evaluating the long-term effectiveness and feasibility of management-related disease control on the herd prevalence of Johne's disease infection in Georgia cattle production units. This project is attempting to control Johne's disease through implementation of specific on-farm manage-

ment and testing practices to reduce direct and indirect transmission of Johne's disease infection by sanitation and/or management protocols. Since the most susceptible animal is the neonatal calf, a large portion of that goal is directed at reducing or eliminating calf contact with infective adult cow manure. To accomplish this goal an infected beef herd was segregated by age of the dam, cattle were tested yearly before calving and test positive cattle were moved to an off farm location. We are also working with an infected dairy herd to alter calf flow and calving location to reduce exposure of neonatal dairy heifers to Johne's disease. Since the incubation period of Johne's disease is 1-10 years, it may be several years before the outcome of altering management to control Johne's disease can be properly evaluated. However, we have seen a reduction in test positive environmental samples and a reduced number of cows that test positive. In 2004 6/1845 cows were culture positive, in 2005 6/2001 cows were culture positive. In 2004 we had 53/2147 cows blood test positive and in 2005 we had 43/1613 cows blood test positive. In 2004 we had 2/12 positive environmental culture samples and in 2005 we had 1/24 positive environmental samples. This presentation will focus on the temporal and spatial relationships of neonatal calves to infective cattle and the environmental contamination with Johne's disease.

Key Words: Johne's disease

148 Results from Minnesota Johne's Disease demonstration herd control program. C. Ferrouillet* and S. Wells, *University of Minnesota, Saint Paul.*

Six dairy cattle and 3 beef cattle herds in Minnesota have participated in a Johne's disease (JD) demonstration herd control program for the past 6 years. Objectives of this project were to 1) evaluate the longterm effectiveness and feasibility of management-related disease control on development of JD on dairy and beef cattle operations, 2) provide information and materials for education and training of public and private practice veterinarians and cattle producers, and 3) develop and evaluate management, testing, and monitoring strategies for use in control of JD in cattle herds. Cattle herds involved in this project have been selected based on history of clinical JD in the herd with organism detection confirmation, willingness of the herd owner to keep records including individual animal identification, cattle movements, and health events, and willingness to implement management practices to control JD. Within each herd, baseline and annually renewed information has been collected through completion of a JD risk assessment and herd management plan to define and prioritize risks and recommend management changes to address those risks identified in the written herd plan. In addition to monitoring of clinical JD, fecal and serum samples from all cattle have been tested by bacterial culture and ELISA, respectively, on an annual basis. Results to date from these herds show a reduction in clinical Johne's disease in nearly all dairy and beef cattle herds after implementation of management changes. A reduction in fecal shedding has occurred in most herds, while a reduction in ELISA prevalence has been observed in some herds. Variability in test results (culture and ELISA) from individual cattle has been observed, especially in cattle identified with low positive test results. Despite this variability in individual cow test results, several herds consistently tested positive as evidenced by results from environmental cultures through time. Much potential remains for use of these data and stored biologic samples in future epidemiologic and other studies.

Key Words: Johne's disease, Demonstration herd, Control

149 Preliminary results from the national Johne's Disease demonstration herd project. J. Lombard*, S. Jensen, B. Wagner, and L. Garber, *USDA:APHIS:VS; Centers for Epidemiology and Animal Health, National Center for Animal Health Surveillance, National Animal Health Monitoring System, Fort Collins, CO.*

A total of 70 dairy operations are currently enrolled in the National Johne's Disease Demonstration Herd Project (NJDDHP) in the United States. The Project began in 2003 and should continue for 5 to 7 years. Data being collected include herd-level risk assessment and management plans with additional animal-level data. A subset of these operations were selected for inclusion in this study based on the availability of accurate dam-daughter identification and fecal culture and serum ELISA test results for *Mycobacterium paratuberculosis* (*M. paratub*) infection, as well as herd-level risk assessment information. Two multivariable logistic regression models were developed to determine risk factors for cattle testing either fecal culture or ELISA positive. Mixed model analysis was performed to evaluate milk production among cows in different testing categories. To date, thirty-nine dairy operations comprising 3,602 dam-daughter pairs from eight states were included in fecal culture analysis. Serum ELISA results were available for 40 dairy operations from ten states, and included 3,687 dam-daughter pairs. Preliminary analysis revealed that daughters born to fecal culture positive dams were at 1.8 times the odds of being fecal-culture positive as those daughters born to fecal-culture negative dams. Other significant covariates in the fecal culture analysis included lactation number and the following risk areas: calving area, cow area and additions/replacements. Similarly, ELISA result analysis demonstrated that daughters from serologically positive dams were at 1.7 times the odds of testing positive compared to daughters of test-negative dams. Other significant covariates for the ELISA model included lactation number and cow risk area. Cows that tested fecal culture positive or serum ELISA strong positive had significantly lower mature equivalent 305 day milk production compared to other test categories. Results of the NJDDHP will quantify milk production loss associated with test status and more importantly assist in identifying and prioritizing specific on-farm management practices that reduce *M. paratub* transmission.

Key Words: Johne's, Paratuberculosis, Control

150 Early diagnosis of Johne's Disease: evaluation of methods. J. Stabel*, S. Robbe-Austerman, and K. Kimura, *USDA-ARS-National Animal Disease Center, Ames, IA.*

Measurement of secreted interferon-(IFN)- γ has been suggested as a tool for the early detection of animals infected with mycobacterial pathogens, including *Mycobacterium avium* subsp. *paratuberculosis* (MAP), the causative agent of Johne's disease. Removal of infected animals at an early stage will help allay the spread of this disease through the herd. In the present study, the accuracy and reliability of the IFN- γ and the intradermal skin tests were evaluated in calves born to naturally infected cows at different time points after birth. At 13-14 months of age calves were necropsied and tissue culture was correlated with results of the 2 assays. Ten of the 17 calves were tissue culture positive (TPos) for MAP and 7 were negative (TNeg). Within the TPos calves, the skin test identified 5 at 4-6 months of age, 4 at 6-8 months of age and 7 at 12-13 months of age. Comparatively, measurement of IFN- γ identified 2 calves at 4-6 months, 4 at 6-8 months, and 10 at 12-13 months. Of the TNeg animals, the skin test identified 3 calves at 12-13 months of age, whereas the IFN- γ identified 1 at 4-6 months, and 6 at the later time points. In a separate experiment, augmentation of secreted and intracellular IFN- γ responses by intradermal injection of

Johnin purified protein derivative was achieved in adult cattle naturally infected with MAP. Intracellular IFN- γ was higher within CD4+ and CD8+ subpopulations for infected cows compared to healthy controls throughout the study. When T cell populations were further defined by CD45RO+ expression, intracellular IFN- γ was higher for CD8+/CD45RO+ lymphocytes compared to CD4+/CD45RO+ cells. These results indicate that intradermal sensitization of cows in the early stage of infection with antigen will enhance the sensitivity of detection by the IFN- γ assay.

Key Words: Johne's disease, *Mycobacterium avium* subsp. *paratuberculosis*, Early diagnosis

151 The impact of *Mycobacterium avium* subsp. *paratuberculosis* fecal shedding and clinical Johne's disease on lactation performance.

E. A. Raizman*^{1,2}, J. Fetrow², S. M. Godden², and S. J. Wells², ¹*Purdue University, West Lafayette, IN*, ²*University of Minnesota, St Paul*.

The objective of this study was to evaluate the lactation performance (measures of health, production, reproduction, and survival) of cows shedding *Mycobacterium avium* subsp. *paratuberculosis* (Map) in feces prior to calving and of cows culled with clinical signs of Johne's disease (JD) during the subsequent lactation. 1,052 cows from two Minnesota dairies were enrolled in the study. Fecal samples were collected immediately prior to calving and tested using bacterial culture to detect Map. Observed signs of clinical disease (milk fever, retained placenta, metritis, ketosis, displaced abomasum, lameness, mastitis, pneumonia, and Johne's disease) and lactation performance data were recorded for each cow. Of the 1,052 study cows, 84 cows (8%) had Map positive fecal samples (46% light, 26% moderate, and 28% heavy shedders). Lactation length of fecal positive cows was on average 106 d less than negative fecal culture cows. Mean milk production for negative fecal culture cows was 9,700 kg and for light, moderate, and heavy shedders was 8,100 kg, 6,300 kg and 2,700 kg, respectively. Fecal culture positive cows were less likely to be bred and conceive than negative cows. Fifty-six cows were culled with clinical signs consistent with JD and remained in the herd an average of 202 days less than cows that completed the study and 49 days less than other cows culled from the herd. Cows culled with clinical signs of JD produced on average 3,280 kg less milk than cows that completed the study. Study results demonstrate the economic impact of fecal shedding and clinical JD on cow lactation performance, information important in motivating dairy producers to implement JD control programs.

Key Words: Johne's disease, Milk production, Reproduction

152 Identification and implications of MAP supershedders.

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The objective of this research was to determine the range of colony-forming units (cfu) per gram of *Mycobacterium avium* *paratuberculosis* (MAP) in manure from cows previously classified as heavy shedders, and the role of these animals in Johne's Disease (JD) in dairy herds. Cattle are typically classified as light, moderate or heavy shedders based on the number of MAP colonies seen on Herrold's egg yolk media (HEYM). Laboratories routinely report the number of cfu up to 70 per HEYM tube. (Seventy cfu corresponds to an estimated 1,470

MAP cfu per gram of manure.) Counts above 70 are reported as 'too numerous to count' and these cows are classified as heavy shedders. Preliminary investigation found that 1:100 and 1:1,000 dilutions of feces from heavy shedders were appropriate for enumerating the actual concentration of MAP in these samples. Subsequently, more than 200 fecal samples from animals currently identified as heavy shedders were diluted and cultured on HEYM. Supershedders (SS) were defined as animals that had manure with more than 10,000 cfu/gm. Culture results on diluted samples demonstrated that a substantial proportion of heavy shedders were SS, with some animals exceeding 1,000,000 MAP cfu/gm. Whole herd cultures from 4 herds found that 10% to 15% of all culture positives were SS. Not all of these SS cattle demonstrated clinical signs of JD at the time of sampling. It was calculated that SS cattle shedding the highest concentration of MAP were shedding more cfu than 2,000 moderate or 20,000 light shedders. Subsequent culture in one herd after the removal of a SS identified up to 15 animals that were potential false positives on the previous culture. This study has demonstrated the previously undocumented presence of MAP supershedders. The results suggest that SS contribute disproportionately to the herd environmental bioburden and the exposure of uninfected animals to MAP organisms. The data also suggest that the bioburden in herds with a SS present may contribute to herd mates being incorrectly identified as culture positive. Identification and removal of SS animals is likely to be a critical component of a JD control and management program.

Key Words: Johne's disease, Supershedder

153 Use of a Fecal PCR assay on environmental samples: Implications for detection of dairy cattle herds infected with Johne's disease.

N Cernicchiaro*¹, S. J. Wells¹, C. Muñoz-Zanzi¹, J. Gaulke², and C. Wees², ¹*University of Minnesota, St. Paul*, ²*Minnesota Veterinary Diagnostic Laboratory, St. Paul, MN*.

Johne's disease is an intestinal disease in ruminants caused by *Mycobacterium avium* subsp. *paratuberculosis* (Map). The objective of this study was to evaluate the application of a fecal PCR assay for diagnosis of Map in environmental samples and to determine its sensitivity for detection of dairy cattle herds infected with Johne's disease. Two samples were collected from up to five different locations at the farm: cow alleyways, manure storage, calving area, fresh cow area, and sick cow area (with a total of 6 to 10 samples per herd). A total of 409 environmental fecal samples from 49 Minnesota dairy farms known to be infected from previous testing were tested using Taqman PCR (ISMAV2) assay and fecal culture (FC, HEYM using the 72-hour sedimentation protocol) for Map. Results were analyzed at the herd and sample level and by location comparing PCR results with those from culture. Herd level analysis showed that of 49 infected farms, 65% were positive by PCR and 90% by FC. From those 44 herds positive by FC, 71% were also positive by PCR. 48% of herds had at least one high or very high bacterial load environmental sample by FC and PCR was able to detect 71% of those herds. At the sample level, 49% of environmental samples were positive by FC. Of those positive samples by FC, 22% were also positive by PCR. PCR was able to detect 36% of high and 59% of very high bacterial load samples. Within environmental areas, highest detection rates were found in fresh cow area (30%), manure storage (27%) and cow alleyways (21%). Our results demonstrated that the PCR test can be used as a screening test for detection of high bacterial load environmental samples in herds of unknown status due to the lower costs and quicker turn around time.

Key Words: Johne's disease, Environment, PCR

154 Evaluation of a risk assessment tool in characterizing environmental Salmonella and Mycobacterium paratuberculosis status in dairy herds. D. Collette*, L. Minicucci, and S. J. Wells, *University of Minnesota, St. Paul.*

The objective of this study was to evaluate the validity of an on-farm risk assessment tool in characterizing the status of manure-cycle pathogens on dairy farms from environmental samples. A risk assessment tool developed by study investigators was used to evaluate management practices on Minnesota dairy farms targeting Salmonella and *M. paratuberculosis*, the causative agent for Johne's disease (JD). Two visits were conducted by two evaluators to Minnesota dairy herds randomly selected from a list of state JD control program herds. Data was collected using the risk assessment tool from 36 herds from January to June 2004 and again from 38 herds from June to August 2004. Environmental samples were collected from high risk areas on the farms, including cow alleyways, fresh cow pens, and manure storage, and bacterial culture was performed to characterize Salmonella and *M. paratuberculosis* environmental status. The highest mean

Salmonella risk scores were from the cow herd, biosecurity, and growing heifer areas and the highest mean Johne's disease risk scores were from the cow herd, biosecurity, and site management areas. At the first visit, 33% of herds had positive environmental samples for Salmonella and 37% of farms were positive at the second visit. Forty-two percent of herds were categorized as high *M. paratuberculosis* bacterial load herds at each herd visit. The criteria for a high bacterial load herd was defined as having an environmental sample with a shedding score of three or four. At the first herd visit, herds with high environmental *M. paratuberculosis* bacterial loads were more likely to be Salmonella-positive farms than herds with low *M. paratuberculosis* bacterial load ($P < 0.05$). Preliminary analysis demonstrated lack of association between mean risk scores overall or within individual management areas and Salmonella or *M. paratuberculosis* environmental status. This is an indication that an evaluation of herd management on-farm using a risk assessment tool does not predict manure-cycle pathogen environmental status on the day of the herd visit.

Breeding and Genetics: Dairy Breeding

155 Genetic impact of utilizing female-sorted semen in commercial and nucleus herds. G. Abdel-Azim* and S. Schnell, *Genex Cooperative Inc., Shawano, WI.*

This study was designed to investigate genetic effects of using sorted semen in a dairy cattle population. Progress was monitored in elite and commercial animals over 20 years of selection. To study the genetic impact of utilizing sorted semen in commercial herds, a scenario in which female-sorted semen was available to commercial herds was evaluated. Second, to study the genetic impact of utilizing sorted semen in nucleus herds, scenarios in which female-sorted semen was used only in a nucleus herd, where multiple ovulation and embryo transfer (MOET) took place, were simulated. Finally, because of the additional advantage of marker-assisted selection when sorted semen is used in nucleus herds, utilization of sorted semen in scenarios that employed marker-assisted selection was simulated. In the scenario where female-sorted semen was used in commercial herds, a large genetic advantage was observed early in commercial cows. Average superiority in first-lactation cows exceeded 30% in year 11 but continued to decrease until it reached 9% in year 20. The increased selection intensity in commercial cows contributed to the genetic merit of future cows (cow→cow contribution) but the contribution of the nucleus grew over time, and gradually marginalized the cow→cow contribution. The genetic advantage of gender control in the MOET scheme was minimal except when marker-assisted selection was also available. Two factors that affected the contribution of marker-assisted selection were studied: within versus across family selection of donors and the number of loci in the QTL component. Schemes that selected donors regardless of their family structure were superior, and more loci in the QTL component increased the effectiveness of sorted semen. Finally a reduced MOET scheme where harvested females were reduced from 42 to 25 per year was studied. It was found that the reduced scheme in combination with female-sorted semen was not genetically inferior to the large scheme in combination with regular semen.

Key Words: Dairy cattle breeding, Marker-assisted selection, Sorted semen

156 Net present value of an artificial insemination: non-sexed versus sexed semen. N. J. Olynk* and C. A. Wolf, *Michigan State University, East Lansing.*

Sexed semen has been a long anticipated tool by dairy farmers to obtain more heifer calves. Using flow cytometry to separate male- and female-bearing sperm decreases sperm numbers per straw and negatively affects sperm viability and longevity leading to decreased conception rates (CR). This decreased CR makes virgin heifers better suited for insemination with sexed semen than lactating dairy cows. Budgets were developed to calculate the net present value (NPV) of an artificial insemination of a virgin heifer using non-sexed and sexed semen. With heat detection rates (HDR) varying widely between farms, and CR varying based on both animal and management factors, multiple scenarios were required to assess differences in NPV with non-sexed versus sexed semen. Bull and heifer calf values were held constant in all scenarios, with heifer calves valued at \$500 and bull calves valued at \$110. Costs per straw were held constant at \$15.00/straw for non-sexed semen and \$45.00/straw for sexed semen of approximately the same genetic value. With sex ratios of 49.2% female with non-sexed semen and 90% female for sexed semen, a sample scenario was performed holding heat detection constant at 51%. Base values for CR with non-sexed of 58% and sexed semen of 31% were obtained from K.A. Weigel (2004). With these HDR and CR we observed an approximately \$50 decrease in the net present value of an insemination with sexed semen. Holding all other factors constant in this scenario, the CR with sexed semen would need to decrease by no more than 6 percentage points to achieve the NPV obtained with non-sexed semen. In this scenario the value of an average calf increased approximately \$150 with sexed semen, although this difference is overwhelmed by the nearly 50% decrease in pregnancy rate. To achieve a positive NPV assuming a 51% HDR, the CR with sexed semen must be at least 20%; assuming a 70% HDR, the CR with sexed semen must be at least 15%. Other considerations include the effect on dystocia, biosecurity, and internal herd growth implications.

Key Words: Sexed semen, Heifer reproduction, Artificial insemination

157 Domestic versus imported artificial-insemination semen for Holstein graziers in the United States. H. D. Norman, J. R. Wright, and R. L. Powell*, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

In recent years, interest has increased in the United States regarding grazing of dairy cows to reduce machinery, feed, and labor costs. Success with grazing requires that cows begin lactations when pasture is ready, which places a premium on fertility, a trait that has been declining. Grazing has been the general practice in New Zealand (NZ) for many years. Use of semen from NZ bulls in the United States assumes that bulls selected for superior daughter performance in NZ will be good choices for US graziers. The study compared US performance of daughters of NZ artificial-insemination (AI) bulls with that of US-sired contemporaries. Data were milk, fat, and protein yields, somatic cell scores (SCS), and days open (DO) from 161 US herds with daughters of 26 NZ Holstein-Friesian bulls. For each of those 565 daughters, difference in standardized phenotype from 6,506 US-sired herd contemporaries was computed for parities 1, 2, and 3. Daughters of the 1,168 US bulls were higher for milk (473 to 545 kg) and protein (5 to 6 kg) yields for each parity and lower for SCS (0.2 units) for parities 1 and 2. Daughters of NZ bulls were slightly higher (1 to 2 kg) for fat yield. First-parity DO were lower (7 d) for NZ daughters, with a possible DO superiority indicated for NZ daughters for parity 2 (1 d) and for US daughters for parity 3 (8 d). Differences favored US bulls for milk and protein yields and SCS; NZ bulls were favored for DO for parity 1. Daughters of US bulls had higher linear composite indexes for body size, feet and legs, and udders, but data were limited. Bulls were compared to all AI bulls in their own country that were born from 1994 to 1996 and found to be generally in percentile 50 or higher (percentiles 47 to 76) for most traits; NZ bulls were in higher percentiles as expected because imported semen is selected based on foreign progeny tests. Importation of semen from bulls selected under NZ conditions has not been advantageous for yield, SCS, and DO to date for US grazing operations.

Key Words: Genetic evaluation, Grazing, Imported semen

158 Assessment of the economically optimal voluntary waiting period for first breeding in dairy cattle. A. Bell*, A. de Vries, and P. J. Hansen, *University of Florida, Gainesville.*

Objective of this study was to assess the economically optimal voluntary waiting period (VWP) for first breeding for individual dairy cows. Recently, greater VWP have been recommended because of increased milk yield and persistency, greater fertility later in lactation, and reduced labor associated with timed-AI protocols. The economically optimal VWP for an individual cow is obtained when expected future cash flows are maximized. An existing model that optimizes breeding and replacement decisions was adjusted. Major adjustments were: 1) weekly instead of monthly stages, 2) separation of the performance of the cows currently in the herd from the performance in the next lactation and of replacement heifers. This allowed for more accurate representations of individual lactation curves and risk of pregnancy. Insemination values, defined as the difference in future cash flows between breeding a cow this week compared to waiting and making the optimal breeding decision 3 weeks later, were calculated. A negative insemination value is the positive value of the delay of the VWP. Inputs for a Holstein herd in the US were used in the model. Estrus detection rate and conception rate were set at 40%. Minimum VWP was set at 42 DIM. Lactation curves were calculated by Best Prediction for 25,000 ME milk. Milk yield for 10 first lactation cows

currently in the herd were incremented by 0 to +9 kg/d. Insemination values at 42 DIM (INS42) decreased from \$45 to -\$47 by greater milk yield. Optimal VWP increased for cows producing $\geq +5$ kg/d (range 49 to 133 DIM). When both estrus detection rate and conception rate were 50%, INS42 were on average \$21 lower. The VWP for cows producing $\geq +4$ kg/d increased (range 63 to 182 DIM). Increased persistency (+0.08 kg/d after peak) reduced INS42 by \$40, increasing the VWP for cows producing $\geq +2$ kg/d (range 49 to 224 DIM). In conclusion, the optimal VWP increased with greater milk yield, greater persistency, and greater risk of pregnancy, and therefore was different for individual cows in the first lactation.

Key Words: Voluntary waiting period, Economics, Optimization

159 Optimal breeding and replacement decisions for dairy cows when heifer supply is constrained. A. de Vries*, *University of Florida, Gainesville.*

Objective of this study was to develop a model that optimizes breeding and replacement decisions for dairy cows when heifer supply is constrained. Herd resource constraints, such as a limited supply of heifers, make optimal breeding and replacement decisions for individual cows dependent on decisions for other cows in the herd. The presence of herd constraints requires that optimal decisions need to be determined simultaneously for all cows in the herd. Previous approaches provided complex and approximate solutions, while exact solutions for realistic problems have not been developed. In this study, the dairy cattle breeding and replacement problem under heifer supply constraints was modeled as a network consisting of nodes, arcs, and side constraints, and solved with the Interior Point algorithm in SAS procedure Netflow. To illustrate the model, data on lactation curves, milk prices, heifer prices, feed cost, labor cost, fixed cost, risk of involuntary culling, and risk of pregnancy for conditions in Florida were used. Heifer supply was varied as a fraction of the number of available slots on the dairy farm. The network formulation resulted in 35,758 nodes, 79,947 arcs, and 43,124 side constraints. Proc Netflow typically used approximately 6 minutes to solve the problem, with the vast majority of the time spent on preprocessing the data. Approximately 40 iterations of the Interior Point algorithm were needed, depending on the constraints. When the supply of heifers was not constrained, profit / slot per year was \$396.76 and 100% of the slots were filled with cows. Per year, 45.93% of slots received a replacement heifer. Forced entry of more or fewer heifers reduced profit. Not all slots were filled if the supply of heifers was considerably limited. Cows were kept longer when heifer supply was more limited. The maximum profit / slot per year was not associated with the greatest milk yield / slot per year. In conclusion, the network formulation solves the dairy cattle breeding and replacement problem under herd constraints for individual cows at a realistic level.

Key Words: Network, Optimization, Culling

160 Protections available for intellectual property in the dairy artificial insemination industry. E. Ogden and K. Weigel*, *University of Wisconsin, Madison.*

The cost of semen has declined due to fierce competition and the ease of erasing competitive advantages by buying sons of competitors' sires. It is difficult for breeding companies to recoup research and development costs, but intellectual property law could be of value. Copyright law protects ideas, but facts such as DNA sequences can't be copyrighted. Trade secret law protects valuable information, but

secrets can be lost by reverse engineering, and it would be difficult to keep DNA information secret. A trademark designates a product's origin, and these have been applied to laboratory animals, so a name or prefix could be trademarked. A patent allows the owner to exclude others from using or selling an invention, and many innovations are patentable, including DNA sequences. The exact sequence and defined utility are required, so patenting a whole genome would be difficult. Process claims can protect methods to create genetically modified animals, but traditional breeding methods are not novel. Patentability rests on whether an innovation is a product of man or nature, not if it is inanimate or living, so plants, animals, and microbes have been patented. A patentable animal must express a DNA sequence that is not naturally occurring, not merely a sequence that is discovered as useful. Due to these limitations, contractual licensing may be the best option. A seller can license a product, rather than sell it outright. In exchange for letting a purchaser use the product, the seller restricts its field of use. This allows the seller to keep the product out of competitors' hands and to use price discrimination. Price discrimination keeps costs low for those who can't impact the seller's ability to recoup expenses and puts the burden on those who can. Acceptance can involve a signed contract or specific conduct, such as opening of a shrink-wrap license (for software). Such restrictions are applicable to the dairy genetics industry. By restricting the reselling of a unit of semen or the resulting calf, a company could keep its genetics out of competitors' hands and use price discrimination in the marketplace.

Key Words: Intellectual property, Genetics, License

161 Genetic analysis of milk urea nitrogen and lactose and their relationships with production traits in Canadian Holstein cattle. F. Miglior^{1,2}, A. Sewalem^{1,2}, J. Jamrozik³, D. M. Lefebvre⁴, and R. K. Moore⁴, ¹*Agriculture and Agri-Food Canada - Dairy and Swine Research and Development Centre, Lennoxville, QC, Canada*, ²*Canadian Dairy Network, Guelph, ON, Canada*, ³*Centre for the Genetic Improvement of Livestock, University of Guelph, Guelph, ON, Canada*, ⁴*Programme d'Analyse des Troupeaux Laitiers du Québec, Ste-Anne-de-Bellevue, QC, Canada*.

The Programme d'Analyse des Troupeaux Laitiers du Québec (PATLQ) has been collecting data in Quebec dairy herds on lactose since 2001 and milk urea nitrogen (MUN) since 1997. While data on MUN is also being collected in other Canadian provinces, testing for lactose concentration in Canada is currently done exclusively in Quebec by PATLQ. Concentrations of MUN are measured at Canadian DHI labs by infrared technology. Several studies have already reported associations of MUN and lactose with fertility, health and/or energy balance traits in dairy cows. The objective of this research was to estimate heritabilities of MUN and lactose in the first three parities, and their genetic relationships with milk, fat, protein and SCS in Canadian Holsteins. Multiple-trait random regression test-day animal model and the Gibbs sampling method were used for parameter estimation. Regression curves were modelled using Legendre polynomials of order four. Data were a random sample of test day records (60,645 records from 5022 cows) extracted from the original data set, which included 1,183,725 records from 235,760 Holstein cows. A total of six 4-trait analyses, which included MUN and/or lactose (yield or percentage) with different combinations of production traits, were performed. One chain of 100,000 cycles was run for each 4-trait analysis and the first 10,000 samples were discarded as a burn-in. Average daily heritabilities were moderately high for MUN (0.384 - 0.414), lactose kg (0.466 - 0.539), and lactose percentage (0.478 - 0.508). Lactose kg was highly correlated with milk yield (0.979). Lactose percentage

and MUN were not genetically correlated with milk yield. Research is underway to assess the relationships between MUN and lactose with fertility traits.

Key Words: Milk urea nitrogen, Lactose, Variance component estimation

162 Blood metabolite profiles in dairy cattle selected for differences in milk component production. M. Westall* and D. Moody Spurlock, *Iowa State University, Ames*.

Long term selection for increased milk production in the US dairy industry has contributed to a decline in fitness traits. The objective of this study was to evaluate energy mobilization in cows selected for high versus average production of milk components. We hypothesized high producing cows would show greater mobilization of body energy reserves, potentially contributing to compromised fitness traits. Cows were randomly chosen to represent selection lines from the Iowa State University research herd that have been selected for high (HFP) versus breed average (AFP) fat plus protein PTA since 1986. Twenty-eight HFP and 22 AFP cows balanced for first and later parities were used. Blood samples were taken weekly from week 1 to 12 post partum, and monthly through week 24. Body condition scores (BCS) and body weights were taken at the time of blood collection. Serum was analyzed for glycerol, non-esterified fatty acids (NEFA) and creatinine concentration. Data were analyzed for each week of lactation using a model that included fixed effects of line, parity and their interaction, and a random effect of cow within line and parity. Preliminary production data project a non-significant difference between AFP and HFP cows for energy corrected milk (23,679 versus 24,164 lb, respectively). BCS for HFP cows were less than for AFP cows at weeks 16 and 20 ($P < 0.05$). Body weights did not differ between lines throughout the experiment. Serum creatinine for AFP cows was less than for HFP cows at weeks 2, 3 and 4 ($P < 0.05$). Glycerol concentrations for AFP cows were greater than for HFP cows at weeks 16 and 20 ($P < 0.05$). NEFA did not significantly differ between lines. In contrast to our hypothesis, differences in glycerol concentration indicate greater mobilization of adipose tissue by AFP than HFP cows in mid lactation. However, this difference may be a reflection of total body fat. The significant difference between lines for creatinine concentration was unexpected, and suggests a potential difference in the tissue origin of mobilizable energy between cows selected for differences in milk component production.

Key Words: Energy mobilization, Fat, Muscle

163 Effects of accounting for heat stress on genetic evaluation of US Holsteins for milk by a test day model. J. Bohmanova¹, I. Misztal¹, S. Tsuruta¹, H. D. Norman², and T. J. Lawlor³, ¹*University of Georgia, Athens*, ²*Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD*, ³*Holstein Association, Brattleboro, VT*.

The purpose of this study was to quantify the effect of heat stress on genotype by environment interaction among different regions of the United States. The national data consisted of 55.5 million first parity test-day (TD) milk yield records on 5.8 million Holstein cows. Subsets of the national data were from the Northeast (NE) with 12.5 million TD records on 1.3 million cows, and from the Southeast (SE) with 3.5 million TD records on 0.36 million cows. Meteorological data from 202 public weather stations were matched with herds based on distance. Daily mean temperature-humidity index (THI) was calculated

from temperature and relative humidity records three days prior to TD. The first model that lacked the effect of heat stress included fixed effects of herd-test date, age at calving class, frequency of milking, and DIM x season class, and random genetic additive (regular breeding value) and permanent environmental effects. The second model that accounted for heat stress included two additional random regressions on degrees of heat stress ($t = \max[0, \text{THI} - 72]$), one for additive genetic (heat breeding value) and one for permanent environmental effect. Breeding values (BV) were computed by BLUP90IOD. Correlations involved sires with at least 300 daughters in regions being compared. When heat stress was ignored, the correlations of regular BV between NE and SE were 0.86. When the heat stress was considered, the correlation increased by 0.01. The correlation between heat BV for NE x SE was 0.72. Heat stress effect as applied explains only a fraction of differences in sire ranking between SE and the NE. The real impact of heat stress may be higher because THI as used accounts only for a fraction of variability due to heat and low correlations are in part due to limited accuracies.

Key Words: Genetic evaluation, Heat stress, Genotype x environment interaction

164 Estimation of genetic parameters of test day milk yields for Holsteins in Khorasan province of Iran. J. Eslami¹, H. Farhangfar^{*2}, and H. Naeemipour², ¹Zabol University, Zabol, Iran, ²Birjand University, Birjand, Iran.

In this research a total of 72187 monthly test day mil yields obtained from 8652 first lactation Holsteins calved from 1993 to 2003 in Khorasan province of Iran was used to estimate genetic parameters using single trait, repeatability and random regression test day animal models. In the random regression test day model orthogonal legendre polynomials of 4th order was used to take account of additive genetic and permanent environmental variation during lactation among individual animals. Heritability estimates of test day milk yields ranged from 0.11-0.25 and 0.10-0.24 for single and random regression test day models respectively. In the repeatability test day model the heritability estimate of monthly test day milk yields was found to be approximately 0.16. The results obtained showed that the second part of the lactation course was more heritable than the first part of the lactation. Repeatability of test day milk yields was 0.64. Genetic correlations among adjacent test day milk yields were high and decreased as the interval between them increased. The genetic

correlations between months 1 and 10 and between months 9 and 10 were the lowest and highest respectively.

Key Words: Genetic parameters, Test day models, Random regression

165 Studies on drops of PTA from first to second crop for final score in Holsteins. V. Koduru^{*1}, I. Misztal¹, S. Tsuruta¹, and T. J. Lawlor², ¹The University of Georgia, Athens, ²Holstein Association USA Inc., Brattleboro, VT.

Drops of PTAs for final score from first to second crop of daughters have been reported for Holstein sires. The objective of the study was to investigate whether the causes of these drops were different distributions of grade and registered animals in the subsequent crops. The PTAs were estimated from 2 datasets: data A (5,993,207 animals with classification year up to 2001) and data B (6,606,175 animals with classification year up to 2005). For the sires born between 1993 and 1996 (N=145) PTA drops were calculated as difference between PTAs estimated from data B (second crop) and PTAs estimated from data A (first crop). The basic single trait (ST) animal model included effects of herd-year-season-classifier (HYSC), age-year, stage of lactation-year, animal genetic, permanent environmental and residual effects. Modifications to the ST model included reduced weights for grade records and treating HYSC as random. A two trait model treated records of registered and grades as separate with animal effects considered correlated or not. The last model corresponded to separate evaluations for grade and registered cows with heritability of 31% for registered and 17% for grades, and the correlation between their additive effects was 77%. Separate analyses used data adjusted for heterogeneous herd variances. The mean and SD of first crop and second crop PTAs estimated with the basic ST model using unadjusted data, were 2.2 and 0.7, and 1.5 and 0.6 respectively. Mean difference of PTAs estimated with ST model was 0.69 and the drops were in the range of -2.1 to 0.3, with more drops (94%) than gains. Drops with the modifications to the ST model were 81% or higher. With a multiple trait model, the percentage of drops was 89 for registered and 80 for grade when genetic effects were assumed correlated, and 86 and 69 when they were not. The adjustment had little effect on the results. Drops of PTA from first to second crop for final score are mostly due to factors other than changing fractions of grades and registered.

Key Words: Final score, Holstein, PTA

Dairy Foods: Cheese I

166 Textural and rheological properties of cream cheese: effect of cream mix homogenization pressure and incubation temperature. M. Brighenti^{*1}, S. Govindasamy-Lucey², J. J. Jaeggi², K. Lim², M. E. Johnson², and J. A. Lucey¹, ¹University of Wisconsin, Madison, ²Wisconsin Center for Dairy Research, Madison, WI.

The objective of this study was to determine the impact of cream mix homogenization pressure (HP) and incubation temperature (IT) on rheological and textural properties of cream cheese. A central composite experimental design and response surface methodology were used for data analysis. Cream cheeses were manufactured using different HP (100, 122, 175, 228, and 250 Bar) during the first stage of homogenization, while the pressure of the second step was constant (50 Bar). The IT used were 20, 21, 23, 25, and 26°C. Curds were

stirred at pH 4.7. Storage modulus (SM) values at 8°C were obtained by small amplitude oscillatory tests. Hardness was determined by texture profile analysis (TPA). A trained sensory panel used spectrum descriptive analysis to determine: firmness, stickiness, and difficulty to spread. Cream cheeses were analyzed 2 and 4 weeks after manufacture. For most samples, significant ($P < 0.05$) differences were observed for hardness between 2 and 4 weeks, suggesting that there were changes in the structure of cream cheeses during storage. In most cases, samples became harder. Increasing IT significantly ($P < 0.05$) decreased SM, hardness (TPA), and sensory firmness and difficulty to spread, while it increased stickiness. This effect may be due to an increase in hydrophobic interactions at higher IT that may cause contraction of the casein particles, which could reduce the contact area and decrease

the number of interactions between caseins. Although HP alone did not have a significant ($P>0.05$) impact on these parameters, there was a significant interaction between HP and IT. At low IT, higher HP caused SM, TPA hardness, firmness and difficulty to spread to increase and stickiness to decrease, while at high IT, an increase in HP had the opposite effect. This study showed that the selection of IT and HP can help develop a product with the desired functionality.

Key Words: Cream cheese, Texture

167 The effect of high pressure processing on the salt distribution in Turkish white cheese. N. Koca*^{1,2}, R. Raghupathy¹, V. M. Balasubramaniam¹, and W. J. Harper¹, ¹The Ohio State University, Columbus, ²Ege University, Izmir, Turkey.

Recently, the research on high pressure processing (HPP) of cheese has focused on the acceleration of cheese ripening and inactivation of microorganisms. The salt distribution in cheese is a very important parameter for its ripening and microbiological quality. The objective of this study was to determine the effect of HPP on salt distribution in white cheese. White cheese samples were produced by using a 1% mixture of mesophilic (*Lactococcus lactis* and *Lc. cremoris*) and thermophilic (*Streptococcus thermophilus*, *Lactobacillus bulgaricus* and *Lb. helveticus*) cultures. Cheese blocks (6x7x10 cm³ and 390±10 g) at the pH of 4.9 were suspended in brine (14g NaCl 100g⁻¹ water) at 22±1°C for 3 and 6 hours. After removing residual surface salt by wiping, the blocks were vacuum packaged in a high barrier pouch. Samples were subjected to HPP at 50, 100, 200 and 400 MPa and 22±2°C for 5 and 15 minutes. Control (0.1MPa) was vacuum packaged as well. Whole cheese blocks were then sampled in external, middle and internal zones after keeping at 4°C for around 3 hours. Salt and moisture contents were determined with a 926 Chloride Analyzer and a vacuum oven, respectively. The salt in moisture values (SM) of external zones for 3 and 6 hours ranged from 3.73 to 4.08 g/100 g and from 4.93 to 5.30 g/100 g respectively while those of middle zone ranged between 0.46-0.71 g/100 g and 0.72-0.80 g/100 g, respectively. The SM values of the internal zones were the same as that of unsalted cheese. No significant difference in salt distribution was observed between control and pressure treated cheeses for both salt concentrations. Additionally, time of pressurization had no effect on salt distribution. Only a significant difference was found in the values of salt and SM of the middle zone of the cheeses salted 3 hours, which could be attributed to sampling difficulties due to textural differences. Results showed that HPP at 50, 100 and 400 MPa for 5 and 15 minutes had no effect on salt distribution in white cheese. Additional study is needed to determine how texture differences resulting from HPP affect salt diffusion during the ripening period.

Key Words: High pressure processing, Salt distribution, Cheese

168 Isolation and purification of angiotensin-I-converting enzyme inhibitory peptides from Cheddar cheeses with the addition of probiotic *Lactobacillus casei* or *L. paracasei*. L. Ong*¹, N. Shah¹, and A. Henriksson², ¹Victoria University, Werribee, Victoria, Australia, ²DSM Food Specialties, NSW, Australia.

Angiotensin-I-converting enzyme (ACE) increases blood pressure by converting angiotensin-I to angiotensin-II, potent vasoconstrictor and by degrading bradykinin, a vasodilatory peptide. ACE-inhibitory peptides have been isolated in various cheeses, released as a result of proteolysis during ripening. The objectives were i) to study the

influence of proteolysis on the release of ACE-inhibitory peptides in probiotic Cheddar cheeses during ripening and ii) to isolate, purify and identify these peptides. Cheddar cheeses were made with starter lactococci and *Lactobacillus casei* 279 or *L. paracasei* LAFTI®L26. ACE-inhibitory activities of the water-soluble fraction of the cheeses were measured by spectrophotometric assay. Peptides were purified using reverse-phase HPLC and identified by automated Edman degradation protein sequencer and mass spectrophotometer. Presence of probiotic organism increased proteolysis in Cheddar cheeses during the nine months ripening at 4°C. The IC₅₀ (concentrations of ACE needed to inhibit 50% of ACE activity) was highest after six months of ripening in the probiotic cheeses (0.23- 0.25 mg/mL) compared to nine months in cheeses without probiotic (0.28 mg/mL). The water-soluble extract of each cheese was subjected to several stages of chromatography fractionation. Inhibitory activity found in the crude fractions ranged from 0.1 to 0.8 mg/mL. The fraction with the highest activity was purified by a second stage chromatography. Various ACE-inhibitory peptides were found, which corresponded to the α_s-casein N terminal peptides, f(1-9), f(1-6), f(24-32) and β-casein N-terminal peptides, f(193-209) and f(191-209). Our results suggested that ACE inhibition in Cheddar cheeses was dependent on proteolysis. Probiotic organisms used in this study can be added successfully in Cheddar cheese in order to produce bioactive peptides.

Key Words: Cheese, Probiotic, Proteolysis

169 Effects of milk proteins and packaging on occurrence of calcium lactate crystals in Cheddar cheese. S. Agarwal*, J. R. Powers, B. G. Swanson, S. Chen, and S. Clark, *Washington State University, Pullman.*

Calcium lactate crystals (CLC) in hard cheeses continue to be an expense to the cheese industry. Major causes of L(+) lactate crystals appears to be 1) increasing protein concentration in cheese milk, which increases cheese yield and 2) type of packaging, which influences serum calcium migration. The research investigates the effects of protein concentration and packaging on migration of serum calcium to the surface of cheese during storage and CLC occurrence. Total and soluble calcium, phosphorus, lactic acid and citrate were measured in cheeses made with skim milk (SM1, 3.14% protein) and skim milk supplemented with ultrafiltered milk (UF) (CSM1, 6.80% protein) or NFDM (CSM2, 6.80% protein). Vacuum and gas flushed cheeses were analyzed for total and soluble calcium, lactic acid and salt at four specific distances from the center of cheeses made from whole milk (WM1) and whole milk supplemented with UF (CWM1). Cheeses made from CSM1 and CSM2, had 26% higher total calcium (1367 mg/100g and 1375 mg/100g cheese, respectively), than cheeses made from SM1 (1066 mg/100g of cheese). At pH 5.2, soluble calcium in cheeses made from CSM1 and CSM2, (550 mg/100g and 558 mg/100g cheese, respectively) was 25% higher than cheeses made from SM1 (441 mg/100g of cheese). At week 10, higher (8%) total and soluble calcium were observed on surfaces of cheeses made from WM1 that were gas flushed compared to the center of the cheese blocks. In contrast, hardly any change was observed in vacuum packaged cheeses, showing that migration of serum calcium to the surface of cheeses was more prevalent in gas flushed cheeses. These results confirm that the risk of occurrence of CLC in cheese increases with concentration of milk proteins. Additionally, loose packaging enhances serum calcium migration to cheese surfaces, increasing the concentration of calcium ions and the risk of CLC.

Key Words: Calcium lactate crystal, Cheddar cheese, Packaging

170 Qualitative analysis of Sicilian traditional cheeses microstructure by scanning electron microscope (SEM). L. Tuminello^{*1}, M. Caccamo¹, and G. Licitra^{1,2}, ¹CoRFiLaC, Regione Siciliana, Ragusa, Italy, ²D.A.C.P.A. Catania University, Catania, Italy.

Nine traditional Sicilian cheese varieties, five pressed and four pasta filata cheeses, at the best commercial representative ripening age, were analyzed by SEM. The cheeses had different peculiar shapes and hardness. They were cylindrical for the pressed cheeses (Sicilian Pecorino P.D.O., Maiorchino, and Tuma Persa hard cheeses, Piacentinu Ennese semi-hard cheese, Fiore Sicano soft cheese), parallelepiped for the pasta filata hard cheeses (Ragusano P.D.O. and Palermintano), pear like surmounted by a short neck with a ball head for the semi-hard pasta filata cheese (Provola dei Nebrodi), and disc like for the other fresh soft pasta filata (Vastedda del Belice). The sampling was done using a cheese trier by extracting a cheese core; three rectangular strips (approximately 1 x 3 x 8 mm) were cut from the medial region of each core and were prepared according to McManus et al. (1993) procedure. Samples were then dried in a critical point drying apparatus, mounted on aluminum stubs, sputter coated with gold-palladium for 15 s, and observed by SEM at 15 kV. A series of sequential images, from two fields, were recorded at 500X and 1000X magnification. As expected, significant differences on the cheeses microstructure between the pressed and pasta filata cheeses were detected. Differences were observed also within each of the above cheese categories. The pressed cheeses showed a protein matrix sponge-like structure permeated by a well distributed system of empty spaces that were originally occupied by fat globules and whey. Casein micelles join each other to form clusters and strands with no defined orientation. These amorphous texture of Sicilian pressed cheeses have been observed also in other pressed cheeses. Pasta filata cheeses showed a fibrous structure (long fiber) as a result of curd stretching. Stretching transforms the amorphous 3-dimensional protein matrix into a network of parallel-aligned protein fibers. Casein molecules interact and bind each other to form a long sheaves uniformly oriented in one direction.

Key Words: Sicilian cheeses, SEM, Microstructure

171 Impact of milk lactose reduction on the chemical, textural and shredded cheese quality of mozzarella. C. Chen^{*}, A. Bostley, J. Jaeggi, K. Lim, and M. Johnson, *Wisconsin Center for Dairy Research, Madison, WI.*

For mozzarella, the primary texture attributes related to acceptable shredding are firmness and adhesiveness. The firmer and less adhesive the mozzarella, the higher the Shred Grade (an indicator of shredded cheese quality). Our goal was to manufacture a firmer more shreddenable cheese using a reduction in milk lactose as a control point for acidity development and solubilization of colloidal calcium phosphate (CCP). LMPS Mozzarella: pasta filata (PF) and non-pasta filata (NP), were manufactured using milk with lactose reduction (RL) or without (control). Milk lactose levels were reduced by ultrafiltration and diafiltration to a ratio of 0.60 lactose:casein. Cheese pH and insoluble calcium levels were measured at 1, 7, 14, 28 and 56 d. Cheeses were shredded using an Urschell CC-D. Texture attributes, as determined by descriptive sensory analysis, and Shred Grade were determined periodically through 56 d of aging. No differences were observed between treatments in the rate of acid production during cheese making, however, the RL cheeses had a higher pH throughout aging. RL NP cheeses had more insoluble calcium, a firmer and less adhesive texture and a higher Shred Grade. PF mozzarella exhibited no difference between control and RL treatments in insoluble calcium levels,

texture or shredded cheese quality. The different outcomes between mozzarella styles can be attributed to when acidity was developed. For PF mozzarella, acidity is developed in the cheese making vat. During plasticizing, brining and early refrigeration there are minimal changes in pH. For NP mozzarella, the majority of the acidity develops during pressing, cooling and early refrigeration. During this time, sugars are fermented, pH drops and CCP solubilizes. Because the RL treatment has a lower concentration of residual sugars, the process ceases earlier, resulting in a higher pH and more insoluble calcium. Reducing lactose as a means of improving shreddenability is most effective in cheeses where acidity is developed during pressing.

Key Words: Mozzarella, Insoluble calcium, Shredding

172 Influence of salt up take and aging temperature on chemical composition and on early gas defects in raw milk pasta filata Ragusano cheese. G. Licitra^{*1,2}, M. Caccamo¹, G. Marino¹, G. Tumino¹, and G. Farina¹, ¹CoRFiLaC, Regione Siciliana, Ragusa, Italy, ²D.A.C.P.A. Catania University, Catania, Italy.

Fifty one 3.8-kg experimental blocks of Ragusano cheese were made. One block was analyzed at time 0 prior to brining, the other 50 blocks were submerged in a not saturated brine (18%) at 15°C and divided in two groups. One group (25) was left in brine for 6 d (GR6), the other group (25) for 12 d (GR12). A block of cheese for each group was sampled after brining. The remaining 24 blocks per group were left to ripen at a different temperature (12, 16, and 20°C), 8 blocks per treatment for 30d. Two blocks per treatment were removed for sampling at 15 and 30d of ripening. The last 6 blocks per treatment were split in 3 sub treatments and left to ripen at a 12, 16, and 20°C, 2 blocks per sub treatments for further 60d, and were sampled at 60 and 90d of ripening. Each block at sampling day, was weighed and divided in P1,P2,P3,P4 portions using a meat slicer (Melilli et al 2003). The trial was replicated three times. Across all treatments the GR12 cheeses had significant higher weight loss, lower moisture content and higher salt up take compared to GR6. The weight lost was significant higher for the ripening treatments at 20°C followed by the cheeses at 12°C and then the one ripened at 16°C. Opposite trend was observed for moisture lost during ripening with the highest differences for the portions P1 and P2. Gas production was measured by image analysis (Caccamo et al., 2004) to determine the percentage of surface area of the cheese slice occupied of gas holes. The cheeses ripened at 12°C for 90d presented the lowest percentage (ca 75%) of gas holes compared to those ripened at 20°C for 90d. Interactions were observed after 30d when cheeses were switched at different temperature. In portions P3 and P4 the only way to control gas production was by keeping the room temperature at 12°C for 90d. To control weight lost, lower gas holes and keep reasonable fermentation during Ragusano cheeses aging, the ripening room temperature should be set up between 12 and less than 16°C.

Key Words: Ripening temperature, Salt uptake, Raw milk pasta filata Ragusano cheese

173 Development of Pasteurized Process Queso Fresco. R. Muhar^{*}, N. Y. Farkye, and A. Schaffner, *California Polytechnic State University, San Luis Obispo.*

The increase in Hispanic population in the United States, especially in California and increased consumer interest in Tex/Mex foods has increased the demand for Hispanic cheeses. The objective of this study was the development of a method for the manufacture of pasteurized

process cheese from Queso Fresco (QF) to help manufacturers salvage excess trimmings, out of spec cheese, etc. QF is a soft, unripened and non melting Hispanic cheese (containing 46.8% moisture, 27.2% fat, 18.5% protein, 2.8% salt and pH 6.5). Pasteurized process Queso Fresco (PPQF) was manufactured on 3 occasions from separate lots of QF (aged 5 d, 1 mo or 2 mo) using 3% sodium citrate or disodium phosphate as emulsifying salt and food grade citric acid for pH adjustment. Mean composition of PPQF was 46.8% moisture, 26.4% fat, 17.8% protein, 2.8% salt, and pH 5.6-7.0. Meltability (mm) and textural parameters (hardness, cohesiveness, springiness, gumminess and chewiness) of PPQF were determined by modified Olson and Price method and TA-XT2 Texture Analyzer, respectively. Meltability of PPQF was significantly ($P < 0.001$) influenced by the type of emulsifying salt and citric acid \times emulsifying salt. There was positive correlation but insignificant effect of PPQF moisture, protein and fat on meltability. All texture parameters except springiness were significantly ($P < 0.05$) decreased with cheese age. All texture parameters except cohesiveness were significantly ($P < 0.05$) affected by emulsifying salt \times citric acid ($P < 0.001$), moisture \times pH ($P < 0.05$) and fat \times pH ($P < 0.05$). PPQF hardness was significantly influenced by emulsifying salt ($P < 0.01$) and cheese moisture \times protein ($P < 0.05$). In addition, PPQF hardness, springiness, gumminess and chewiness were significantly ($P < 0.05$) increased with decreased cheese pH. Results show that QF age influenced PPQF texture but not meltability. However, meltability and texture parameters of PPQF were influenced by type of emulsifying salt and pH adjustment of QF before processing.

Key Words: Pasteurized process Queso Fresco, Metability, Texture

174 Effect of total calcium content, intact casein content, and pH on the functional properties of process cheese. R. Kapoor* and L. E. Metzger, *MN-SD Dairy Foods Research Center, University of Minnesota, St. Paul, MN.*

The objective of this study was to evaluate the effect of total calcium content, intact casein content, and pH on the functional properties of process cheese. Eight process cheese food (PCF) formulations with two levels each of total calcium content (Ca) (0.45 and 0.65 %), intact casein content (IC) (14 and 18 %), and pH (5.5 and 6.1) were manufactured on a small-scale using a rapid visco analyzer (RVA). All the eight PCF were formulated so that their total moisture, fat, and protein content were the same. Therefore, the only chemical properties that were different in the eight PCF were Ca, IC, and pH. All the PCF manufactured were analyzed for functional properties including unmelted texture and melted texture using texture profile analysis (TPA) and RVA-melt test, respectively. The mean values of TPA-hardness, RVA-hot apparent viscosity and time at 5000 cP ranged from 53 N, 360 cP and 12.35 min respectively for the PCF formulated to 0.45 % Ca, 14 % IC, and a pH of 5.5 to 117 N, 716 cP and 11.09 min respectively for the PCF formulated to 0.65 % Ca, 18 % IC, and a pH of 6.1. As IC of PCF increased, its TPA-hardness significantly increased ($P < 0.05$). Additionally, as Ca and IC of PCF increased, its RVA-hot apparent viscosity significantly increased ($P < 0.05$) and the time at 5000 cP significantly decreased ($P < 0.05$). Consequently, Ca, IC, and pH of a process cheese are critical chemical properties that determine the functional properties of the process cheese. This information will help process cheese manufacturers to appropriately balance these chemical properties during process cheese manufacture to produce process cheese with consistent functional properties.

Dairy Foods: Political, Economic, and Scientific Considerations of Milk Component Utilization

175 Withdrawn by author.

176 Status of milk component separation and utilisation in Europe. J. F. Kleibeuker*, *European Dairy Association, Brussels, Belgium.*

Milk has been an ingredient in food preparations for many hundreds, if not thousands, of years. This is because both the nutritional and taste contribution of milk as well as its functionality in the physical structure of a broad range of preparations has been appreciated by consumers. In the development of the industrial production of food products, also a lot of work has been done on milk based ingredients. Separation of milk in various fractions allowed a further optimisation of the contribution of milk based ingredients to food products quality. For more than 50 years, European dairy industries have worked on the development of a range of products such as casein, whey proteins, lactose and milksalts. A survey will be given of the present separation

and modification techniques and of the market environment that stimulated the development of customer designed products.

Key Words: Milk ingredients, Market orientation, Market policies

177 Conditions of competition for milk protein products in the U.S. market. J. Coleman*, *U.S. International Trade Commission, Washington, DC.*

This paper draws from a Congressionally-mandated study by the U.S. International Trade Commission on conditions of competition for milk protein products in the U.S. market. This paper identifies recent trends in production and international trade in milk protein products. It describes how economic and non-economic factors (such as food regulations and standards) have impacted product development and international trade in milk components. The paper also discusses the major uses and applications for such products in processed food and pharmaceutical products.

Key Words: Milk protein, International trade, U.S. International Trade Commission

Graduate Student Paper Competition: National ADSA Production Division (cont'd)

178 Development of a mechanistic model to understand the dynamics of liquid flow out of the reticulo-rumen in dairy cattle. S. Seo^{*1}, C. Lanzas¹, L. Tedeschi², and D. Fox¹, ¹Cornell University, Ithaca, NY, ²Texas A&M University, College Station.

A mechanistic model was developed to investigate the dynamics of liquid flow out of the reticulo-rumen (RR) through the reticulo-omasal orifice (ROO) quantitatively. The model assumes liquid outflow rate (LOFR, kg/h) is a product of frequency of ROO opening, its duration per opening and the amount of liquid passed per opening. Based on published studies, ROO openings were assumed to be coordinated with primary reticular contractions. Two principles of fluid dynamics were applied in estimating the amount of liquid passed per opening, which is a function of area of the orifice, pressure gradient between reticulum and omasum and density of fluid. Pressure gradient was assumed to be the same as amplitude of reticular contraction. A database was built to quantify the relationships between the variables. A random coefficients model was used with the MIXED procedure of SAS with studies as a random variable to identify significant variables. The parameters were estimated using the same procedure only if a random study effect was significant; otherwise the GLM procedure was used. A linear regression model was developed to predict frequency of ROO openings associated with primary reticular contractions during eating, ruminating and resting. Means of database were used for estimating duration and amplitude. Previous studies indicated the ROO opens about 3 seconds at the second phasic primary reticular contraction. However, simulations of our model suggested that ROO should be opened longer for each contraction cycle. Analysis of 15 observations indicated that ROO should have opened 2.36 (± 0.93) times more than the mean values; this value was successfully estimated with a regression equation containing DMI, BW and total digesta in the rumen. With this equation incorporated, the model explained 89% and 83% of variations in 17 observations in an independent database with root mean square prediction errors of 0.80 and 1.17 for LOFR and fractional liquid passage rate (%/h), respectively. We conclude this mechanistic model can be used to increase our understanding of liquid dynamics in the RR.

Key Words: Reticulo-omasal orifice, Ruminal liquid dynamics, Modeling

179 Supplementation of diets with limited methionine content with rumen-protected forms of methionine, choline, and betaine in early lactation Holstein cows. S. Davidson^{*}, B. Hopkins, J. Odle, C. Brownie, V. Fellner, and L. Whitlow, *North Carolina State University, Raleigh.*

Eighty lactating Holstein cows from 21 to 91 days in milk were fed a corn silage-based total mixed ration (TMR) formulated to meet National Research Council (2001) recommendations except the Met content was limited (42 g/d) in order to investigate the impact of supplementing rumen-protected (RP) forms of Met, betaine, and choline on performance and metabolism. One of four supplements was blended into the TMR to produce four dietary treatments: 1.) control, 2.) 20 g/d RP-Met, 3.) 45 g/d RP-betaine, and 4.) 40 g/d RP-choline. Calcium salts of fatty acids were used to protect both RP-betaine and RP-choline supplements and were added to both control and RP-Met supplements so that equal amounts of fat were supplied to all treatments. Intake of DM was not different among treatments ($P > 0.2$). The treatment by parity interaction tended to be different ($P = 0.06$)

for milk yield with 44.3 kg/d produced in MP cows fed RP-choline compared to MP cows fed all other treatments (37.8, 40.0, and 38.7, respectively) while there were no differences among treatments in PP cows. Cows fed RP-Met or RP-choline had higher milk CP yield than cows fed control or RP-betaine ($P = 0.02$). There were no differences in milk fat yield or milk urea nitrogen (MUN) ($P > 0.2$). Mean body weight and body condition score (BCS) were not different among treatments ($P > 0.2$).

Table 1.

Item	Control	RP-met	RP-bet	RP-cho	SEM	Treatment ($P =$)	Parity ($P =$)
Milk yield, kg/d	32.8 ^b	33.9 ^{a,b}	32.3 ^b	35.8 ^a	0.9	0.04	0.01
Primiparous milk yield, kg/d	27.7	27.5	26.0	27.2	1.3	0.79	-
Multiparous milk yield, kg/d	37.8 ^b	40.0 ^b	38.7 ^b	44.3 ^a	1.3	0.01	-
Milk CP, %	2.54 ^b	2.69 ^a	2.55 ^b	2.59 ^{ab}	0.04	0.05	0.01
Milk CP, kg/d	0.82 ^b	0.90 ^a	0.83 ^b	0.93 ^a	0.03	0.02	0.01
Milk fat, %	2.89 ^a	2.60 ^b	2.98 ^a	2.77 ^{a,b}	0.10	0.05	0.04
Milk fat, kg/d	0.93	0.88	0.95	0.98	0.04	0.28	0.01
MUN, mg/dl	17.1	15.8	16.6	16.3	0.6	0.45	0.09
Body weight, kg	525	547	526	547	12	0.34	0.01
BCS	2.22	2.29	2.16	2.14	0.08	0.51	0.58

^{a,b}Means within a row with different superscripts differ ($P < 0.05$).

Key Words: Methionine, Choline, Betaine

180 Effect of ruminally degraded protein source on microbial protein flow in Holstein cows. A. B. Peterson^{*1}, R. L. Baldwin, VI², B. J. Bequette¹, and R. A. Kohn¹, ¹University of Maryland, College Park, ²USDA-ARS, Beltsville, MD.

The objective was to evaluate the effect of ruminally degraded protein (RDP) source on microbial protein flow measured from the reticulum and duodenum using ¹⁵N and estimated from milk, urine and blood using allantoin. Eight early lactation Holstein cows were arranged in a repeated 4x4 Latin square design balanced for carryover effects with 21 d periods. All diets were isoenergetic (1.71 Mcal/kg) and had the same rumen undegraded protein content (5.6%). Cows were fed either a base diet containing 12.8% CP or one of three treatment diets containing 16% CP supplemented with urea, casein or both. Cows were also infused with Cr-mordanted NDF, Co-EDTA and ¹⁵NH₄ as solid passage, liquid passage and microbial protein markers, respectively. Microbial protein flow was lower ($P < 0.05$) for cows fed the base diet than for cows fed the other diets irrespective of which method was used for estimation. Microbial N flow through the duodenum in cows fed the base diet was 237 g/d compared with 292 g/d for cows fed the other three diets. Microbial N leaving the rumen was 227 g/d for cows fed the base diet compared with 322 g/d for the other three treatments. Allantoin concentration, an indicator of microbial protein yield, was lower in milk and plasma for cows fed the base diet (130 and 191 $\mu\text{mol/L}$) than for cows fed the urea/casein diet (267 and 231 $\mu\text{mol/L}$, $P < 0.05$). Additionally, allantoin excretion in urine was 81 mmol/d for cows fed the base diet compared with 116 mmol/d for cows fed the urea/casein diet ($P < 0.05$). These results indicate that by using passage markers, reticulum samples can accurately measure flow of microbial protein to the duodenum, and allantoin was a good indicator of microbial protein flow. Additionally, amino acids and non-protein N can be used in equal efficiency for microbial protein production and the amount of RDP in the diet, not the source of RDP, is most important in diet formulation.

Key Words: Rumen degraded protein, Microbial protein, Allantoin

181 Milk replacer composition and nutrient utilization in pre-weaned calves. S. R. Hill*, K. M. Daniels, K. F. Knowlton, R. E. James, R. E. Pearson, and R. M. Akers, *Virginia Polytechnic Institute and State University, Blacksburg.*

Twenty-four newborn Holstein heifer calves (n=6) were fed one of four diets: CON (20/20 fed at 450 g/d, 24%CP, 0.53%P); HP (28/20 fed at 970 g/d, 32%CP, 0.55%P); HFHP- (28/28 fed at 970 g/d, 32%CP, 0.46%P); and HFHP+ (28/28 fed at 1460 g/d, 32%CP, 0.46%P). Calves were grouped by age and treatments were assigned randomly within group. Calves were fed 3.4 L of colostrum twice within 16h of birth. Upon arrival at the research farm, calves were fed a 20/20 milk replacer for the first two feedings. On d 3, treatments were imposed and calf starter (20% CP, 0.48%P) comprised of corn (40%), soybean meal (40%) and cottonseed hulls (20%) was offered free choice. Calves were on study for ~63 d. Total collection of feed refusals, feces and urine were initiated on d 59 ± 2d. Body weight and body size measures were taken weekly. Feces, urine, milk replacers, and starter samples were pooled (25% of each daily sample) by calf or diet, respectively, across collection period and analyzed for total Kjeldhal N and total P. All calves were slaughtered at 63 d to evaluate additional tissues (reported elsewhere). Preplanned contrasts were used to compare CON to all, HP to HFHP-, and CON to HFHP-. Total DMI was not different as calves fed CON consumed more starter than those fed greater amounts of milk replacer. Apparent DMD was lower for calves fed CON. Fecal output (kg DM/d) and fecal N excretion were highest in calves fed CON while urine output (kg/d) and urine N excretion were lowest. Nitrogen intake and urine N excretion were highest for calves fed HFHP+ but were not affected by fat content (HFHP- vs. HP). Nitrogen retention was not improved by increasing energy intake (mean = 34.9%), however, it was improved by increasing N intake (CON vs. HP; 20.5 vs. 38.2%). Phosphorus digestibility, total excretion, partitioning, and retention were not impacted by treatment. Calves fed HP tended to have higher P retention compared to those fed CON. Milk replacer composition influenced nutrient excretion in pre-weaned calves.

Key Words: Calf, Milk replacer, Nutrient excretion

182 Use of infrared thermography to non-invasively identify lesions in dairy cows. B. A. Munsell*¹, D. K. Beede¹, J. J. Domecq¹, W. B. Epperson², A. Ragavendran¹, N. T. Wright¹, and A. J. Zanella¹, ¹Michigan State University, East Lansing, ²Ohio State University, Columbus.

Infrared thermography (IRT) creates a pictorial representation of the surface temperature of an object. It has potential to detect inflammation associated with lameness. In the dairy industry, lameness is a costly problem and currently few methods are available for early lameness detection. In this study, IRT was used to assess the surface temperature of the coronary band region of the hind limbs of dairy cows. On day 1 of the 11 day collection period, 30 multiparous Holstein cows less than 40 DIM were selected based on their locomotion score (LS): 15 sound LS 1 cows and 15 moderately lame LS 3 cows (Sprecher et al., *Theriogenology*:43, 1997). IRT images and locomotion scores were collected once daily after the second of 3 milkings for 11 consecutive days. On d 6, claws of all cows were trimmed to identify lesions. Sixteen cows had 1 or more lesions; 9 cows with an average LS of 2 (mildly lame) or greater and 7 cows with an average LS of less than 2

over the 5 d prior to hoof trimming had at least 1 lesion. Three different image views were analyzed for each hind limb: dorsal, lateral and plantar aspects of the coronary band. Images were analyzed using ThermoCAM Reporter 7.0 (FLIR Systems, Inc., Boston, MA). Average and maximum temperatures (max temps) were identified from within an area approximately 2 cm above to 2 cm below the coronary band. Max temps were correlated with average temperatures ($r = 0.88$, $P < 0.01$) and max temp values were used in all statistical analyses. Data were analyzed using the PROC MIXED procedure of SAS with view, limb, lesion, pre and post trimming as fixed effects. Variability due to cows, view and limb were modeled using appropriate covariance structures. There was a significant difference ($P < 0.05$) in max temp among the three views. Cows with lesions had a higher max temp of the coronary band in the lateral view than cows without lesions over the 5 d prior to trimming ($P < 0.05$; 33.7 ± 0.16 and $33.0 \pm 0.18^\circ\text{C}$ respectively). There was no significant difference in max temp between lesion and non-lesion cows over the 5 d post trimming. These results suggest that IRT may be useful to distinguish cows that have claw lesions.

Key Words: Infrared thermography, Lameness

183 Effect of feeding soybean and linseed oils as whey protein gel composites, calcium salts or free oil on rumen fermentation, digestibility and duodenal flow of fatty acids. S. O. Juchem*, J. M. Heguy, E. J. DePeters, J. E. P. Santos, M. Rosenberg, and S. J. Taylor, *University of California, Davis.*

Different methods exist to reduce rumen biohydrogenation of dietary polyunsaturated fatty acids (PUFA), but responses in flow of PUFA to the small intestine have been inconsistent. A novel gel composed by whey protein, water, and oil (U.S. Patent Application 20040058003 A1 [Pending]; U.S. Patent Application 20050089550 A1 [Pending]) was developed. The objective was to compare the efficacy of feeding PUFA in different chemical forms on rumen fermentation, nutrient digestibility in the rumen and postrumen, and flow of PUFA to the duodenum. The supplemental fatty acid (FA) source was a 1:1 (w:w) mixture of soybean:linseed oils (S/L) from which the three supplements were manufactured. Four primiparous Holstein cows were used in a 4x4 Latin square with 14 d periods. Cows were surgically fitted with cannulas in the rumen and duodenum. The S/L was included in the diet as (1) unmodified oil (O; 1.9%), (2) calcium salts (CaS; 2.2%), (3) whey protein concentrate (WPC; 2.6%) gel composite or (4) whey protein isolate (WPI; 2.8% of DM) gel composite. Gel composites were hand-mixed in the TMR twice daily, while O and CaS were part of the TMR. Diets were formulated to provide similar amounts of FA. Data were analyzed by the MIXED procedure of SAS and repeated measures were utilized for variables that contained a time component. Dry matter intake and production traits were not affected. Rumen pH (6.41, 6.51, 6.41 and 6.45) was unaffected by treatments. Molar concentrations of total VFA (117, 107, 113 and 113 mM/L) were similar across diets, for O, CaS, WPC and WPI, respectively, as well as acetate, propionate and butyrate concentrations. Changes in body weight (7.3, -0.12, 7.1 and -2.1 kg) and BCS were not affected. Feeding WPI increased the flow of C18:2 and C18:3 (g/d) to the duodenum compared to the other treatments.

Key Words: Whey protein gel, Biohydrogenation, Unsaturated

Growth and Development

184 Fetal programming of offspring growth due to maternal high protein diet is genotype dependent in mice. M. Langhammer, M. Derno, N. Dietrich, U. Renne, G. Nürnberg, U. Hennig, and C. C. Metzges*, *Research Institute for the Biology of Farm Animals (FBN), Dummerstorf, Germany.*

Poor fetal growth is incompatible with adult health. We have shown in a rat model that maternal dietary high protein (HP) intake throughout pregnancy results in low birth weight and increased body fatness in the offspring. This paper addresses whether effects of a maternal HP diet throughout pregnancy and/or lactation are genotype dependent. Female mice of 3 strains (selected for long distance running, LDR; high body weight, HBW; and unselected control, CON; n=25 each) were fed isoenergetic HP (40% protein) or control (C) diets (20%) from mating to end of lactation (21d). Litters were standardized to 10 pups at birth. Pups were cross-fostered and offspring was tested in 3 combinations of pre- and postnatal dietary exposure: HP-C, C-HP, and C-C (n=10 litters each). In HBW, CON, and LDR maternal growth from mating to term was reduced by 64, 45 and 11% in HP fed dams as compared to C dams (HBW, CON; $P < 0.05$). CON and LDR offspring showed reduced birth weight when their mothers received HP diet throughout pregnancy (CON 1.40 vs. 1.46 g; LDR 1.58 vs. 1.62 g; $P < 0.05$), whereas in HBW no difference between HP and C diet was found (2.17 vs. 2.12 g). Litter size at birth was lower in CON dams fed HP diet (10.96 vs. 12.03 pups in C; $P < 0.05$). Until weaning, losses were highest among C-HP pups (CON 23% and HBW 16% of all litters). In all strains body mass gain per litter between birth and age 21d were lowest in C-HP (CON 43.9; LDR 51.8; HBW 88.1 g), as compared to HP-C (95.1; 71.7; 199.9 g) and C-C (95.7; 78.7; 197.3g) offspring (lactation diets HP vs. C; $P < 0.05$). Lactating dams fed HP diet are less able to support normal growth development in pups until weaning. The LDR strain is less susceptible to early postnatal exposure to maternal HP diet. In the HBW strain fetal growth in offspring of HP dams is maintained presumably due to larger body reserves of their mothers.

Supported by EC (EARNEST, Food-CT-2005-007036).

Key Words: Fetal programming, High protein intake, Gestation

185 Development and enteral long-chain n-3 fatty acids differentially alters muscle intracellular pools of free amino acids in the neonate piglet. M. C. Thivierge*¹, K. Bergeron¹, P. Julien², and T. A. Davis³, ¹*Institute of Nutraceuticals and Functional Food (INAF), Université Laval, QC, Canada,* ²*Laval University Medical Ctr. (CHUL), QC, Canada,* ³*USDA/ARS Children's Nutr. Res. Ctr., Baylor College of Medicine, Houston, TX.*

Recent studies suggest that feeding long-chain n-3 fatty acids (LCn-3FA) in the diet may blunt the developmental reduction in insulin sensitivity and anabolism in the neonate piglet. To examine the effect of LCn-3FA on protein anabolism, 2-day-old piglets (n=28) were weaned and assigned to one of two semi-purified milk replacers and raised until 10- or 28-d-old. Milk replacers differed in their fatty acid composition (Control: 0.82% and Enriched: 10.99% LCn-3FA). At either 10 or 28 d of age, phenylalanine kinetics were conducted by simultaneously infusing L-[1-¹³C]phenylalanine (22 $\mu\text{mol/kg}\cdot\text{h}$) along with total parenteral nutrition (7.9 ml/kg $\cdot\text{h}$). After a 4-h infusion period, piglets were killed and longissimus dorsi muscle was sampled. Fractional synthetic rate of muscle proteins (FSR) was not altered by feeding milk replacer enriched in LCn-3FA. However, FSR decreased

between 10 and 28 d of age (from 13 to 8%/d; $P < 0.01$). The age-regulated fall in FSR coincided with reductions in the concentrations of many non-essential amino acids (NEAA) in the cellular milieu (Asp $P = 0.04$; Ala $P = 0.02$; Ser $P < 0.01$; Pro $P = 0.03$). 3-Methyl-histidine, a marker of myofibrillar protein degradation, also decreased ($P < 0.01$) with development. Essential amino acids (EAA) remained mostly unaltered, except Arg ($P < 0.01$) and Phe ($P = 0.03$) concentrations that increased with age. Feeding milk replacer enriched in LCn-3FA reduced the cellular EAA to NEAA ratio ($P = 0.03$). The results suggest that feeding a diet enriched in LCn-3FA blunts the developmental increase in cellular EAA to NEAA ratio but does not block the fall in muscle protein synthesis.

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Key Words: Muscle amino acid free pools, Fractional synthetic rate, Piglets

186 The adipogenic enzymatic activity of bovine intramuscular, perirenal, and subcutaneous cultured preadipocytes differs, and increases in all depots following exposure to dexamethasone. G. Ortiz-Colón*, A. C. Grant, M. E. Doumit, and D. D. Buskirk, *Michigan State University, East Lansing.*

The objective of this study was to determine if there were differences in adipogenic capacity among bovine preadipocytes derived from intramuscular (IM), subcutaneous (SC), and perirenal (PR) adipose tissue, and to evaluate the effects of dexamethasone (DEX) on the adipogenesis of these preadipocyte populations. Preadipocytes isolated from three steers were grown to confluence in culture and then exposed to 0 (control), 25, or 2500 nM DEX for 48 h. After an additional 10 d in differentiation media, the propensity to differentiate, determined by glycerol-3-phosphate dehydrogenase (GPDH) specific activity and oil red O staining was PR > SC > IM ($P < 0.05$). Compared with control, 2500 nM DEX increased GPDH activity in preadipocytes from all depots ($P < 0.05$). There was no interaction between adipose tissue depot and DEX concentration for GPDH activity ($P = 0.99$). However, the percentage of PR preadipocytes with lipid droplets greater than 10 μm -diameter increased in response to DEX in a dose-dependent manner, but only increased above control in SC preadipocytes exposed to 2500 nM DEX ($P = 0.002$). Furthermore, DEX did not statistically increase the percentage of IM preadipocytes with large (10 μm -diameter) lipid droplets ($P > 0.27$). These observations reflect an adipose tissue depot by DEX concentration interaction ($P = 0.03$). It appears that for IM preadipocytes, DEX increased the lipogenic activity of the cells more than it increased the number of lipid-filled preadipocytes. Relative differences in adipogenic capacity among preadipocytes isolated from IM, SC, and PR bovine adipose tissue were evident. Dexamethasone enhanced adipogenic enzyme activity in all three depots, but did not enhance morphological differentiation of IM preadipocytes.

Key Words: Bovine, Preadipocyte, Dexamethasone

187 Identification of two cell culture models to study bovine CAT1 activity and expression. S. F. Liao*, C. A. Woods, J. A. Boling, and J. C. Matthews, *University of Kentucky, Lexington.*

Although L-Lysine (Lys) is a dietarily-essential amino acid (AA) for cattle fed a high corn diet, proteins responsible for absorption of Lys by

cattle have not been described. CAT1 is a major intestinal transporter of cationic AA. CAT1 demonstrates a high-affinity (μM) System γ^+ activity that differs from $\text{b}^{0,+}$, $\gamma^+\text{L}$, and $\text{B}^{0,+}$ cationic AA transporter systems due to its independence of Na^+ ($-\text{Na}^+$) and/or insensitivity to neutral AA. This project was conducted to determine if Madin-Darby Bovine Kidney (MDBK) cells and steer hepatocytes express CAT1 activity and/or mRNA. Putative System γ^+ activity was assessed in wells ($n = 8-12$) of 2-d cultured MDBK cells ($250,000/2 \text{ cm}^2$ well) by characterizing the $-\text{Na}^+$ uptake (pmol/mg protein) of Lys ($10 \mu\text{M}$; [^3H]Lys, radiotracer) in the presence and absence of 2 mM L-Arg or L-Leu. System γ^+ Lys uptake accounted ($P < 0.001$) for 50% of total $-\text{Na}^+$ Lys uptake, as did Systems $\text{B}^{0,+}$ and/or $\gamma^+\text{L}$. K_m determination for $-\text{Na}^+$ Lys in the presence of 5 mM L-Leu was $250 \mu\text{M}$, consistent with CAT1 activity. RT-PCR of total RNA extracted from MDBK cells (and bovine kidney, and ileal epithelium), using the full-length pig CAT1 as a template, produced a single cDNA product of about 700 bp. Sequencing of the MDBK and kidney products revealed a 695-bp cDNA that possessed 89, 87, 99% homology with corresponding regions of the pig, human, and predicted bovine CAT1 mRNA, respectively. The expression of System γ^+ activity and CAT1 mRNA next was evaluated in wells (4-6) of 2-d cultured hepatocytes ($200,000/2 \text{ cm}^2$ well) isolated (collagenase perfusion) from the caudal lobe of 30-d old Angus steer livers ($n = 4$), using transport and RT-PCR parameters identical to those used for MDBK cells. Systems γ^+ , $\text{b}^{0,+}$, and $\gamma^+\text{L}$ accounted ($P < 0.034$) for 19, 34, and 47% of $-\text{Na}^+$ Lys uptake, respectively, and RT-PCR yielded a product of about 700 bp. These results demonstrate that MDBK cells and steer hepatocytes express CAT1 activity and mRNA and indicate their usefulness to study bovine CAT1 function and expression.

Key Words: CAT1, SLC7A1, MDBK, Hepatocytes

188 Leptin increases IGF-I-induced expression of SOCS3 mRNA in prepubertal heifer mammary parenchyma. B. E. Etchebarne^{*1}, L. F. P. Silva², J. S. Liesman³, and M. J. VandeHaar³, ¹Stanford University, Palo Alto, CA, ²University of Sao Paulo, Pirassununga, SP, Brazil, ³Michigan State University, East Lansing.

High-energy diets promoting body growth rates $>1 \text{ kg/d}$ impair mammary development in prepubertal dairy heifers. Biological mechanisms to explain this result are not well understood, but the hormones insulin-like growth factor-I (IGF-I) and leptin likely play a role. Adipocytes produce the protein leptin, and leptin concentrations increase with increased fat deposition in the body and mammary gland. IGF-I stimulates and leptin inhibits proliferation of mammary epithelial cells in vitro and in vivo in cattle. We hypothesize that leptin inhibits the mammogenic action of IGF-I, and diets that promote rapid prepubertal body growth inhibit mammary development if fat deposition is increased. Our objectives were to elucidate the effects of IGF-I and leptin infusion on cell cycling in mammary epithelial cells, by identifying key genes controlling the interaction of these two hormones in bovine parenchyma. Selected genes were measured using quantitative real-time-PCR to analyze mammary tissue collected from six prepubertal Holstein heifers after 7 d of intramammary hormone infusions of IGF-I, leptin, IGF-I plus leptin, or saline control. Addition of leptin to IGF-I treated quarters increased suppressor of cytokine signaling (SOCS)-3 mRNA 2.3-fold relative to IGF-I-infused quarters. Assuming protein changes follow mRNA expression, increased SOCS3, which signals within the JAK/STAT cell proliferation pathway, could possibly explain the inhibition of IGF-I-induced mammary epithelial cell proliferation. We propose that a SOCS-mediated feedback mechanism exists in which SOCS3 decreases MEC sensitivity

to the IGF-I mitogenic effect, reduces the progression of cells into the S-phase of the cell cycle, and thereby prevents IGF-I-stimulated mammary epithelial cell proliferation during periods of high energy feeding or increased adiposity in the ruminant.

Key Words: IGF-I, Leptin, Mammary

189 Cellular and biochemical features of skeletal muscle and subcutaneous adipose tissue in pigs differing in IGF-II genotype. D. Gardan^{*1}, I. Louveau¹, K. Van den Maagdenberg², N. Buys³, S. De Smet², and F. Gondret¹, ¹INRA/Agrocampus Rennes, Systèmes d'Élevage, Nutrition Animale et Humaine, Saint Gilles, France, ²Laboratory for Animal Nutrition and Animal Product Quality, Department of Animal Production, Ghent University, Melle, Belgium, ³Division of Gene Technology, Department of Biosystems, K.U. Leuven, Heverlee, Belgium.

In pigs, a mutation in the regulatory sequence of the paternally imprinted IGF-II gene (Q allele) is associated with increased muscle mass and decreased backfat thickness. This study aimed to determine the impact of this mutation on some cellular and biochemical features of skeletal muscle and adipose tissue. Muscle (trapezius) and subcutaneous adipose tissue (SCAT) were collected in pigs (average weight at slaughter 106 kg) differing in IGF-II genotype (Qpat, $n = 6$; qpat, $n = 7$). Tissue lipid content, cell size and activities of lipogenic enzymes were determined using standard assays. Real-time PCR was performed to examine mRNA expressions of IGF-II gene and of genes involved in lipogenesis or lipolysis. Levels of IGF-II mRNA were higher in muscle from Qpat than qpat pigs ($P < 0.05$), but did not differ ($P > 0.1$) between the two groups in SCAT. Muscle lipid content and intramuscular adipocyte size were not influenced by IGF-II genotype. In contrast, lipid content was lower ($P < 0.05$) in SCAT from Qpat than qpat pigs. In this tissue, adipocytes were smaller ($P < 0.05$) while their number tended to be higher ($P = 0.06$) in Qpat than in qpat pigs. Expressions and/or activities of malic enzyme, fatty acid synthase and hormone-sensitive lipase were not influenced by IGF-II genotype in the examined tissues. Our results suggest that IGF-II mutation may favor adipocyte proliferation in SCAT at the expense of differentiation process.

Key Words: Adipocytes, IGF-II, Lipid metabolism

190 Evaluation of a mathematical model to estimate total feed required for pen-fed Santa Gertrudis steers and heifers based on performance and diet composition. B Bourg^{*1}, L. O. Tedeschi¹, G. E. Carstens¹, E. Brown¹, and D. G. Fox², ¹Texas A & M University, College Station, ²Cornell University, Ithaca, NY.

The Cornell Value Discovery System (CVDS) was developed to predict growth and body composition based on animal, diet, and environment information. This model has been adapted to facilitate individual management of pen-fed cattle, and to harvest animals at the most profitable USDA quality and yield grade endpoints. The CVDS is also used to allocate feed to individual cattle fed in pens. The objective of this study was to evaluate the model's effectiveness in predicting total DM required (DMR) for Santa Gertrudis steers and heifers ($n = 457$) fed in five separate pens at the King Ranch feedyard. Pens 1 and 4 contained heifers only, pens 3 and 5 contained steers only, and pen 2 contained a mix of both heifers and steers. The cattle were fed three step-up rations and one finishing ration, that ranged from 2.3 to 2.82 Mcal ME/kg. Dietary ME was calculated using actual feed analysis in the Cornell Net Carbohydrate and Protein System (CNCPS) model.

Animal performance and carcass traits (HCW, backfat, ribeye area, and marbling scores) were used to compute the BW at 28% empty body fat (EBF) for each animal. The CVDS model with the adjustment of ME efficiency for composition of gain was used to predict individual DMR and to estimate total DMR of the pen. The 90% confidence interval of predicted EBF at the harvest BW was similar between steers and heifers and ranged from 25-36% EBF. The mean bias, calculated as the difference between DMR and feed fed divided by feed fed and weighed by animals per pen, was 4.64% and 1.46% for heifers and steers respectively, with an overall value of 2.43% ($P = 0.16$). A sensitivity analysis of the dietary ME (± 5 and $\pm 10\%$) indicated the accuracy decreased when dietary ME used was lower or higher than the CNCPS predicted value. Our findings suggest the CVDS accurately predicted feed requirements for Santa Gertrudis steers and heifers.

Key Words: Finishing cattle, Feed intake, Modeling

191 Using ultrasound to determine body composition of breeding heifers. M. J. Baker^{*1}, L. O. Tedeschi², D. G. Fox¹, W. R. Henning³, and D. J. Ketchen¹, ¹Cornell University, Ithaca, NY, ²Texas A&M University, College Station, ³Pennsylvania State University, College Park.

Carcass traits and ultrasound have been used to predict empty body fat (EBF) of steers and yearling bulls, which is used to predict their energy and DM requirements for growth. This study was conducted to develop equations to predict EBF from ultrasound measurements in

breeding heifers for use in predicting their individual DM requirements when fed in group pens. One hundred eighteen spring-born purebred and crossbred beef heifers (BW=271 kg) were sorted into 3 marketing groups on projected days to USDA low Choice Quality grade and fed a common high energy diet in twelve slatted floor pens (10 hd/pen) until estimated to average the target quality grade. The heifers were evaluated for body composition with ultrasound at approximately one year of age. Ultrasound measurements included backfat (uBF), rump fat (uRmpFt), ribeye area (uREA) and intramuscular fat (IMF); hot carcass weight (HCW) was predicted with an equation (pHCW). Carcass data collected included HCW, backfat over the 12th-13th rib (BF), marbling score (MRB), and ribeye area (REA). The 9-11th rib section was removed and dissected into soft tissue and bone. Chemical fat determined by ether extract was used to compute carcass fat (CF) and EBF. Regression analysis showed that carcass measurements explained 62% of the variation (RMSE = 1.42) in EBF ($23.6 + 3.16*BF + 0.0138*HCW + 0.778*MRB - 0.0894*REA$). Adding body density (final SBW divided by volume predicted from girth circumference, width, and length) accounted for 70% of the variation in EBF. The equation developed with ultrasound measurements on the live heifers ($EBF = 14.7 + 8.73*uRmpFt + 11.4*uBF - 0.0669*uREA + 0.452*IMF + 0.0148*pHCW - 6.267*uRmpFt*uBF$), explained 61% of the variation (RMSE = 1.5). The measured EBF was 31.3% and the predicted EBF was 31.6% and 31.5% using the carcass and ultrasound equations, respectively. Ultrasound can be used as effectively as direct measure of carcass traits in predicting EBF in breeding heifers.

Key Words: Beef heifers, Ultrasound, Body composition

Lactation Biology

192 Effects of CLA on bioenergetic and milk production parameters in grazing dairy cows offered ad libitum or restricted pasture. J. K. Kay^{*1,2}, T. R. Mackle¹, D. E. Bauman³, N. A. Thomson¹, and L. H. Baumgard², ¹Dexel, Hamilton, New Zealand, ²University of Arizona, Tucson, ³Cornell University, Ithaca, NY.

Conjugated linoleic acid (CLA) reduces milk fat synthesis in grazing and TMR-fed dairy cows and often improves calculated net-energy balance (EBAL). Study objectives were to determine if CLA-induced milk fat depression could be utilized during times of nutrient limitations (i.e. droughts) to improve bioenergetic and milk production parameters. Twelve multiparous mid-lactation rumen-fistulated Holstein cows were offered ad libitum (AL) or restricted (R) pasture allowances and abomasally infused twice daily with 0 (0) or 50 (50) g/d CLA (containing a variety of CLA isomers) in a crossover design. Treatment periods lasted 10 d and were separated by a 10 d washout period. Milk and plasma samples were averaged from d 9 and 10, and EBAL was calculated from d 6-10 of the infusion period. Pasture restriction reduced the yield of milk ($P < 0.01$; 15.7, 15.4, 11.5, 11.9 kg/d for AL0, AL50, R0 and R50, respectively) and milk components. CLA reduced ($P < 0.01$) milk fat yield by 45 and 46% in AL and R, respectively. There was no CLA effect on milk yield nor milk lactose content or yield, however milk protein content increased ($P < 0.05$) in both AL and R, resulting in an increased ($P < 0.05$) protein yield of 6 and 9% in AL and R, respectively. The CLA-induced changes to milk fat and protein increased ($P < 0.01$) the protein:fat ratio by ~2-fold in both AL and R. Milk fat trans-10, cis-12 CLA content increased following CLA infusion ($P < 0.01$; 0.10, 0.64, 0.09, 0.74 % for AL0, AL50, R0, R50, respectively). Calculated net-EBAL improved following CLA infusion (-1.8 vs. 11.2 and 1.6 vs. 13.8 MJ/cow/d for AL and R, respectively;

$P < 0.05$), however CLA did not alter plasma bioenergetic markers (including insulin, NEFA, BHBA, urea, glucose and AST). Data indicate that during short periods of nutrient restriction, CLA may provide an alternative management tool to improve the milk protein:fat ratio and calculated EBAL, however further studies are required to determine if CLA is effective at improving bioenergetic parameters during long term feed shortages.

Key Words: CLA, Milk fat, Pasture

193 Variation in milk yield response to once-daily milking in Friesian-Jersey crossbred cattle. S. Davis^{*}, L. McNaughton, G. Bracefield, K. Sanders, and R. Spelman, *Livestock Improvement Corporation, Hamilton, New Zealand.*

Once-daily milking (OAD) of cows in New Zealand is an increasingly popular management option. The major constraint to adoption of OAD is the production loss which is variable between individual cows and differs significantly between Friesian and Jersey breeds. The objective of this study was to identify animals consistently showing a minimal loss in production during 7-day periods on OAD in mid and late lactation and to examine the relationship between losses in short (7d) and long-term (70d) OAD challenges. The first study used 306 crossbred cattle (from 6 sires) all in their 2nd lactation and grazing rye-grass/white clover pasture. Mean twice-daily yields in mid- and late-lactation were 16.1 and 10.3 l/d respectively. Mean OAD yield loss after 7d on OAD was 3.6 ± 1.5 (SD) (22.4%) and 1.3 ± 1.0 (SD) (12.7%) l/d. at the same stages. Yield loss ranged from 0 to 8.1 l/d at mid and 0-4.3l/d in late-lactation. 20 animals showed a yield loss of

less than 10% at each lactation stage. However, repeatability of yield loss for the whole herd was relatively poor. Correlation coefficient relating yield loss in mid- and late-lactation was 0.15. Rank correlation coefficient was 0.20. Percentage loss was constant within quartiles ranked on twice-daily yield at mid- but not in late-lactation where %loss was lowest (11.4%) in cows with highest TAD yields. A further study was undertaken in 3rd lactation (mid) with a 70d period on OAD. Yield losses were similar (20%) to 2nd lactation during the first week of the 10 week period on OAD. The correlation of yield loss during week 1 with yield loss in week 5 and week 10 was < 0.10, again indicating that short-term yield responses are not strongly related to long-term yield losses on OAD. In conclusion, yield losses during short-term OAD challenges were not a good predictor of long-term yield loss. The lack of repeatability between mid-and late-lactation indicates an interaction of stage of lactation and/or diet quality with short-term yield loss.

Key Words: Crossbred, Milking, Once-daily

194 Short day photoperiod increases milk yield in cows with a reduced dry period length. J. M. Velasco*, E. D. Reid, K. E. Karvetski, T. F. Gressley, R. L. Wallace, and G. E. Dahl, *University of Illinois, Urbana.*

Photoperiod manipulation during the dry period, particularly exposure to short days, increases milk yield in cows in the subsequent lactation. The duration of short day photoperiod (SDPP) exposure necessary to influence milk yield is unknown, but is of interest as reduced dry period length gains industry acceptance. To determine if exposure to SDPP cows could be combined with a reduction in dry period duration, we used 40 multiparous Holstein cows at dry off approximately 42 d before calving and assigned 20 cows each to long day photoperiod (LDPP, 16L:8D) or SDPP (8L:16D). To quantify PRL concentrations during the dry period, weekly blood samples were collected and frequency of collection increased to twice daily around parturition. Dry matter intake (DMI) was recorded during the dry period and for 42 d after calving. Treatments ended at calving when all cows were exposed to an ambient photoperiod and milked twice daily; milk production was recorded until 120 d in milk. SDPP cows calved 4.8 d earlier than LDPP cows (P<0.09) and days dry averaged 37 for SDPP and 42 for LDPP. Cows on SDPP (17 kg/d) had slightly more DMI during the dry period than LDPP cows (16 kg/d; P<0.10) but did not differ after parturition. There was no difference between groups in pre-partum and postpartum BW. The periparturient PRL surge peak was 22.4 and 17.1ng/mL for LDPP and SDPP, respectively (P<0.11). Milk production was inversely related to the periparturient PRL surge. Milk production through 120 d of lactation averaged 38.7 and 35.4 kg/d for SDPP and LDPP cows (P<0.07). Short day photoperiod combined with a reduced length of the dry period increases milk production in the subsequent lactation relative to long days, even when SDPP exposure is limited to 42 d.

Key Words: Photoperiod, Dry period, Prolactin

195 Circulating metabolites from postpartum cows supplemented with POSILAC® and given various lengths of days dry. T. Klusmeyer*, A. Fitzgerald, J. Ballam, and J. Vicini, *Monsanto Co., St. Louis, MO.*

Cumulative net marginal income calculated from milk production and feed consumption has been improved for multiparous cows in which

the dry period was eliminated or reduced (Annen et al., 2004; J. Dairy Sci. 87:3746). An additional benefit may be realized from reducing the effects that occur with changing diets at dryoff and parturition. A three-site study was initiated to examine effects of altering the length of the dry period. Treatments were: 1) 60-d Dry/Label POSILAC (60-d L), 30-d Dry/Label POSILAC (30-d L), 0-d Dry/Label POSILAC (0-d L), and 0-d Dry/Continuous POSILAC (0-d C). Cows administered POSILAC according to label were supplemented until dryoff and resumed POSILAC at 57-70 days-in-milk of the subsequent lactation. Blood samples were collected during postpartum weeks 1 and 2. Preliminary data, based on one site in which all the cows have freshened (N=120), are presented here. LSM means with unlike letters are different at P<0.05. Concentrations of BHBA and NEFA were greatest and P was reduced for cows that were targeted for a 60-d dry period. These data indicate that cows with shortened dry periods may be at a reduced risk for metabolic disease in early lactation.

Table 1. Blood Metabolites

Item	60d-L	30d-L	0d-L	0d-C	SEM
No of Cows	29	26	28	27	
Ca, mg/dl	9.35	9.22	9.53	9.66	0.21
P, mg/dl	4.71a	5.28b	5.39b	5.28b	0.19
BHBH, mmol/L	0.93a	0.73b	0.53c	0.72bc	0.07
NEFA, µEq/L	841a	604b	454b	555b	63

Key Words: Somatotropin, Dry period, Blood metabolites

196 Identification of putative bovine mammary stem cells by their retention of labeled DNA strands. A. V. Capuco*, *Bovine Functional Genomics Lab, USDA-ARS, Beltsville, MD.*

Stem cells characteristically retain labeled DNA for extended periods due to their selective segregation of template DNA strands during mitosis. In this study, proliferating cells in the prepubertal bovine mammary gland were labeled using five daily injections of 5-bromo-2-deoxyuridine (BrdU). Five weeks later, BrdU-labeled mammary epithelial cells were still evident. The percentage of BrdU-labeled epithelial cells was greatest in basal regions of the mammary gland and decreased toward the periphery of the parenchymal region, where the ducts were invading the mammary fat pad. Increased numbers of BrdU-labeled epithelial cells in basal regions of the gland are likely a consequence of decreased proliferation rates and increased cell cycle arrest in this area. In peripheral regions of mammary parenchyma, the percentage of heavily labeled epithelial cells averaged 0.24%, a number that is consistent with estimates of the frequency of stem cells in mouse mammary gland. Epithelial, label-retaining cells represent a slowly proliferating population, as 5.4% were positive for the nuclear proliferation antigen, Ki67. Furthermore these putative stem cells can likely respond directly to mitogenic stimulation by estrogen, as 57% of the BrdU-labeled epithelial cells were estrogen receptor-positive. Continuing studies will address the usefulness of this technique to identify bovine mammary stem cells and facilitate studies of stem cell biology.

Key Words: Progenitor cells, Proliferation, Bromodeoxyuridine

197 Significance of delta-lactoferrin in mammary tissue: Lack of confirmation for expression of human and bovine isoforms. C. R. Baumrucker*, Y. Wang, and D. L. Greger, *The Pennsylvania State University, University Park.*

The significance of paracrine, autocrine, and intracrine endocrine signaling for optimal growth and differentiation of mammary tissue is well known. According to previous reports, a unique form of Lf mRNA, termed delta-lactoferrin (Δ -Lf) has been detected in human tissues and cell lines (Δ -hLf). Our objective was to determine if Δ -bovine Lf (Δ -bLf) is expressed in bovine mammary tissue. Our earlier work indicated that bLf appears in the nucleus and affects retinoid signaling in mammary cells *in vitro*. Furthermore, *in vivo* experiments using transgenic mice that over-express mammary hLf indicated a Lf:retinoid interaction that perturbed lactation. Δ -hLf mRNA is reported to be identical to Lf except that exon 1 is modified such that a signal sequence is deleted. Because Lf has a nuclear localization sequence, loss of a signal sequence would direct a cytoplasmic protein and subsequent nuclear location. The presence of Δ -bLf mRNA expression in bovine tissue was explored by using bovine mammary cells; BME-UV and primary bovine mammary cells as well as controls with human mammary cells. While BME-UV and the human cell lines make little or no Lf mRNA, the primary bovine cells exhibit high expression that could be modified by culture with hormones. Primers reported for human Δ -Lf were used for human mammary cell extracts and were used as templates to design bovine-specific primers. No evidence of Δ -Lf mRNA was identified in any of the cell extracts of either species with any primer sets. Bioinformatics searches of TIGR, Ensembl, and NCBI expressed sequence tags (ESTs) for presence of Δ -bLf (bLf with different message length) in the bovine data base were negative. Similar searches of the human EST data base for Δ -hLf produced little evidence for the presence of the message save the submitted Δ -Lf sequence and several rare transcripts that did not indicate a differential mRNA expression of Δ -hLf. The presence and perhaps the significance of Δ -bLf in bovine mammary tissue is unresolved.

Key Words: Lactoferrin, Δ -Lf, Bioinformatics

198 The tight junction (TJ) protein zonula occludens-1 (ZO-1) is down-regulated during apoptosis of rat mammary glands. C. V. C. Phyn*^{1,2}, J. M. Dobson¹, C. D. McMahon¹, S. R. Davis³, K. Stelwagen¹, and K. Singh¹, ¹AgResearch Ltd., Hamilton, New Zealand, ²Dexcel Ltd., Hamilton, New Zealand, ³ViaLactia Biosciences (NZ) Ltd., Auckland, New Zealand.

Extended periods of milk accumulation result in reduced milk secretion, increased apoptosis and eventually, involution of mammary glands. This process is associated with increased TJ permeability between mammary epithelial cells and down-regulated expression of the major transmembrane TJ proteins, occludin and claudin-1. This study investigated the temporal expression of the cytoplasmic TJ component ZO-1 relative to the onset of apoptosis during mammary engorgement. Sprague-Dawley rats at peak lactation had three abdominal inguinal glands on one side sealed to induce mammary engorgement; the remaining glands were not sealed and acted as suckled controls. Mammary tissue was collected post-mortem at 0, 6, 12, 18, 24 and 36h

after teat sealing (n = 6 per time point). A dramatic increase ($P < 0.001$) in the number of apoptotic nuclei located within alveolar epithelia or lumina was observed by 18, 24 and 36h in the engorged glands compared with suckled controls. The number of apoptotic nuclei was generally greater ($P < 0.001$) in the epithelial layer than within alveolar lumens for both control and engorged glands, except at 36h when a similar number was detected in both locations for engorged glands. Apoptotic nuclei present in the alveolar lumen of engorged glands at 18, 24 and 36h were associated with the presence of leukocytes. These changes were accompanied by a significant reduction in ZO-1 protein expression in engorged glands compared with control glands within 12h following teat-sealing. Furthermore, quantitative real-time RT-PCR analysis showed that mRNA expression of ZO-1 was decreased 1.8-fold by 12h ($P < 0.05$). Responses to mammary engorgement were locally regulated as no changes were detected in suckled controls. In conclusion, the down-regulation of TJ proteins is consistent with a loss of epithelial cell-cell integrity and communication during mammary apoptosis and involution.

Key Words: Tight junction, Apoptosis, Mammary engorgement

199 Streptococcus uberis increases apoptosis of bovine mammary epithelial cells (MEC) and decreases integrin and focal adhesion kinase (FAK) mRNA expression. K. Singh*¹, J. Dobson¹, C. Phyn¹, S. Davis², V. Farr¹, and A. Molenaar¹, ¹AgResearch Ltd., Ruakura Research Centre, Hamilton, New Zealand, ²ViaLactia Biosciences (NZ) Ltd., Auckland, New Zealand.

Mastitis is caused by bacterial infection of the mammary gland. The inflammatory responses caused by mastitis pathogens reduce milk yield, possibly via apoptosis of MEC. Survival of MEC requires anchorage to the extracellular matrix (ECM), mediated via integrin signalling. *S. uberis* is the main causative organism of mastitis in New Zealand. We have investigated the importance of cell-ECM communication in MEC survival and the downstream apoptotic signalling events following mastitis. Two mammary quarters of mid-lactating Friesian heifers (n=5) were infused (~1000 cfu) with *S. uberis* isolated from a cow with acute mastitis. Clinical signs of mastitis were observed, bacteriology of milk confirmed *S. uberis* infection and milk SCC were increased in infused quarters. Alveolar tissue was collected from infused and control non-infused quarters. Histological analysis showed the infected quarters to have a more involuting non-lactating phenotype with increased neutrophil infiltration compared to control quarters. Apoptotic mammary nuclei were measured by in situ end-labelling (ISEL). The control non-mastitic samples had low levels of positive ISEL nuclei per alveolus whereas apoptosis was increased ($P < 0.001$) in mastitic samples. There was a strong positive association ($P < 0.001$) within cows between number of ISEL nuclei per alveolus and logSCC. mRNA levels were measured by quantitative real-time RT-PCR. There was a negative association ($P < 0.05$) of logSCC with the expression of $\beta 1$ -integrin, $\alpha 6$ -integrin and cell survival factors FAK and Bcl-x_{long}. Pro-apoptotic Bax mRNA levels were the same in mastitic and non-mastitic controls. These results demonstrate that *S. uberis* infection stimulates apoptosis in bovine MEC by down-regulating the cell survival pathway via a loss in communication between integrins and the ECM.

Key Words: Mastitis, Apoptosis, Integrin

Physiology and Endocrinology: Estrous Synchronization

200 Assessment of vaginal electrical resistance (VER) as an indicator of follicular maturity and suitability for timed AI in cows subjected to a synchronization of ovulation protocol. J. F. Zuluaga*, J. P. Saldarriaga, D. A. Cooper, J. A. Cartmill, and G. L. Williams, *Texas A&M Agricultural Research Station, Beeville.*

Objectives were to use retrospective analysis to determine the efficacy of VER for identifying cows with and without a mature preovulatory follicle (defined as ≥ 10 mm) at timed AI (TAI) and as a prospective decision aid for determining cows that should not be bred. Brahman x Hereford (F1) females ($n=233$) were synchronized with the CO-Synch + CIDR protocol that consisted of an Eazy-Breed CIDR and i.m. injection of GnRH (GnRH-1; 100 μ g) on d 0, removal of CIDR and i.m. injection of Prostaglandin F₂ α (PGF; 25 mg) on d 7, and i.m. injection of GnRH (GnRH-2, 100 μ g) and TAI 66 h after CIDR removal (d 10). A commercially-available device (Ovascan; Animark Inc., Aurora, CO) was used to determine VER at d 0, 7, and 10. Transrectal ultrasonography was used on d 10 to assess ovarian morphology at TAI in all cattle and in a subset of females ($n=98$) on d 0 and 7. Mean (\pm SEM) age, BCS, BW and d postpartum were 7.2 ± 0.3 yr, 5.2 ± 0.1 , 538 ± 5.3 kg, and 77 ± 1.1 d, respectively. Mean VER (ohms) was greatest (101.8 ± 1.1) on d 0 and declined ($P < 0.01$) to 95 ± 0.7 and 82.4 ± 0.7 ohms, respectively, on d 7 and 10. We observed a low negative relationship ($r = -0.35$; $P < 0.001$) between follicular size and VER on d 0, 7, and 10. Timed AI conception rate was correlated positively ($r = 0.16$; $P < 0.05$) with follicular size and negatively ($r = -0.15$; $P < 0.05$) with VER at TAI. Timed AI conception rate was also correlated with changes in follicular size (FollSizediff; $r = 0.24$; $P < 0.05$) and VER (VERdiff; $r = -0.18$; $P < 0.01$) between d 10 and 7. However, VERdiff and FollSizediff were not correlated. Vaginal electrical resistance at TAI and VERdiff did not differ between females that became pregnant and those that did not. Females without a large follicle on d 10 were not identifiable with VER.

Supported by TAES and Animark Inc.

Key Words: Vaginal electrical resistance, Follicular size, Synchronization

201 Influence of preovulatory concentrations of estradiol on interval to ovulation and uterine pH. G. A. Perry* and B. L. Perry, *South Dakota State University, Brookings.*

Research has shown following the CO-Synch protocol, cows in estrus within 24 h of TAI had elevated concentrations of estradiol, a shorter interval to ovulation, and greater pregnancy rates compared to cows not in estrus. Our objective was to assess the influence of elevating preovulatory concentrations of estradiol on the percentage of animals exhibiting standing estrus, the interval to ovulation, and the uterine environment. Lactating beef cows ($n = 57$) received the CO-Synch protocol (100 μ g GnRH on d -9; 25 mg PG on d -2; and 100 μ g GnRH on d 0). Half the cows received an injection of estradiol cypionate (ECP; 1mg) 12 h after the PG injection. More cows administered ECP exhibited estrus ($P < 0.01$) compared to cows not administered ECP (66% vs. 25%). No difference ($P = 0.20$) was detected in the interval from GnRH to ovulation between treatments (27.4 ± 1.1 and 29.4 ± 1.1 h for ECP and control, respectively), but cows that exhibited estrus had a shorter interval to ovulation ($P < 0.03$) compared to cows that did not exhibit standing estrus (25.4 ± 1.1 , 26.0 ± 1.7 , 32.0 ± 1.7 , and 30.9 ± 1.1 h for ECP estrus, no ECP estrus, ECP no estrus, and no ECP no estrus, respectively). Among cows not administered ECP, cows that exhibited estrus within 24 h of GnRH tended ($P = 0.09$)

to have a lower uterine pH at the time of the second GnRH injection compared to cows not exhibiting standing estrus (6.8 ± 0.09 vs. 7.0 ± 0.07 , respectively). Cows administered ECP were intermediate (6.9 ± 0.05). Cows that initiated estrus after the time of pH determination had a similar pH as cows that did not receive ECP and did not exhibit estrus ($P > 0.47$; 7.09 ± 0.17). Cows that received ECP and did not exhibit estrus or initiated estrus within 1 h of pH measurement tended ($P \leq 0.10$) to have a lower pH (6.79 ± 0.09) compared to cows that did not receive ECP and did not exhibit estrus. In summary, elevating preovulatory concentrations of estradiol increased the proportion of cows exhibiting standing estrus and decreased uterine pH to a level similar to cows exhibiting standing estrus.

Key Words: Fixed-time AI, Uterine environment, Estradiol

202 Optimizing ovulation to 1st GnRH improved outcomes to each hormonal injection of Ovsynch in lactating dairy cows. N. M. Bello*, J. P. Steibel, and J. R. Pursley, *Michigan State University, East Lansing.*

Ovulatory response to 1st GnRH of Ovsynch is the critical determinant for successful synchronization of ovulation in dairy cows. Our objective was to develop a pre-Ovsynch treatment that increases the percentage of cows that ovulate to 1st GnRH of Ovsynch. To accomplish our goal, we evaluated a strategy based on PGF_{2 α} and GnRH administered prior to 1st GnRH of Ovsynch. Lactating dairy cows ($n = 137$) were assigned to receive either no treatment prior to Ovsynch (Control) or 25 mg of PGF_{2 α} (Pre-P) followed 2 d later by 100 mg of GnRH (Pre-G), administered 4 (G4G), 5 (G5G) or 6 (G6G) d prior to 1st GnRH of Ovsynch. Transrectal ultrasonography was performed to assess follicular size and ovulation, and blood samples were collected to measure circulating concentrations of P₄ and E₂. Cows were AI 16 h after final GnRH of Ovsynch. Pregnancy diagnosis was performed 35 d later by palpation. Proportion of cows that ovulated to 1st GnRH of Ovsynch was 56.0, 66.7, 84.6 and 53.8% for G4G, G5G, G6G and controls, respectively, and was greater for G6G vs. controls ($P < 0.03$). Luteolytic response to PGF_{2 α} of Ovsynch was greater in treated vs. control cows (92.0, 91.7, 96.2 and 69.2% for G4G, G5G, G6G and Control, respectively; $P < 0.05$). Synchronization rate to Ovsynch was greater (92 vs. 69%, respectively; $P = 0.05$) in G6G vs. controls. Also, cows that ovulated in response to 1st GnRH of Ovsynch had greater response to PGF_{2 α} of Ovsynch (92.7 vs. 77.1 %, respectively; $P < 0.03$) and greater synchronization rate to the overall protocol (87.9 vs. 62.9%, respectively; $P < 0.005$) than those that did not. Concentrations of P₄ at PGF_{2 α} , and E₂ and follicle size at final GnRH of Ovsynch, were identified as significant predictors of probability of pregnancy 35 d after AI. In summary, a PGF_{2 α} -and-GnRH based Pre-Ovsynch strategy with a 6-d interval between Pre-G and 1st GnRH of Ovsynch resulted in a greater ovulatory and luteolytic response to 1st GnRH and PGF_{2 α} of Ovsynch, respectively, compared to controls. This, in turn, optimized synchronization rate to Ovsynch.

Key Words: Dairy cow, Ovsynch, Follicle maturation

203 Delaying injection of prostaglandin F_{2 α} (PGF) in an Ovsynch protocol. J. S. Stevenson*, M. A. Portaluppi, and D. E. Tenhouse, *Kansas State University, Manhattan.*

Our objective was to determine whether delaying PGF injection by 24 or 48 h after the first GnRH injection in an Ovsynch protocol altered

ovarian characteristics in dairy cows. Beginning 9 d after removal of a CIDR insert and injection of PGF (d 7 of the estrous cycle; 65 DIM), 36 Holsteins (average BW = 707 kg and BCS = 2.2) were given 100 µg of GnRH and assigned randomly to receive 25 mg of PGF 7, 8, or 9 d later. Timed AI was performed at 48 h after PGF at which time a second injection of GnRH was administered (91 DIM). Day 0 represented the first day of the Ovsynch protocol, initiated on d 7 of the estrous cycle. Ovarian structures were mapped by ultrasonography on d 0 and 2 to determine responses to the first GnRH injection, at PGF injection, and daily thereafter for 4 d. Blood was collected on d 0, 2, at PGF injection, and at 24 and 48 h after PGF to monitor progesterone (P4). Based on serum P4 and ovarian exams, 2 anestrus cows were eliminated, but 3 others were retained because they ovulated in response to the first GnRH injection. Final numbers of cows per treatment were: 7 d (n = 13); 8 d (n = 9); and 9 d (n = 10). Pretreatment responses: 27 of 32 cows ovulated (87.5%) in response to the first GnRH injection (d 0); number (d 0) of follicles ≥ 10 mm (1.9 ± 0.2); number (d 0) of original CL (1.3 ± 0.1); number (d 7) of new CL (1.0 ± 0.1); total CL (d 7) at PGF (2.3 ± 0.1); and diameter of follicles (d 0) that ovulated (13.1 ± 0.4 mm). Of cows not ovulating in response to the first GnRH injection, 3 had 2 original CL and 2 had 1 original CL. Despite a 24- or 48-h delay between first GnRH and PGF injections, diameter (mm) and volume (mm³) of the ovulatory follicle did not differ among treatments: 7 d (13.9 ± 0.2 ; 1526 ± 62); 8 d (13.7 ± 0.3 ; 1479 ± 97); and 9 d (13.7 ± 0.2 ; 1490 ± 69). All cows ovulated at least one follicle and ovulation rates did not differ: 1.2 ± 0.1 , 1.1 ± 0.1 , and 1.3 ± 0.2 , respectively. Four cows in the 7-d treatment inseminated 24 h late were excluded before assessing conception rates ($P = 0.07$): 5/9 (55.6%); 5/9 (55.6%); and 1/10 (10%), respectively. We concluded that delaying PGF by 24, but not 48 h, had little effect on outcomes.

Key Words: Ovsynch, Ovulation, Follicle

204 Effects on conception rates of lactating dairy cows by altering the time of the second GnRH and AI during Ovsynch. D. J. Brusveen*, A. P. Cunha, C. D. Silva, P. M. Cunha, R. A. Sterry, E. P. B. Silva, J. N. Guenther, and M. C. Wiltbank, *University of Wisconsin, Madison*.

A recent study (Portaluppi & Stevenson, 2005; JDS 88:914) indicated that CoSynch at 72 h after PGF had better conception rates (CR) than Cosynch at 48 h using data from first AI after Presynch. In this study we reexamined these 2 programs at first AI (Presynch) and at later services (Resynch). Further, we hypothesized that CR would be improved to a greater extent when GnRH was administered at 56 h after PGF prior to AI at 72 h due to a more optimal interval (16 h) between the LH surge and AI. A total of 1507 AIs in 927 lactating dairy cows were randomly assigned to one of three treatments by pen from August to December 2005. Cows ranged from 30 to 36 DIM at start of Presynch (two injections of PGF 14 d apart with the second injection 11 d before Ovsynch). All cows received GnRH followed 7 d later by PGF and then received one of the following: 1) GnRH + TAI 48 h after PGF (G48) 2) GnRH 56 h after PGF + TAI 72 h after PGF (G56) or 3) GnRH + TAI 72 h after PGF (G72). Pregnancy diagnoses were performed by ultrasound at 31 to 33 d post-AI and again at 52-54 d post-AI. CR were similar ($P > 0.1$) for the G48 and G72 groups (26.7% and 27.2%, respectively). The G56 group had a much greater CR (36.2%) than G48 ($P = 0.006$) or G72 ($P = 0.002$) groups. Cows at first AI (Presynch) had greater CR than cows at later AIs (Resynch) in G48 (37.8 vs. 23.6%; $P = 0.002$) and G56 (45.2 vs. 33.1%; $P = 0.021$) but not in G72 (27.5 vs. 27.3%; $P > 0.1$). Similarly, primiparous cows had greater CR than multiparous cows in G48 (34.1 vs. 23.1%; $P = 0.009$) and G56 (41.3 vs. 32.7%; $P = 0.065$) but not G72 (29.8 vs. 25.4%;

$P = 0.264$). Pregnancy loss was higher for primiparous than multiparous cows in the G48 and G56 groups but not in G72 ($P = 0.02$, $P = 0.016$, and $P > 0.1$, respectively). In conclusion, we found no advantage to Cosynch at 72 h vs. 48 h either at first or later AIs. In contrast, we found a clear advantage to treating with GnRH at 56 h prior to a 72 h AI probably due to the more optimal timing of AI prior to ovulation.

Key Words: Ovsynch, GnRH, TAI

205 Effect of synchronization protocols on follicular development of dairy heifers. J. L. Stevenson*¹, R. C. Chebel¹, J. C. Dalton¹, J. E. P. Santos², R. Sartori³, and A. Ahmadzadeh⁴, ¹University of Idaho, Caldwell, ²University of California-Davis, Tulare, ³EMBRAPA, Brasilia, DF, Brazil, ⁴University of Idaho, Moscow.

The objective of the present study was to evaluate the effect of synchronization protocols on follicular development of dairy heifers. Holstein heifers (n = 151), 13 mo of age, were assigned to one of four synchronization protocols in a 2 x 2 factorial arrangement, presynchronization (PRES) or no presynchronization (NPRES) with GnRH on study d -6 (study d 0 = initiation of the Co-Synch) and an injection of PGF2a (PGF) or no injection of PGF2a (NPGF) on study d 0. This resulted in 4 treatments (NPRES and NPGF; PRES and NPGF; NPRES and PGF; PRES and PGF). On d 0, all heifers received the Co-Synch protocol with a CIDR insert for 7 d. After the PGF2a of the Co-Synch, heifers detected in estrus were AI, and those not AI by d 10 were timed AI and received the final injection of GnRH of the Co-Synch. Ovaries were scanned by ultrasound on d 0, 2, 5, and daily from d 7 to 14. Blood samples collected on d 0, 2, 7, 9, and 16 were analyzed for P4. Pregnancy was diagnosed at 29 d after AI. Data was analyzed using GLM and CHISQ procedures of SAS. Greater proportion of heifers presynchronized ovulated in response to the GnRH injection given on d 0 (NPRES = 30.7 vs. PRES = 54.0%, $P = 0.004$). Presynchronization did not affect P4 concentration on d 0 ($P = 0.80$), but tended to affect it on d 2 (NPRES = 4.5 ± 0.3 vs. PRES = 5.4 ± 0.3 ng/mL; $P = 0.06$). Treatment with PGF2a on d 0 affected ($P < 0.001$) P4 concentration on d 2 (NPGF = 6.4 ± 0.3 vs. PGF = 3.5 ± 0.3 ng/mL) and 7 (NPGF = 2.7 ± 0.2 vs. PGF = 1.4 ± 0.2 ng/mL). Size of the ovulatory follicle on d 7 was not affected ($P = 0.50$) by pre-synchronization treatment, but it was affected by treatment with PGF2a on d 0 (NPGF = 13.5 ± 0.3 vs. PGF = 15.0 ± 0.3 mm; $P = 0.001$). Treatment with PGF2a on d 0 affected interval from CIDR removal to ovulation (NPGF = 3.7 ± 0.1 vs. PGF = 3.4 ± 0.1 d; $P = 0.004$). Presynchronization treatment did not affect P4 concentration on d 16 ($P = 0.60$), but heifers that received a PGF2a injection on d 0 had greater P4 concentration on d 16 (NPGF = 2.8 ± 0.2 vs. PGF = 3.5 ± 0.2 ng/mL; $P = 0.002$). Pregnancy rate was not affected by presynchronization treatment ($P = 0.85$) or treatment with PGF2a on d 0 ($P = 0.99$).

Key Words: Heifers, Ovulation

206 The effect of postpartum anovulatory interval on first service conception rate in crossbred dairy cattle. L. R. McNaughton*, K. M. Sanders, G. E. Stanley, and R. J. Spelman, *Livestock Improvement Corporation Ltd., Hamilton, Waikato, New Zealand*.

To maintain profitability and sustainability it is important to achieve a consistently high reproductive performance in the seasonal, pastoral-based dairy production systems found in New Zealand. An extended postpartum anovulatory interval (PPAI) is considered to be a major cause of infertility. Short PPAI allow more cycles prior to mating,

which can improve fertility, whilst animals with long PPAI may be anestrus when the mating period begins. This study investigates the incidence of extended PPAI and the relationship between the length of PPAI and reproductive performance in a herd of F2 Friesian x Jersey dairy cattle. Animals were the daughters of six crossbred sires and born in 2000 and 2001. The data includes lactation one and two of all animals and lactation three of the 2000 born animals. Calving began in mid-July and mating began in mid-October each year. Progesterone concentrations were measured 2x per week. The incidence of extended PPAI (not ovulated within 42 days postpartum) was 45.7, 9.7 and 4.4% in first, second and third lactation (significant effect of age, $p < 0.01$). First service conception rates were not different between animals with normal vs. extended PPAI. The length of the PPAI (split into 6 categories; see table) did not affect first service conception rates. This was despite the interval from ovulation to first service being longer in animals with short PPAI, enabling more cycles prior to first service, which has previously been reported to be associated with better fertility. First service conception rate was not related to the length of the PPAI in this population.

Table 1. The effect of postpartum anovulatory interval on the interval from first ovulation to artificial insemination an first service conception rate

PPAI (days)	n	PPAI-AI (days \pm se)	first service conception rate
≤ 16	311	62.4 \pm 1.1 ^a	0.65 ^{ab}
17-20	298	55.6 \pm 1.1 ^b	0.68 ^a
21-26	271	50.4 \pm 1.2 ^c	0.63 ^{ab}
27-34	266	45.0 \pm 1.2 ^d	0.56 ^b
35-50	305	35.6 \pm 1.2 ^e	0.66 ^{ab}
> 50	270	18.5 \pm 1.3 ^f	0.61 ^{ab}

Different superscripts within a column indicate significant differences ($p < 0.05$)

Key Words: Fertility, Postpartum anovulatory interval, Conception rate

207 Effects of source of supplemental Se and method of presynchronization on reproduction and lactation of dairy cows. H. M. Rutigliano*¹, F. S. Lima¹, R. L. A. Cerri¹, L. F. Greco¹, J. M. Vilela¹, V. Magalhaes¹, J. Hillegass¹, W. W. Thatcher², and J. E. P. Santos¹, ¹University of California Davis, Tulare, ²University of Florida, Gainesville.

Objectives were to determine the effect of source of supplemental Se and method of presynchronization on pregnancy rates and lactation performance of dairy cows. Holstein cows, 577, were enrolled in a 2x2 factorial design. Treatments were sodium selenite (SS) or Se yeast (SY, Sel-Plex™) supplemented at 0.3 ppm from 25 d prior to calving to 80 d in milk, and two methods of presynchronization, Presynch (2 PGF2a given 14 d apart) or CIDR inserted for 7 d with an injection of PGF2a at removal. Cows were AI following the Ovsynch protocol starting at 12 or 3 d after the presynchronization for Presynch and CIDR, respectively. Body condition was scored at study enrollment. Lactation performance was followed for the first 80 d postpartum. Cows were diagnosed for pregnancy at 28, 42 and 56 d after AI. Cows receiving SY produced (kg/d) more ($P < 0.05$) 3.5% FCM (40.4 vs 38.5) and milk fat (1.42 vs 1.35) than SS, but yields of milk (41.1 vs 40.1)

and true protein (1.14 vs 1.12), and SCC (120 vs 132 x 1000/mL) were all similar ($P > 0.10$) between treatments. Body condition score was similar ($P = 0.45$) for SY and SS throughout the study and averaged 3.08 and 3.07, respectively. Source of Se did not ($P = 0.23$) influence cyclicity, but fewer ($P = 0.02$) CIDR than Presynch cows were cyclic at the beginning of the Ovsynch (78.0 vs 86.1). Ovulatory responses were not influenced by source of Se. However, Presynch increased ($P < 0.01$) ovulation to the first GnRH (73.5 vs 58.7), and size of ovulatory follicle at PGF (16.0 vs 15.2mm) and final GnRH (19.0 vs 18.2mm) of the Ovsynch, but did not influence ovulation at the final GnRH of the Ovsynch. Pregnancy on d 28 after first AI was not influenced ($P > 0.15$) by source of Se (SY=31.2 vs SS=34.4%) or method of presynchronization (CIDR=33.0 vs Presynch=33.3%). Similarly, pregnancy loss from 28 to 56 d of gestation was not influenced ($P > 0.15$) by Se (SY=23.5 vs SS=20.5%) or method of presynchronization (CIDR=22.5 vs Presynch=21.3%). SY improved lactation performance, but neither source of Se nor method of presynchronization altered pregnancy rates and embryonic survival in dairy cows.

Key Words: Selenium, Presynchronization, Dairy cow

208 Effects of presynchronization with GnRH on conception rates and ovarian events in *Bos indicus*-influenced females synchronized with CO-Synch + CIDR. J. F. Zuluaga*¹, J. P. Saldarriaga¹, D. A. Cooper¹, J. A. Cartmill¹, R. L. Stanko^{1,2}, and G. L. Williams¹, ¹Texas A&M University Agricultural Research Station, Beeville, ²Texas A&M University, Kingsville.

Objectives were to evaluate the effect of presynchronization with GnRH on conception rates (CR, Exp.1) and ovarian events (Exp.2) in *Bos indicus*-influenced females synchronized with the CO-Synch + CIDR (CSC) protocol. In Exp.1, 135 Brahman x Hereford (F1) females were stratified by BW, BCS, age, and d postpartum (dpp) and assigned randomly to 1) Presynch; presynchronization followed by CSC or 2) CSC only. On d -7, cattle received either 100 μ g GnRH (GnRHpre) or 2 mL saline i.m. The CSC protocol included an Eazy-Breed CIDR and i.m. injection of GnRH (GnRH-1) on d 0, removal of CIDR and i.m. injection of 25 mg PGF2 α on d 7, and i.m. injection of GnRH (GnRH-2) and timed AI (TAI) 66 h after CIDR removal (d 10). Mean (\pm SEM) age, BCS, BW and dpp were 6.1 \pm 0.4 yr, 5.4 \pm 0.1, 498 \pm 8.7 kg, and 77 \pm 1.8 d, respectively. Conception rates for Presynch (37 \pm 6 %) and CSC (49 \pm 6.1 %) did not differ. Deleting data from females with BCS < 5 (n = 18) increased TAI conception rates to 38 \pm 6.3 % and 54 \pm 6.7 %, respectively (Presynch vs CSC; $P = 0.085$). In Exp.2, non-cycling (46 %) and cycling (54 %) Brahman x Hereford (F1) cows (n = 98) were stratified as described previously and assigned randomly to Presynch or CSC. Ultrasonography and serum progesterone were utilized to monitor ovarian events. Mean age, BCS, BW and dpp were similar to Exp. 1. Ovulatory response and synchronized follicular wave emergence (SFWE) after GnRHpre were 50 \pm 7.1 % and 84 \pm 5.2 %, respectively. Ovulatory responses after GnRH-1 differed ($P < 0.01$) between Presynch (58 \pm 7.1 %) and CSC (27 \pm 6.5 %) but treatment did not affect SFWE after GnRH-1 (86 \pm 3.6 %), ovulation after GnRH-2 (74 \pm 4.4%), follicular size, or TAI CR (31 \pm 4.7 %). Presynch improved ovulation rate after GnRH-1, but did not increase CR compared to CSC.

Supported by TAES and Pfizer Animal Health

Key Words: Timed AI, *Bos indicus*, CIDR

209 Effects of ovulation rate and fetal number on fertility in twin-producing cattle. S. Echternkamp*, R. Cushman, and M. Allan, *USDA, ARS, US Meat Animal Research Center, Clay Center, NE.*

Effects of ovulation rate (number of corpora lutea; OR) and of fetal number and distribution within the uterus on pregnancy rate (PR) and fetal survival were evaluated from 1994 to 2004 in heifers (n = 1230) and cows (n = 3104) selected for twin births. Cattle were distributed equally between a spring (70 d) and fall (60 d) breeding season and bred by a combination of AI and natural service. Ovulation rate, PR, and fetal number and distribution were determined by real-time ultrasonography (US) of the uterus and both ovaries at 35 to 70 d post-breeding; PR was confirmed by rectal palpation at 75 to 135 d. For cows and heifers combined, OR increased ($P < 0.01$) from 1.46 in 1994 to 1.89 in 2004; number of calves/parturition increased from 1.34 to 1.56, respectively. Pregnancy rates at US and palpation diagnosis and at term for females with one (89.1, 85.1, and 85.1%, respectively), two (91.2, 86.5, and 82.7%), or three (91.5, 75.8, and 63.0%) ovulations were not affected by OR at US but PR decreased ($P < 0.01$) at calving with increasing OR. Cows with single ovulations had similar PR between seasons, but cows with twin or triplet ovulations had lower PR in the fall (OR x season; $P < 0.05$). Also, PR increased ($P < 0.01$) with postpartum interval but was decreased ($P < 0.01$) for dams with twin versus single calves. For females diagnosed with one, two, or three fetuses at US, calving rate was 95.7%, 87.8%, and 54.9%, respectively, and differed ($P < 0.01$) among fetal groups. In addition, fetal survival was reduced ($P < 0.01$) for unilateral versus bilateral twins or triplets in heifers but did not differ in cows. Calf survival at birth was 97.2% for singles, 92.0% for bilateral twins, 83.2% for unilateral twins, 73.8% for bilateral triplets, and 51.9% for unilateral triplets and differed ($P < 0.01$) among single, bilateral twin, unilateral twin, and triplet births. Thus, increased calf production from increased OR in beef cattle is tempered by increased fetal and calf mortality, especially in heifers.

Key Words: Cattle, Twins, Fertility

210 Factors affecting ovulatory follicle size and ovulation success to GnRH-induced ovulation in postpartum beef cows. J. A. Atkins^{*1}, T. W. Geary², K. J. Wells³, M. C. Lucy¹, and M. F. Smith¹, ¹University of Missouri, Columbia, ²USDA ARS Fort Keogh, Miles City, MT, ³Washington State University, Pullman.

Optimizing pregnancy rates following fixed-time AI is dependent on reducing the proportion of cows with small dominant follicles that are physiologically immature at GnRH-induced ovulation and AI. A likely explanation for the presence of small dominant follicles at insemination is failure of the previous dominant follicle to ovulate in response to the first GnRH injection and thereby synchronize a follicular wave. In the present study, the effects of day of the estrous cycle and ovulatory response at the first GnRH injection on size of the dominant follicle at the second GnRH were examined in multi-parous lactating beef cows (n = 60). GnRH was administered on day -9 (GnRH1), prostaglandin $F_{2\alpha}$ on day -2, and GnRH on day 0 (GnRH2). Cows were classified into groups based on day of the estrous cycle

(Day 2, 5, 9, 13, or 18; Day 0 = estrus) at GnRH1. With the exception of cows in the Day 2 group (0%; $P < 0.05$), the proportion ovulating to GnRH1 (63%) did not differ ($P > 0.10$) by day of the estrous cycle. Neither day of the estrous cycle nor ovulatory response at GnRH1 affected ($P > 0.10$) size of the dominant follicle or proportion ovulating at GnRH2. Cows that ovulated a follicle ≥ 13 mm had a greater rate of increase in progesterone (P_4) following ovulation (d2-d12) than cows that ovulated 11-12 mm ($P < 0.05$) follicles or ≤ 10 mm follicles ($P < 0.01$). Cows that displayed estrus within 12 hours of GnRH2 had a greater rate of increase in P_4 (d2-12) than cows that did not exhibit estrus ($P < 0.01$). In summary, ovulation at GnRH1 did not affect follicle size or proportion ovulating at GnRH2. In cows that ovulated at GnRH2, those that ovulated a follicle ≥ 13 mm and(or) expressed estrus had a more rapid rise in P_4 compared to cows that ovulated smaller follicles or did not display estrous behavior.

Key Words: Ovulation, Follicle size, Estrus synchronization

211 Progesterone concentrations after the first GnRH injection in a GnRH-based estrus synchronization protocol and AI pregnancy rates in primiparous cows exposed to bulls. J. G. Berardinelli* and S. A. Tauck, *Montana State University, Bozeman.*

The objectives were to evaluate whether exposing primiparous beef cows to the biostimulatory effect of bulls alters progesterone (P_4) concentrations after the first GnRH injection; and, examine the relationship between P_4 concentrations after the first GnRH injection and AI pregnancy rates in an estrus synchronization (ES) protocol that included GnRH, $PGF_{2\alpha}$ (PG), GnRH and fixed-time AI (TAI). Three experiments were conducted over consecutive yr. In each yr cows were exposed (BE; n=94) or not exposed (NE; n=67) to the biostimulatory effect of bulls for at least 55 d before the start of the ES protocol which included GnRH (d -10) followed by PG 7 d later (d -3). Cows that showed estrus were AI 12 h later. Cows that failed to show estrus were given GnRH and TAI at ~68 h (d 0) after PG. Blood samples were collected from each cow on d -10, -7, -6, -5, -4, -1, and 0. Pregnancy rates were determined 35 d after TAI. Year or its interaction with other independent variables did not affect response variables. There was an interaction ($P < 0.05$) between treatment and sampling d for P_4 concentrations due primarily to a more rapid increase in P_4 concentrations between d -7 and -4 after GnRH in BE cows than in NE cows. More ($P < 0.001$) BE cows were cycling at the start of the ES protocol than NE cows. Pregnancy rate for BE cows bred at TAI was greater ($P < 0.001$) than that for NE cows. Pregnancy rate for cows bred by AI 12 h after estrus did not differ between BE and NE cows. Probability of pregnancy to AI was more likely ($P < 0.001$) to occur if P_4 exceeded 1 ng/mL between d -7 and -4 after the first GnRH injection than if P_4 were ≤ 1 ng/mL between d -7 and -4 in BE and NE cows. We conclude that the biostimulatory effect of bulls alters the P_4 response in an ES protocol that included GnRH, $PGF_{2\alpha}$, GnRH and TAI, and that P_4 concentrations after the first GnRH injection may determine the success rate of GnRH-based ES protocols in primiparous beef cows.

Key Words: Biostimulation, Estrus synchronization, Progesterone

Ruminant Nutrition: Connecting Rumen Microbiology to Ruminant Nutrition: Are We There Yet?

212 Ruminant nitrogen metabolism: The current microbiological outlook. M. Morrison* and Z. Yu, *The Ohio State University, Columbus.*

Historically, the microbiological outlook of ruminal nitrogen metabolism has been focused on the degradative, assimilatory and metabolic fate of nitrogenous compounds. Select bacterial species or “mixed rumen contents” have been used in most of these studies. Sometimes, cultivation-dependent, and more recently, cultivation-independent approaches have been employed to enumerate and observe shifts in microbe numbers. Such studies have allowed us to better understand how substrate preferences and availability affect rumen bacterial growth efficiency and yield, as well as some of the microbial interactions underpinning ruminal proteolysis. However, the variability implicit within the dietary models used by nutritionists for ration formulation suggest we still have much to understand about rumen microbiology and its direct role in affecting protein (amino acid) availability for the host animal. Additionally, there has been scant attention paid to understanding how peptides, amino acids, and other nitrogenous compounds might influence rumen microbial physiology and (or) metabolism; for example as effector molecules coordinating diverse functions such as quorum sensing and the conjugative transfer of genetic material. In other words, how might the intermediates and (or) products of ruminal nitrogen transactions elicit changes in microbial “behavior”, resulting in quantifiable alterations of rumen metabolism and nutrient utilization? Microbial (meta)genomics provides the opportunity to examine the rumen microbiome in a more holistic and mechanistic way, and to obtain new insights into gene expression, microbial action and rumen function. We will present several examples of the advances that are emerging from the (meta)genomic analysis of ruminal microbes, within the contextual bases outlined above.

Key Words: Rumen microbiology, Genomics, Nitrogen metabolism

213 Ruminant nitrogen metabolism: The current nutritional outlook. J. L. Firkins*, *The Ohio State University, Columbus.*

Historically, research evaluating ruminal nitrogen transactions has primarily focused on aspects concerning the degradative, assimilatory and metabolic fates of nitrogenous compounds. The microbiological aspects of these processes have been integrated into nutritional goals of improving the efficiency of microbial protein synthesis, maximizing amino acid supply to the host animal, and (or) minimizing the loss of nitrogenous compounds in animal waste. As described in the companion paper by Morrison and Yu, microbiological techniques have advanced from phenotypic descriptions of pure and mixed cultures to metagenomic comparisons of population structure in vivo. Correspondingly, although major shifts in microbial populations have been associated with large in vivo treatment differences, more narrow treatment differences have demonstrated shifts in microbial populations that are only relatively comparable to differences among animals fed the same diets, indicating considerable variability in microbial populations occupying similar niches. As nutritionists move toward more sophisticated dietary modeling approaches based on some overall average animal response, we must better account for the variability in model predictions for feeding groups of animals to decrease current reliance on dietary safety factors and anecdotal animal assessment strategies to prevent ruminal acidosis or shortages of rumen degraded

protein. Dietary factors influencing ruminal degradative capacity and outflow of microbial protein include the types and numbers of protozoa, the availability of specific nitrogenous and carbohydrate fractions, rumination activity, stratification and location in the rumen, and time after feeding. Besides reviewing such individual processes, the overall aim of this presentation will be to explore how dietary changes influence microbial ecology in the rumen ecosystem as assessed by current and future techniques, thus improving the predictability of microbial end-products and their impact on ruminant nutrition.

Key Words: Ruminant nitrogen metabolism, Microbial ecology, Microbial protein synthesis

214 Ruminant acidosis in beef cattle: The current microbiological outlook. T. G. Nagaraja* and E. C. Titgemeyer, *Kansas State University, Manhattan.*

Ruminal acidosis continues to be a common and economically significant ruminal digestive disorder in beef cattle. Ruminal acidosis or increased accumulation of organic acids in the rumen reflects imbalance between microbial production, microbial utilization and ruminal absorption of organic acids. The severity of acidosis, generally related to the amount, frequency and duration of grain feeding, varies from acute, typically due to lactic acid accumulation, to subacute acidosis due to accumulation of VFA in the rumen. Ruminal microbial changes associated with acidosis are reflective of increased availability of fermentable substrates and subsequent accumulation of organic acids. Microbial changes in the rumen associated with acute acidosis have been well documented. The changes include increases in lactic acid-producing bacteria, primarily acid-tolerant amylolytic bacteria, and a general decrease in ciliated protozoa and gram negative bacteria, particularly lactic acid-utilizing bacteria. Other microbial factors, such as endotoxin and histamine, are suspected to contribute to the systemic effects of acidosis. Microbial changes in subacute acidosis resemble those observed during adaptation to grain feeding, in that there is a general increase in total number of bacteria, including lactate-utilizing bacteria. The decrease in ciliated protozoal population is a common feature of both forms of acidosis and may be a good microbial indicator of an acidotic condition in the rumen. Ciliated protozoa in the rumen impart a stabilizing effect on the fermentation because of their ability to influence ruminal starch and lactic acid fermentations. However, protozoal populations in the rumen of grain-fed cattle, even after reaching full feed, fluctuate considerably, and not much is known about factors responsible for their volatility. Besides prudent management practices, initial approaches to control acidosis were generally aimed to inhibit or slow down lactic acid-production, but relatively recent methods are also aimed at enhancing ruminal lactate utilization.

Key Words: Rumen, Acidosis, Microorganisms

215 Ruminant acidosis in beef cattle: The current nutritional outlook. E. C. Titgemeyer* and T. G. Nagaraja, *Kansas State University, Manhattan.*

Ruminal acidosis in beef cattle can lead to marked reductions in cattle performance. Numerous models have been developed to assess the effects of variation in feed intake, of dietary roughage amount and source, of dietary grain amount and processing, of step-up regimen, and of dietary addition of fibrous byproducts, antibiotics, probiotics,

and direct-fed microbials. These models typically address ruminal fermentation, and they yield useful results that, unfortunately, often differ from those observed for growth performance. Models have been developed to study both the adaptation of cattle to grain-based diets as well as the effects of management considerations on acidosis in cattle previously adapted to grain-based diets. Although these models have provided valuable information related to ruminal acidosis, many of the models have been inadequate for detecting responses to treatment due to inadequate replication (required to overcome the variable responses being studied), low feed intakes by the experimental cattle (which can limit the expression of acidosis), and the feeding of cattle individually (which reduces experimental variation but limits extrapolation of the

data to industry conditions). Treatment responses to a wide range of management and nutritional modulations are often explained on the basis of acidosis prevention (or stimulation), whether or not direct evidence of acidosis is available. Optimal model systems for assessing impacts of various management and nutritional strategies on ruminal acidosis will require technologies that allow feed intake patterns, ruminal conditions, and animal health and performance to be measured simultaneously in a large number of cattle managed under conditions similar to commercial feedyards. Data generated under these conditions could provide valuable insight into the true extent to which acidosis impacts cattle performance.

Key Words: Acidosis, Cattle, Rumen

Ruminant Nutrition: Non-fibrous Carbohydrate & By-Product Feedstuffs

216 Influence of endosperm vitreousness and kernel moisture at harvest on site and extent of digestion of high moisture corn by steers. J. Szasz*¹, C. Hunt¹, P. Szasz¹, R. Weber², F. Owens², and W. Kezar², ¹University of Idaho, Moscow, ²Pioneer Hi-Bred International, Johnston, IA.

Six ruminally and duodenally cannulated steers (mean BW 450 kg) were used in a 6 x 6 Latin square to evaluate the impact of kernel vitreousness and moisture on intake and digestibility of high moisture corn. Arranged in a 2 x 3 factorial, diets included a floury (FLO) and a vitreous (VIT) endosperm hybrid harvested at DRY, MID, and WET kernel moistures (28.1, 31.2, and 35.7%). High moisture corn was dry-rolled and allowed to ensile for at least 45 d. Diet DM consisted of 88% high moisture corn, 6% chopped alfalfa hay, 2.0% corn gluten meal, 0.75% urea, and 3.0% supplement. Geometric mean diameter was less ($P = 0.06$) for VIT than FLO and increased ($P < 0.05$) linearly with kernel moisture content. Surface area was greater ($P < 0.05$) for VIT versus FLO particles. In situ rapidly degraded starch (a fraction) and effective starch degradability (assuming 5%/h fractional passage rate) increased linearly ($P < 0.01$) with kernel moisture. An interaction ($P < 0.05$) was observed between kernel vitreousness and moisture for in situ rapidly degraded starch and effective starch degradability, both being greater ($P < 0.05$) for VIT-DRY than FLO-DRY. Intake and ruminal disappearance of DM, OM, and starch were not influenced by vitreousness or moisture. Ruminal starch digestion, averaging 90.9%, was not impacted by dietary treatment. Digestion of starch entering the small intestine, averaging 91.0%, was greater ($P < 0.05$) for VIT than FLO corn. Averaged across moisture levels, total tract starch digestibility was greater ($P < 0.003$) for VIT than FLO. Compared with FLO kernels, VIT kernels were more brittle and shattered more readily when rolled, particularly when DRY. The increased surface area of smaller particles may be responsible for the improved starch utilization. For processed high moisture corn, total tract starch digestibility was greater for the vitreous than the floury endosperm corn.

Key Words: Starch, Processing, Particle size

217 Influence of endosperm vitreousness, moisture at harvest, and microbial inoculant on chemical composition, available starch and ruminal dry matter disappearance of ensiled high moisture corn. J. Szasz*¹, C. Hunt¹, P. Szasz¹, R. Weber², F. Owens², and W. Kezar², ¹University of Idaho, Moscow, ²Pioneer Hi-Bred International, Johnston, IA.

Samples from two corn hybrids, one floury (FLO) and one vitreous (VIT) endosperm type, were harvested at DRY, MID, and WET

kernel moistures (28.1, 31.2, and 35.7 percent moisture, respectively). Samples of rolled high moisture corn from each endosperm by kernel moisture subclass were ensiled in triplicate, with or without a bacterial inoculant (Pioneer® brand 1189), in polyethylene packets which were then vacuum packed, heat sealed, and stored for a minimum of 210 days. Compared to FLO, fermented VIT tended ($P = 0.10$) to have a lower pH but greater available (enzyme digested) starch, CP, NDF, and ash. Within DRY, protein solubility was greater ($P < 0.05$) for VIT than FLO. Ash content and 24-h in situ DM disappearance increased linearly ($P < 0.05$) with kernel moisture. Microbial inoculation tended ($P < 0.10$) to reduce pH, ash content, and available starch. Within FLO, microbial inoculant reduced ($P < 0.05$) concentration of CP. Microbial inoculant reduced ($P < 0.05$) ammonia N concentration for FLO-DRY, FLO-MID, and VIT-MID compared to non-inoculated high moisture corn. Microbial inoculant increased ($P < 0.05$) 24-h in situ DM disappearance for VIT corn harvested and ensiled DRY. For inoculated DRY corn, 24-h in situ DM disappearance was greater ($P < 0.05$) for VIT than FLO. In a companion study, VIT had smaller particle size than FLO, particularly for DRY treatments. Accordingly, the greater starch availability and soluble CP for VIT compared to FLO may have been due partly to smaller particle size and greater surface area. The beneficial response from the microbial inoculant for DRY-VIT also may be a result of application of the inoculant to smaller particle size corn characteristic of DRY-VIT compared with DRY-FLO.

Key Words: Processing, Particle size, In situ

218 Effects of feeding steam-rolled corn in lieu of dry-rolled corn on the odor of finishing beef steer manure. S. L. Archibeque*¹, D. N. Miller², D. B. Parker³, H. C. Freetly¹, and C. L. Ferrell¹, ¹USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE, ²USDA, ARS, Soil and Water Conservation Research Unit, Lincoln, NE, ³West Texas A&M University, Canyon.

Fecal starch is the major source of odorous compounds produced in the manure of steers fed typical finishing diets. We hypothesized that feeding steam-rolled corn (SR) in lieu of dry-rolled corn (DR) in finishing diets would increase starch digestibility and thus reduce odor production from manure. Eight steers (318 ± 15 kg) were used in a nutrient balance trial with a crossover design and fed either a DR- or SR-based finishing diet. Feces collected during the first day of each balance trial were analyzed for volatile organic compound emission and olfactometry by a trained sensory panel. There was no difference ($P = 0.96$) in starch intake between steers fed DR (4,293 g/d) or SR (4,283 g/d) diets, but fecal starch of steers fed SR (253 g/d) was lower ($P < 0.01$) than that of steers fed DR (490 g/d). Although N intake was

greater ($P < 0.01$) in steers fed DR (137 g/d) than those fed SR (110 g/d), there was no difference ($P = 0.99$) in retained N. Although starch concentrations of feces collected during the balance trial were different ($P < 0.01$), there was no difference ($P = 0.40$) in fecal starch concentration used for odor detection. There was no difference in odor intensity ($P = 0.28$), hedonic tone ($P = 0.29$), or total ionizable current (a measure of total organic volatilization, $P = 0.24$) of fresh feces from steers fed DR or SR. However, fecal odor of steers fed SR tended ($P = 0.09$) to have a higher panel detection threshold and a greater ($P = 0.03$) volatilization of branched chain VFA than that of steers fed DR. Total ionizable current was correlated to both odor intensity ($r = 0.56$, $P = 0.02$) and hedonic tone ($r = -0.52$, $P = 0.04$). Differences between the fecal starch concentrations during the balance trial and the odor assessment may have contributed to the lack of difference in odor detection.

Key Words: Odor, Beef cattle, Starch

219 Evaluation of dried distillers grains plus solubles compared to soybean hulls as a feedstuff for heifers during the last trimester of gestation. C. L. Engel*, H. H. Patterson, and G. A. Perry, *South Dakota State University, Brookings.*

Research has shown supplementation with undegradable intake protein (UIP) or fat during the first gestation can improve subsequent reproduction of young cows. Dried distillers grains plus solubles (DDGS) contain significant amounts of UIP and fat, and may be a good source of protein and energy for gestating heifers. The objective of this experiment was to evaluate the effects of DDGS or soybean hulls (SBH) on heifer and calf performance when incorporated into limit fed late gestation diets. Ninety-five crossbred, primiparous heifers were blocked by previous development, stratified by expected calving date (April 05), BW (507 ± 0.55 kg), BCS (5.91 ± 0.04), and randomly allotted to DDGS or SBH. Treatments consisted of 4.0 kg ground grass hay, 0.3 kg supplement, and either 3.3 kg SBH or 3.0 kg DDGS. Diets were formulated to meet nutrient requirements under thermo-neutral conditions at d 240 of gestation. Both diets were similar in NEM (11.8 Mcal/d) and were adequate in CP and degradable intake protein. Diets were fed from about d 190 of gestation until parturition. BW and BCS were measured at start of dietary treatments and just prior to parturition. Both DDGS and SBH heifers had positive BW gains, but DDGS heifers had a greater ($P < 0.01$) ADG compared to SBH heifers (0.84 ± 0.03 and 0.69 ± 0.03 kg, respectively). However, BCS was similar ($P = 0.29$) for DDGS (5.96 ± 0.07) and SBH (5.84 ± 0.07) just prior to parturition. Treatment had no effect on calving ease ($P = 1.0$) or calf vigor ($P = 0.46$). In addition, there were no differences between calves of DDGS and SBH treated heifers in birth weights ($P = 0.43$), weaning weights ($P = 0.66$), or ADG ($P = 0.89$) from birth to weaning. There was a tendency ($P = 0.11$) for more DDGS heifers to become pregnant during the breeding season compared to SBH heifers (92% vs 80%; respectively). In summary, heifers fed DDGS during late gestation had higher ADG compared to heifers fed SBH; with no effect on BCS or calf performance.

Key Words: DDGS, Soybean hulls, Gestation

220 Starch and digestible fiber supplementation to orchardgrass hay based programmed gain heifer diets. R. L. Mills*¹, J. C. Waller¹, J. Dowlen¹, and C. J. Richards², ¹*The University of Tennessee, Knoxville*, ²*Oklahoma State University, Stillwater.*

A 56-day randomized block design using twenty-four individually fed Angus heifers (293 ± 9 kg) in each of two years was conducted

to assess supplements containing varying combinations of fibrous and starch based energy feedstuffs. Heifers were limit fed to meet their metabolizable energy requirement (NRC, 2000) to achieve a programmed gain of 0.55 kg /d. Dietary treatments consisted of an orchardgrass hay control (CON) or orchardgrass hay plus supplement with the hay providing 60% and the supplement providing 40% of the daily energy requirement. Supplements, on a metabolizable energy basis, consisted of corn (C), soybean hulls (SH), 75% soybean hulls with 25% corn (75:25), 50% soybean hulls with 50% corn (50:50), and 25% soybean hulls with 75% corn (25:75). Heifers were fed once daily and orts were collected daily prior to feeding. Heifers were weighed on d 0, 1, 28, 55, and 56. Initial and final weights were an average of the two beginning and ending weights, respectively. Data were analyzed using the MIXED procedure in SAS with contrasts of CON versus supplemented (SUPP) and linear and quadratic effects of soybean hull inclusion. There were differences among treatments in total ADG and weight gain ($P = 0.01$). Among supplemented heifers, there was a linear increase with greater SH inclusion in the supplement ($P < 0.01$) with SH (0.47 kg/d and 26.14 kg, respectively) having the greatest gain and corn (0.27 kg/d and 15.08 kg, respectively) having the least gain. Total feed:gain efficiency results showed 75:25 (11.7:1) to be more efficient than the other supplements and corn to be least efficient (20.08:1; $P < 0.01$). When providing supplements to limit-fed, high-quality hay diets, minimizing the amount of the starch in the supplements increases animal performance and the efficiency of the diet.

Key Words: Cattle, Programmed gains, Soybean hulls

221 The effect of sample grinding on gas production profiles and end-products formation in expander processed barley and peas. A Azarfar*, A. F. B. van der Poel, and S Tamminga, *Wageningen University, Wageningen, The Netherlands.*

Grinding is a technological process widely applied in the feed manufacturing industry. It is also a prerequisite to obtain representative samples, necessary for laboratory procedures like for instance gas production analysis, an in vitro technique used to determine the degradative behaviour of feeds. Grinding feed samples prior to laboratory analyses is normally through a 1 mm screen. When feeds are subjected to technological processes other than grinding, like for instance extrusion, grinding afterwards may disturb the effect of processing, both in practice and when laboratory techniques are applied to study the effect of processing. Therefore, this study aimed to establish the possible effects of different types of the grinding and sample preparation on the degradative behaviour of expander processed barley and peas. In a 2×6 factorial arrangement of treatments with three replicates, samples of expander processed barley and peas were subjected to 6 different types of sample preparation (intact sample, slurry sample, samples stepwise ground over a 6 and 3 mm sieve, samples stepwise ground over a 6 and 1 mm sieve, samples ground over a 3 mm sieve and samples ground over a 1 mm sieve). Pattern of gas production in these samples were studied over a period of 72 hours incubation using an automated in vitro gas production system. The results showed that in raw and expanded peas stepwise grinding leads to a faster degradation. In expander processed barley, however, the difference in the degradation pattern due to the different grinding methods was small.

Key Words: Sample preparation, Gas production, Expander processing

222 Effects of corn germ on digestibility of hay and corn.

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New technologies in dry milling corn yield a corn germ (germ) fraction consisting of 91.3% DM, 15.3% CP, and 18% crude fat. Two experiments were conducted to evaluate effects of germ on dry matter disappearance (DMD) of forage and grain. In Exp. 1, 48 h IVDMD were conducted on diet substrates oat hay, corn and a blend diet (90% corn 10% oat hay). Two fermentation runs were conducted using these 3 diets. Germ additions to the blend diet replaced only corn. Run 1 evaluated germ inclusions of 0, 10, 20, and 30%. Run 2 evaluated germ inclusions of 0, 7, 14, 21, 28, and 42%. The oil layer was not removed with the liquid phase at the conclusion of in vitro fermentations. Combining Run 1 and 2 produced a quadratic response for IVDMD of oat hay ($P < 0.01$; $DMD = 49.5 - 0.31(\text{run}) - 0.37(\text{germ}) + 0.006(\text{germ})^2$; $R^2 = 0.60$). Depression of forage DMD was maximized at a germ inclusion of 31.4%. There was no response for IVDMD of corn suggesting corn and germ had equal digestibility. A linear decrease of IVDMD in the blend diet was detected ($P < 0.05$; $DMD = 77.6 - 2.47(\text{run}) - 0.07(\text{germ})$; $R^2 = 0.80$). In Exp. 2, 24 crossbred lambs ($BW = 41 \pm 2.6$ kg) were used in a randomized complete block design experiment (block=breed). Lambs were fed 1 of 4 isonitrogenous (12.3% CP) diets as a complete pellet. A basal diet of 10% beet pulp, 79% corn, and 8.5% soybean meal (SBM) was fed as the control. Germ was added to diets at levels of 10, 20, and 30%, replacing corn and SBM. Total fecal collections were performed for 6 d following a 21 d adaptation period. One lamb was removed from the 20% germ treatment ($n = 5$). The addition of germ caused a linear decrease in DMD ($P < 0.0001$; $DMD = 88.5 - 0.23(\text{germ})$; $r^2 = 0.70$). Based on these results, the addition of germ will cause a linear decrease the DMD of a concentrate diet and a quadratic decrease in the DMD of a roughage diet.

Key Words: Corn germ, Digestibility, Sheep

223 Corn Germ from ethanol production as an energy supplement

for lactating dairy cows. M. M. Abdelqader*¹, A. R. Hippen¹, D. J. Schingoethe¹, K. K. Kalscheur¹, K. Karges², and M. L. Gibson², ¹South Dakota State University, Brookings, ²Dakota Gold Research Association, Sioux Falls, SD.

Sixteen multiparous cows (12 Holstein and 4 Brown Swiss, 132 ± 36 days in milk) were used in a replicated 4×4 Latin square design with a 4-week periods to determine the effects of feeding corn germ on dairy cow performance. Diets were formulated with increasing concentrations of corn germ at 0, 7, 14, and 21% of the diet DM. All diets contained 55:45 forage to concentrate ratio, where forage was 60% corn silage and 40% alfalfa hay. Diets were formulated to be similar in CP (17.2%), NDF (30.8%), and ADF (19.2%). Dietary fat increased from 4.6% in the control diet to 8.3% at the highest inclusion rate of corn germ. The addition of corn germ had no effect ($P > 0.05$) on DMI (27.8, 28.4, 27.5, and 26.8 kg/d). Feeding increasing concentrations of corn germ caused yields of milk (36.8, 37.8, 38.3, and 36.7 kg/d) and energy-corrected milk (38.7, 40.4, 40.4, and 37.4 kg/d) to respond in a quadratic fashion ($P < 0.05$). Milk fat concentrations (3.73, 3.81, 3.77, and 3.53%) and yields (1.36, 1.45, 1.44, and 1.28 kg/d), also responded in a quadratic fashion ($P < 0.05$) to increased concentrations of corn germ in the diets. Furthermore, milk fat yield decreased ($P < 0.05$) when cows were fed the 21% corn germ diet compared with other dietary treatments. Milk protein content decreased linearly (3.44, 3.35, 3.33, and 3.33%; $P < 0.05$) as the concentration of corn germ increased in the diet; however, milk protein yield (1.26, 1.28, 1.27, and 1.23 kg/d) was not affected ($P > 0.05$). Dietary treatments

had no effect on feed efficiency, which averaged 1.44 kg ECM/kg DMI. Inclusion of corn germ at 7% and 14% of dietary dry matter resulted in increased milk and fat yields, however, inclusion of corn germ at 21% of diet DM decreased concentration and yield of milk fat. Germ removed from corn grain prior to ethanol production provides an alternative source of fat for energy in lactating dairy cows.

Key Words: Corn germ, Fat, Dairy cows

224 Effect of fatty acid treatment of different particle size of rolled corn and barley on dry matter digestion in rumen studied in-situ.

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The objective was to evaluate the protection conferred to particles of cereals from ruminal degradation by covering them with Fatty Acids. Dry Matter disappearance (DM) was used to indicate the level of ruminal degradation. A $2 \times 3 \times 3$ was used, two grains:(G), three particle sizes (PS):small (s), medium(m) and large(l) and three levels of Fatty Acids:(FA) inclusions: 0%, 20% and 40%. Saturated FA was used. The average diameter of different particles was: (s)=0.85 mm, (m)=2.0 mm and (l)=2.81 mm. Nylon Bags, with 5 gr of sample were incubated 0, 4, 8, 12, 24 and 48 hr in rumen. After removal, bags were washed and freeze dried. DM disappearance with time was modeled using Marquardt-Levenberg algorithm to minimize the least squares and compared by orthogonal contrasts. Interactions (Tables 1,2 and 3) were found between G x PS and G x FA ($P < 0.05$). In Table 4, can be observed a tendency to reduce the rate of degradation by adding FA to different PS of both grains ($P > 0.05$).

Table 1. Fractions a, b and c of dry matter disappearance for interaction grain x particle size after ruminal incubation of corn and barley

Interaction	Fraction	Corn			Barley			Std. Error
		Particle Size			Particle Size			
		Small	Medium	Large	Small	Medium	Large	
G x PS	a	9.52	6.73	8.23	17.60	11.22	9.20	1.12
	b	88.27	90.73	88.60	61.31	65.70	66.58	1.39
	c	0.025	0.017	0.021	0.214	0.134	0.096	0.007
		Fatty Acid Concentration (%)						
		0 (%)	20 (%)	40 (%)	0 (%)	20 (%)	40 (%)	
G x FA	a	14.57	6.37	3.54	20.21	11.13	6.69	1.15
	b	82.12	89.03	96.45	70.51	69.63	53.44	1.420
	c	0.03	0.02	0.008	0.14	0.13	0.16	0.021

Fractions: a, soluble fraction; b, potentially digestible; and c, rate of degradation (h^{-1})

Key Words: Rumen, Digestion, Dry matter

225 Evaluating in vitro cell wall polysaccharide digestibility of high-fiber byproduct feeds and forages.

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The objective of this experiment was to examine the repeatability of in vitro cell wall polysaccharide digestibility (IVCWPD) analysis across time using 10 byproduct feeds and 12 forages. Ruminal contents were collected on a biweekly basis, over a 6-wk period, from a single lactating Holstein cow maintained on a total mixed ration. For every collection, feedstuffs were incubated in duplicate for 48 h at 39°C using

the Ankom Daisy Oven system. The Uppsala dietary fiber method was used to analyze feeds and residues for cell wall polysaccharide constituents (neutral sugars and uronic acids). Week of rumen fluid collection significantly ($P < 0.05$) affected IVCWPD across feeds, with collection 3 having lower IVCWPD values than collections 1 and 2. Ranking of forages, but not byproduct feeds, by IVCWPD was affected ($P < 0.05$) by collection week. Average IVCWPD for whole cottonseed and wheat middlings were 33 and 56%, respectively, while the other 8 byproduct feeds ranged from 73-92%. For two corn silage samples (conventional and BMR), IVCWPD results from collections 1 and 2 were greater ($P < 0.05$) than for collection 3. Comparing the conventional and BMR corn silages, IVCWPD was different for collection 2 (72 vs. 64%), but not different for collections 1 (74 & 67%) and 3 (57 & 57%). For an alfalfa haylage sample, IVCWPD was greater ($P < 0.05$) for collection 2 than collection 3 (74 vs. 67%), with collection 1 being intermediate. Rankings of 3 alfalfa samples (1 haylage, 2 hays) for IVCWPD changed among rumen collections. The IVCWPD of the haylage was greater ($P < 0.05$) than of hay 2 for collection 1 (72 vs. 63%), greater than hays 1 and 2 for collection 2 (74 vs. 66 & 65%), but similar to hays 1 and 2 for collection 3 (67 vs. 63 & 62%). Repetitive rumen fluid collections under standardized conditions resulted in different IVCWPD values for forages but not byproduct feeds.

Key Words: In vitro cell wall polysaccharide digestibility, Forages, Byproduct feeds

226 Influence of bovine somatotropin and varying levels of enzose on nutrients intake, digestibility, milk yield and its composition in mid-lactating *Nili-Ravi* buffaloes. M. Nisa*, A. Sufyan, M. Sarwar, and M. A. Shahzad, *University of Agriculture, Faisalabad, Pakistan*.

The study was conducted to investigate the effect of bovine somatotropin hormone (bST), with varying levels of enzose (corn dextrose, by product of corn products Industry) in the ration, on nutrients intake, digestibilities, nitrogen balance, milk yield and its composition in mid lactating *Nili-Ravi* buffaloes ($n=12$). Three rations were formulated to replace 0, 20 or 40% concentrate with enzose of equivalent energy and offered to buffaloes administered 0 or 250 mg bST, biweekly, for a period of 100 days in a 2×3 factorial arrangement and means were compared by using Duncan's Multiple Range test. The bST administration increased ($P < 0.05$) DM, CP, NDF and ADF intakes, N retention and N excretion in the milk. The NDF and ADF digestibilities, daily milk yield and milk fat% were also increased by bST administration. Addition of 40% enzose in the ration decreased ($P < 0.05$) DM, CP, NDF and ADF intakes, NDF and ADF digestibilities and daily milk yield. Overall N balance was not affected either by bST administration or enzose addition in the ration. Enzose interacted ($P < 0.05$) with bST for milk yield and milk ash contents. The bST administration in buffaloes increased milk production by 30%. Up to 20% concentrates can be replaced with enzose in the ration. Replacement of 40% concentrate with enzose in the ration can adversely affect nutrients intake, their digestibilities and milk yield in lactating buffaloes.

Key Words: Mid lactating buffaloes, Bovine somatotrophin, Enzose

ADSA – SAD Undergraduate Competition: Dairy Foods

227 Effect of pasteurization on the survival of *Mycobacterium avium paratuberculosis*. A. Bush*, *University of Kentucky, Lexington*.

The goal of milk pasteurization is to provide consumers with a safe, shelf-stable product, while preserving milk's unique organoleptic properties. Pasteurization is applied primarily for safety, but also greatly reduces the number of spoilage microorganisms and slows degradative enzymatic activity in milk products. Some recent studies suggest *Mycobacterium avium paratuberculosis* (MAP) may be capable of surviving current milk pasteurization standards (72°C for 15 sec). MAP is the causative agent of Johne's disease in cattle. Johne's is a chronic, incurable bowel condition that leads to weight loss, decreased milk production, and eventual death. Humans do not contract Johne's disease, but can develop Crohn's disease, which some scientists suspect may involve MAP organisms. Those that suffer from Crohn's disease commonly experience abdominal pain, diarrhea, fever, and weight loss. MAP is difficult to study because of the lack of a common selective lab media, a long incubation period, and because of the waxy cell wall that makes differential staining tedious. Various studies have been performed with MAP in the United States, as well as Europe, but have produced conflicting results. If MAP is proven to survive pasteurization and to be involved with Crohn's disease, then revisions will need to be made in the FDA processing standards for fluid milk.

Key Words: Pasteurization, *Mycobacterium*, Crohn's

228 Dairy foods and reduced risk of colon cancer. A. Greenbaum*, *Louisiana State University, Baton Rouge*.

The American Cancer Society estimated that there will be 146,940 cases of colon cancer in the United States in 2006 and 56,730 deaths.

Colon cancer is thought to be caused by genetic predisposition and dietary factors. Low fat dairy foods might have a protective role against colon cancer. Several components in dairy foods namely, calcium, vitamin D, conjugated linoleic acid (CLA), sphingolipids, butyric acid, bacterial cultures (in cultured dairy products), protein and vitamin A may protect against colon cancer. Several studies indicate that increasing calcium intake reduces colonic epithelial cell hyperproliferation or normalizes the distribution of proliferating cells within colorectal crypts in individuals at risk for colon cancer. Mechanisms on how calcium directly induces cell death of colonic epithelial cells have been proposed. Vitamin D increased calcium absorption and reduces the risk of developing colon cancer. Three to four servings of low fat dairy foods daily along with a well planned high fiber diet and exercise can go a long way in preventing the onset of colon cancer.

Key Words: Cancer, Health, Dairy

229 Probiotic dairy products: A healthy choice. R. Kilgore*, *Pennsylvania State University, University Park*.

During the early 1900s, Eli Metchnikoff, a Russian biologist, first advocated the benefits provided by yogurt with *Lactobacillus* bacteria. He linked those positive effects to the longevity of Bulgarian peasants. Since then, a significant amount research has been conducted to determine the exact effects of probiotics. These are living microorganisms that when consumed in sufficient numbers can provide health benefits beyond basic nutrition. According to studies by the California Dairy Research Foundation, proven positive effects of probiotic products include improving immune function, minimizing symptoms

of lactose intolerance, preventing intestinal diseases, and even reducing the risk of colon cancer. After gaining much popularity in other parts of the world, several probiotic dairy products are now on the market within the United States. Leading this campaign is Dannon which manufactures DanActive, a probiotic fermented milk product. Additionally, Dannon has recently released Activia, the first probiotic yogurt available in the United States. To assist consumers in identifying products which contain probiotics, the National Yogurt Association has established the Live and Active Cultures seal that manufacturers can place on their products that contain at least 100 million bacterial cultures per gram. As Americans become more and more concerned about the health benefits of their foods, products such as probiotic yogurts and fermented milk drinks will gain public interest and appeal.

Key Words: Probiotic, Yogurt, Cultured dairy products

230 The rippling effects of processor expansion: A Texas sized example. S. Brauning*, *Virginia Polytechnic Institute and State University, Blacksburg.*

Cheese consumption across America has been on the rise for many years in the United States. The demand and market for cheese products are continuing to increase both a domestically and internationally. Hilmar Cheese Company, located in the Central Valley, of California is

currently the largest single site producer of wholesale cheddar cheese and whey products in the United States. The company was founded in 1984 by twelve Jersey dairy farmers who wanted to capitalize on the value of their high-component milk. Today Hilmar Cheese Company processes the world's largest volume of Jersey milk, over 11 million pounds per day, with over 600 employees. The company prides itself in maintaining "mutually beneficial relationships between company owners, employees, milk producers, customers and the local community." To keep abreast the growing demand for their product, they have broken ground in Dalhart, Texas to install a second processing plant. Dalhart is located in the northwest panhandle of Texas, with a population of 7500 people; the local economy flourishes off agriculture. The Dalhart expansion of Hilmar is to be made in two phases. It is anticipated that the plant will originally have the capacity to process about 5 million pounds of milk per day with room for future expansion. The company expects to hire approximately 120 local residents, and hopes to contract their milk supply exclusively from Jersey herds. With such an expansion upon Texas's Dairy Industry one must consider the impacts the expansion could have. One may expect changes to be seen in areas such as cattle numbers, milk supply, milk prices, dairy cattle replacement availability and replacement pricing. The installation of the new plant can be expected to have local, regional and national effects on the economy in various facets.

Key Words: Cheese plant

Sheep Species: Application of Genomics to Sheep Production

231 Resources available for sheep genomics research. N. E. Cockett*, T. S. Hadfield, C. H. Wu, and K. Nomura, *Utah State University, Logan.*

Animal geneticists have been searching for the molecular basis of production traits in livestock species, including sheep, for over 40 years. Phenotypes of interest in sheep include fertility, reproduction, growth rate and efficiency, milk production, carcass quality and composition, wool characteristics, and disease resistance. The development of an ovine genome map containing molecular markers and genes has greatly advanced the identification of genetic regions containing quantitative trait loci (QTL) in sheep. Other genomic resources available for researchers investigating traits in sheep include an ovine radiation hybrid panel, large insert genomic libraries, and large-scale sequencing projects. These resources will greatly facilitate current positional cloning efforts to identify causal mutations that underlie economic trait loci. Scientists involved in sheep molecular genetics will be better able to exploit comparative information from the fully sequenced, information-rich genomes (human, mouse, and rat). These resources will also provide the scaffold for sequencing the ovine genome, a project that the sheep community is working towards for the future. In order to continue the identification of genes controlling important phenotypes in sheep, development of ovine genomic resources should continue.

Key Words: Ovine, Genomics, Resources

232 Molecular tools for sheep breeding: DNA-based markers for monogenic traits and QTL. J. E. Beever* and A. D. Markey, *University of Illinois, Urbana.*

Advances in sheep genomics during the past decade have led to the identification of molecular variation influencing a number of

phenotypic characteristics. As a result, DNA-based genetic tests are becoming common in selection programs and thus, are destined to impact breeding management. A review of current DNA-based diagnostic tests for monogenic traits, as well as the potential use of marker-assisted selection for QTL will be discussed.

Key Words: Sheep, DNA, QTL

233 How genomics will continue to improve productivity for the New Zealand sheep sector. T. Wilson*, *AgResearch, University of Otago, Dunedin, New Zealand.*

The New Zealand sheep industry has been very successful over the past 15 years in increasing production of lambs and increasing the meat produced per lamb for the export market. This is due to many factors such as better fertilisers, and improved plant cultivars and farming systems. Alongside this, significantly more attention has focused on detailed phenotyping and selection of rams for key traits which has maintained this growth in an upward direction. Genomics has already started to deliver benefits with the discoveries of the causative gene mutations for reproduction genes (Inverdale and Booroola) now having commercial application in certain farming systems. Several other research programmes are close to finding the gene mutations, with many traits fine mapped to regions where commercial strategies can be employed. For the next five to ten years, outcomes from genomic research programmes will be needed to maintain the growth in on-farm productivity within the New Zealand sheep industry. Strategies combining bioinformatics, expression profiling and high density SNP chips soon to be available will offer unprecedented opportunities for the sheep sector.

Key Words: Genomics, Productivity, DNA technologies

234 SheepGenomics – An integrated gene discovery program. T. M. Fischer*, *Australian Wool Innovation, Sydney, New South Wales, Australia.*

SheepGenomics (the Program) is a functional genomics program designed to discover genes and their functions and deliver products based on new genetic technologies for the benefit of the Australian sheep industry. There are four industry subprograms contained within the program, including wool biology, muscle growth and development, host resistance to internal parasites and reproductive efficiency. The research strategy of each of these industry subprograms uses positional and functional candidates for gene mapping with a view to identifying precise QTL regions for use in selection and then identification of candidate gene targets for therapeutic intervention of these traits. The most immediate outcome from the program is a series of DNA marker tests for muscle quality and quantity, parasite resistance and wool quality. Work is currently underway to validate existing marker tests and integrate allele effects into routine breeding value calculations so as to facilitate optimal use of genomic information in breeding decisions. SheepGenomics has placed particular emphasis on developing the tools needed to conduct genomic research in sheep including evaluation of bovine micro arrays, development of gene screening assays as well as building large well characterised sheep flocks to enable powerful gene mapping studies. A number of public domain outcomes arise from the Program, which are the result of significant international collaboration. They include development of a virtual sheep genome based on alignment of the end-sequences of BAC clones spanning the entire sheep genome with existing bovine sequence. Current research also involves development of a 1.5x ovine sequence, discovery of tens of thousands of new SNP and microsatellite markers as well as timely integration of this information into an informative sheep genome map. The scope for delivery of long-term benefits to the Australian sheep industry is enormous. Furthermore, each of the publicly available resources will be extremely beneficial to worldwide sheep genome related research efforts.

Key Words: Genomics, Sheep, DNA markers

235 Genomic regions associated with sheep muscle and carcass traits. C. Bidwell*¹ and N. Cockett², ¹*Purdue University, West Lafayette, IN,* ²*Utah State University, Logan.*

Linkage maps for the sheep genome have been developed but to date no complete genome scan for muscle, adipose or carcass traits are in the public record. Genome scans of selected chromosomes have identified four regions affecting carcass traits in Suffolk and Texel breeds. Chromosomes 2 and 3 were reported to have quantitative trait loci for fat depth and chromosomes 1 and 18 had quantitative trait loci for muscle depth. Several loci affecting muscle growth traits have been identified in sheep. These include callipyge and rib-eye muscling (Carwell) on chromosome 18. The muscle hypertrophy locus in Texels maps near the myostatin locus on chromosome 2. The rib-eye muscling locus lies close to the callipyge region on chromosome 18 but the specific mutation is not known. The callipyge mutation has been identified as a single nucleotide polymorphism in an intragenic region of an imprinted gene cluster. The mutation has altered the expression of at least 5 genes surrounding the mutation. Two of the genes, DLK1 and PEG11 that have paternal allele-specific expression, are candidates for causing muscle hypertrophy in callipyge lambs. With the completion of whole genome sequences in several species including human, rodents, chickens and cattle, the role of noncoding RNA and micro RNA in regulating gene expression has become better understood. The imprinted gene cluster surrounding the callipyge mutation expresses several noncoding RNA and micro RNA that are likely to be involved in polar overdominant inheritance of the phenotype. Recently, a micro RNA that is normally expressed in sheep skeletal muscle has been reported to down-regulate a mutant myostatin allele in Belgian Texels resulting in the muscle hypertrophy phenotype. The callipyge allele and Belgian Texel myostatin allele provide examples of how single nucleotide mutations can have substantial phenotypic effects on muscle and carcass traits through genomic regulatory mechanisms.

Key Words: Sheep, Genomics, Muscle

ADSA – SAD Undergraduate Competition: Original Research

236 Probiotic ice cream manufactured with a weight loss ingredient. M. Brown* and K. J. Aryana, *Louisiana State University, Baton Rouge.*

Obesity is directly related to about 300,000 deaths per year in the United States. The Surgeon General estimated obesity to cost \$117 billion a year. A novel ingredient, namely “Super Citrimax”, is being marketed as a weight loss ingredient (WLI). *Lactobacillus acidophilus* is one of the most effective forms of probiotic (good, helpful) bacteria discovered. The objective was to determine the effect of various amounts of the WLI on the physico-chemical, microbiological and sensory characteristics of probiotic ice cream. The WLI “Super Citrimax” was incorporated at the rate of 0, 1.5, 3.0 and 4.5g per 473 ml (pint) of ice cream. *L. acidophilus* was incorporated into all the pasteurized, homogenized and cooled ice cream mixes at the rate of 0.7% w/v mix. Product manufacture was replicated three times. The meltdown time for the first 15 ml of the ice creams with 3.0 and 4.5g WLI was significantly lower compared to the control. The meltdown volume of the control after one hour was significantly lower compared

to the ice creams with WLI at all concentrations. There were no significant ($p < 0.05$) differences between the control and all treatments for standard plate counts. Control had significantly the highest lactobacilli counts followed by the ice creams with 1.5 g WLI. The ice creams with 3.0 and 4.5g WLI had significantly the lowest lactobacilli counts. The flavor scores for the ice creams with 0, 1.5, and 3.0g WLI were not different from each other but were higher than the ice cream with 4.5 g. Similar results were obtained for the flavor scores of the heat shocked ice creams. There were no differences in body and texture scores of any of the ice creams. The body and texture scores of the heat shocked ice creams with 0, 1.5, 3.0g WLI were not significantly different from each other, but scores for the ice creams with 4.5g were significantly lower than the ice creams with 0 and 1.5g. Incorporation of WLI up to 3 g per 473 ml of ice cream did not influence its flavor. The use of WLI decreased meltdown time, increased meltdown volume, did not alter the standard plate counts, lowered the lactobacilli counts and did not influence sensory body and texture.

Key Words: Probiotic, Obesity, Dairy

237 Nitrogen and dry matter digestibility of high and low forage diets in dairy heifers. J. M. Daubert*, M. L. Moody, G. I. Zanton, and A. J. Heinrichs, *Pennsylvania State University, University Park.*

Diets fed to growing dairy heifers normally contain high levels of forages and are fed at ad libitum consumption. Feeding high concentrate diets in a restricted manner to achieve optimal ADG however can be more efficient because of reduced metabolic losses associated with digestion and lower feed costs per unit of energy. The objective of this experiment was to determine the DM and N digestibility of 2 diets with differing forage to concentrate ratios in dairy heifers. A 77% corn silage, 23% grain TMR (11.1% CP, 67.9% TDN, 40.9% NDF) and a 67% grain, 33% corn silage TMR (12.0% CP, 67.7% TDN, 37.9% NDF) were fed to 8 Holstein heifers (5 and 12 mo, 172 kg and 337 kg BW). Diets were fed at restricted intake ($BW^{0.75}$) twice daily. A split plot design was used with the ages of heifers as the whole plot and the sub-plot of treatment, administered in a 2 period Balaam's design. Periods were 21 d in length with 17 d of adaptation and 4 d total fecal and urine collection. Urine was collected via indwelling urinary catheters and feces were collected immediately at hourly intervals, stored in an airtight container, and weighed daily, mixed, sub-sampled, dried, and ground. DM digestibility was greater for low forage diets (74.3% vs. 70.7%; $P < 0.02$). DM digestibility was higher for older than younger heifers (74.3% vs. 70.7%; $P < 0.05$). N intake was 90.8 g for the high forage diet and 100.9 g for the low forage diet ($P < 0.04$). N digestibility was not different between treatments (57.5%, low forage vs. 55.1%, high forage; $P > 0.20$). Retained N was higher for low forage than high forage diets (35.5 g vs. 26.2 g; $P < 0.03$) and was higher for older than younger heifers (36.5 g vs. 25.2 g; $P < 0.05$). From these data we conclude that high concentrate diets are more digestible with greater retained N than high forage diets with equal nitrogen digestibility for both ages of heifers studied.

Key Words: Dairy heifers, Forage: concentrate, Digestibility

238 Nutritional management practices and current trends on Virginia Grade A dairy farms. J. Leech*, S. Sink, C. Stallings, K. Knowlton, and G. Groover, *Virginia Polytechnic Institute and State University, Blacksburg.*

The objective of this study is to describe current management practices, trends, and plans of Virginia Grade A dairy farms and then compare and contrast these practices based on residency in the Chesapeake Bay Watershed (CBW). In September of 2005 surveys were mailed to 806 Grade A permit holders. Using the Dillman (1978) protocol, follow-up postcards and surveys were mailed based on a predetermined calendar. By January of 2006, 56% of the surveys were returned. CBW herds participating in this survey reported 60,370 dairy animals, including replacement heifers, inside the CBW and 45,382 outside of the CBW. Formal nutrient management plans (NMP) were found on 72% of farms in the CBW, compared to 58% of farms outside of the CBW. Average milking herd size with a NMP is 140 cows and 73 cows without a NMP. Average milk production with a NMP is 63 lbs/cow/day, while farms without a NMP average 53 lbs/cow/day. This analysis indicates that higher levels of management are associated with higher milk production. Thirty-seven percent of the respondents reported plans to expand their herd size in the next 3 years and 52% plan to stay the same size. Of the expanding herds, 68% currently have a NMP in place, while 31% do not. Average herd size on farms planning to expand is currently 141 milking cows. Mixed rations are fed by 96% of the surveyed dairies and these rations are formulated by the feed companies a majority of the time (59%) and by independent nutrition consultants less often (28%). Results of the project have helped to

characterize Virginia Grade A dairy farms and highlight differences between management across an environmentally sensitive watershed.

Key Words: Nutrient management

239 A critique of RFV: Comparing RFV to degradation parameters and proposal of an alternative model. T. J. Hackmann* and J. N. Spain, *University of Missouri, Columbia.*

Relative feed value (RFV) is an index used to describe forage quality. RFV scores are calculated using DM concentrations of forage NDF and ADF. Rate and extent of digestion are not directly incorporated into RFV. It has not been determined whether RFV accounts for variation in these parameters across forages. The objectives of this study were to evaluate RFV relative to degradation parameters and to develop an alternative model. Forty-six alfalfa, 16 grass, and 19 mixed grass/legume forage samples were collected from duplicate hay bales submitted to the 2002 and 2003 MO State Fair Hay Contests. Sub-samples were placed in duplicate in situ bags and incubated at 0, 6 or 8, 12, 24, and 48 h. Residues were analyzed for DM, ADF, NDF and CP. PROC NLIN of SAS fit degradation data best to an age-dependent model based on the second-order Erlang distribution. Forage degradation parameters were sorted according to forage (alfalfa, grass, grass/legume). PROC CORR was used to determine correlation coefficients between these parameters and RFV. RFV was correlated to digestible NDF for alfalfa ($r = 0.30$, $P < 0.05$) and grass/legume ($r = 0.52$, $P < 0.03$). RFV was correlated to digestible hemicellulose in the grass/legume class ($r = 0.57$, $P < 0.05$). No correlations between RFV were observed for grasses (NDF: $P > 0.25$; hemicellulose: $P > 0.24$). For all forage classes, there were no relationships between RFV and rates of degradation of any chemical fraction ($P > 0.22$). This suggests that RFV is inadequate in describing forage quality, particularly of grasses. An alternative mechanistic model was formulated that incorporates a library of digestion rate and digestibility values measured in this study. Based on a previously published model, the model is contained in a spreadsheet and designed to be accessible to producers. In sum, this study demonstrates that RFV has little correlation with degradation parameters. RFV possesses shortcomings that limit its accuracy in describing forage quality. A mechanistic model has been developed that may serve as an effective alternative in predicting forage quality.

Key Words: Forage, RFV, In situ degradation

240 Effects of dietary addition of unsaturated fat, vitamin E, and sorbitol on performance of dairy cows and fatty acid concentrations in milk. A. Todd*, M. L. Eastridge, C. V. D. M. Ribeiro, J. Engel, and B. Mathew, *The Ohio State University, Columbus.*

Dietary addition of soybean oil will increase conjugated linoleic acid (CLA) in milk but not to the extent that results from feeding fish oil. Data are limited on CLA in milk from feeding a combination of soybean and fish oils to provide different sources of fatty acids (FA). There is some evidence that increasing dietary concentration of vitamin E may affect milk CLA when feeding unsaturated fat. Sorbitol is being used in commercial feed, but limited published data are available. Eight lactating dairy cows (4 Holstein and 4 Jersey) were used in a Latin square design. Each period consisted of 3 wk, with wk 3 being used for data analyses. Rumen samples were taken from the Holstein cows (one with rumen cannula and via stomach tube for the other 3 cows). Diets consisted of 44% forage (80% corn silage and 20% alfalfa hay), were mixed once daily as TMR, and fed twice daily. The cows

were fed 4 diets: 1) control diet (CNTL; 500 IU vitamin E), 2) 2% fish oil, 0.5% soybean oil, and 500 IU of vitamin E (FSO), 3) 2% fish oil, 0.5% soybean oil, and 2000 IU of vitamin E (FSOE), and 4) 1% sorbitol (SORB, dry form; 500 IU vitamin E). Diets with oil reduced DMI (18.8 versus 22.7 kg/d), but DMI was similar between CNTL and SORB. Milk yield (31.7 kg/d) and MUN (17.0 mg/dl) were similar among diets. Diets with oil reduced milk fat and protein percentages (3.87, 2.50, 2.58, and 3.96%; 3.38, 3.09, 3.16, and 3.32% for CNTL, FSO, FSOE, and SORB, respectively). Rumen VFA were similar among diets. Concentrations of vaccenic acid (3.49, 8.03, 11.8, and 1.96% of FA, respectively) and CLA (0.63, 1.28, 2.00, and 0.39%, respectively) in milk were increased with the diets containing oil; concentrations of vaccenic acid tended to be higher and CLA was higher for FSOE versus FSO. Both breeds responded similarly to the dietary treatments with respect to performance and individual milk FA. Addition of soybean and fish oils increased CLA in milk, but the higher concentration of vitamin E in combination with the oils further increased milk CLA. Feeding the sorbitol resulted in similar responses as to feeding the CNTL diet.

Key Words: Fish oil, Sorbitol, Vitamin E

241 The effect of lactoferrin on the appearance of immunoglobulins in the peripheral blood of Holstein calves. W. Knauer* and J. M. Smith, *University of Vermont, Burlington.*

The objective of this study was to determine the effect of a single dose of lactoferrin on the appearance of immunoglobulins in the peripheral blood of Holstein bull calves. Shortly after birth, all calves were fed 3.8 L of whole milk supplemented with bovine serum immunoglobulin and with lactoferrin according to treatment. Treatment 1 (n=3) received 4 g lactoferrin; treatment 2 (n=3) received 8 g lactoferrin; treatment 3 (n=3) served as the control and received no supplemental lactoferrin. Subsequently, all calves were fed a 26% crude protein, 18% crude fat milk replacer, mixed at a 15% concentration, to provide dry matter at 2% of body weight per d, for 6 wk. Calves were offered starter grain from 3 d of age and were weaned at d 42. Ten ml of blood were drawn from each calf at 0, 2, 4, 6, 8, 12, 16, 24, 32, and 42 h after the first feeding and at wk 1, 3, 5, 7, and 9. At 24 h, plasma immunoglobulin measured by radial immuno-diffusion did not differ, being 1430 ± 268 , 1020 ± 607 , and 960 ± 664 mg/dl, respectively, for treatments 1, 2, and 3. This study will be repeated with 3 more blocks of calves

before we can conclude whether lactoferrin affects immunoglobulin absorption in neonatal calves.

Key Words: Immunoglobulin, Lactoferrin, Dairy calf

242 Dairy farmers' perceptions and attitudes about lameness. A. M. Edgecomb*, C. L. Wickens, A. J. Zanella, and D. K. Beede, *Michigan State University, East Lansing.*

Lameness reduces productivity and welfare of dairy cattle. Incidence rates (IR) and severity of lameness in some herds are unacceptable. Various management strategies are recommended to reduce lameness; however, success is not observed in many instances. Our objective was to try to better understand the perceptions and attitudes of dairy farmers about lameness. A survey was mailed to all Michigan dairy farmers in July (n = 1,280) and December (n = 1,008). The survey asked four Likert Scale and 22 forced-choice questions. Survey return rate was 33%. Herd size profile of respondents was similar to Michigan's overall herd size profile. Data were analyzed using Statistical Package for the Social Sciences[®] 13.0. Ninety-nine percent of respondents believed lame cows feel pain. Overall, 43% 'strongly agreed' or 'agreed' that lameness was a problem in their herds; 23% 'neither agreed nor disagreed', and 31% 'disagreed or strongly disagreed'. However, 53% of farmers indicated that their IR was <10%; 35% believed it was between 11 to 30%; and, only 7% believed their IR was 31%, suggesting that lameness was not perceived as a major issue. The actual severity and frequency of lameness in the survey herds was not known. Furthermore, 69% of respondents indicated that they do not use a specific method to record occurrence of lameness. In 38% of herds a professional hoof trimmer was not used, yet only 2% indicated a person on-staff who trimmed hooves. The owner was identified as the main person (79%) responsible for managing lameness; yet, 37% indicated that no other person was responsible to help the owner with lameness in their herd (e.g., no team approach). We conclude based on survey responses that Michigan dairy farmers may underestimate the potential seriousness of lameness on cow productivity and welfare; or, what they might do to reduce lameness. Thus, careful consideration should be given for the best approaches in extension education and research to affect perceptions and attitudes of dairy farmers about lameness to improve animal health, welfare and productivity.

Key Words: Farmers' perceptions, Animal welfare, Dairy lameness

Companion Animals: Advances in Companion Animals - BioMarkers

243 Gut microbial and immunological responses of dogs to diets containing alternative carbohydrates with properties similar to those of dietary fibers. I. S. Middelbos*, N. D. Fastinger, M. R. Godoy, and G. C. Fahey, Jr., *University of Illinois, Urbana.*

Several blends of carbohydrates containing fructooligosaccharides (FOS) and/or mannanoligosaccharides (MOS) from yeast cell wall were evaluated as proxies for traditional dietary fibers in animal protein-based diets fed to dogs. Six mixed breed dogs with hound bloodlines were fitted with ileal "T"-type cannulas. In a 6 x 6 Latin square design with 14 d periods, six diets with different carbohydrate sources were tested. Dogs were offered 175 g twice daily of a brewer's rice and poultry byproduct meal-based diet supplemented with: no additional fiber (CO); 2.5% cellulose (CL); 2.5% beet pulp (BP); 1.0

% cellulose + 1.5% FOS (CF); 1.0% cellulose + 1.2% FOS + 0.3% MOS (CFM1); or 1.0% cellulose + 0.9% FOS + 0.6% MOS (CFM2). Chromic oxide was provided in gelatin capsules as a digestion marker at each feeding. On d 11 through 14 of each period, ileal samples and total feces excreted were collected. On d 14, a blood sample was collected for a complete blood count. Additionally, a fresh fecal sample was collected for bacterial enumeration by serial dilution and plating on selective agars. Treatment least squares means were compared using a Tukey adjustment. Feed intake, fecal score, and fecal pH were similar among treatments, but wet fecal output tended (P = 0.09) to be higher for dogs fed BP compared with CFM1. Fecal *Bifidobacterium* concentrations were higher for CF (P = 0.02) and CFM2 (P = 0.09) than for CL, and tended to be higher (P = 0.06) for CF than for CO.

Lactobacillus concentrations tended to be increased ($P = 0.07$) for CF compared to CL and CO. Total anaerobic microbe concentrations were increased for CF ($P = 0.04$) and CFM2 ($P = 0.05$) compared to CL, while total aerobic microbe concentrations were increased for CF compared to CL ($P = 0.05$) and CO ($P = 0.06$). White blood cell counts and serum immunoglobulin concentrations were not affected by treatment. These data suggest that fiber blends containing FOS and/or MOS modulate intestinal microbial populations but do not appear to affect immunological status of the dog.

Key Words: Dog, Carbohydrates, Dietary fiber

244 Mapping QTL for osteoarthritis in dogs. R. G. Mateescu^{*1}, N. I. Burton-Wurster¹, G. Lust¹, K. Tsai², J. Phavaphutanon³, and R. J. Todhunter¹, ¹*Cornell University, Ithaca, NY*, ²*Texas A&M University, College Station*, ³*Kasetsart University, Nakhon-Pathom, Thailand*.

Osteoarthritis (OA) is a common disease in dogs, with multiple risk factors, including a complex genetic pattern. The origins of cartilage degeneration in canine and human OA are still poorly understood, and fundamental questions regarding the precise molecular nature of this complex disease remain to be answered. The objective of this study was to identify QTL for OA in a dog model of the condition. A genome-wide scan was undertaken to identify QTL associated with this disease. An experimental canine pedigree was developed for linkage analysis by crossbreeding dysplastic Labrador Retrievers

with unaffected Greyhounds. We used 100 dogs from this pedigree, including backcrosses to both parental lines and F2 individuals. At necropsy, the hip joints were examined macroscopically and a score (ranging from 0 to 4) was assigned to describe the degree of cartilage degeneration. A set of 342 microsatellite markers were genotyped on 100 dogs. Interval mapping was performed using the QTL Express package. To adjust for the effect of age of the animal at the time of necropsy, the age at necropsy was included in the model as a covariate. Estimates were obtained for the additive and dominance effect of the putative QTL at that location. Chromosome-wide significance thresholds for each trait were determined empirically by permuting the marker data. Five chromosomes were identified to harbor putative QTL for necropsy score. The recent completion of the canine genome sequencing has facilitated the comparison of the dog genome with the human genome, allowing the further investigative analysis of canine QTL. The region on CFA18 flanked by markers AHT130 and FH2429 and identified in our study to harbor putative QTL is syntenic with 11q12.2-q12.3 region on the human chromosome 11, where a primary hip OA susceptibility locus was fine-mapped. Similarly, the region on CFA19 between markers FH2279 -Ren91114 is syntenic to human 2q14.2-2q21.1, region identified as linked to an OA locus segregating in different human populations. This indicates that the genetic mechanism underlying hip OA in dogs may have similarities to human OA and the dog model would greatly improve our ability to identify candidate genes for further investigation.

Key Words: OA, Dogs, QTL

Tuesday, July 11, 2006

POSTER PRESENTATIONS

Animal Health II

T1 Release of CD14 by bovine neutrophils results in down-regulation of IL-8. M. Paape*¹, E. Sohn², E. Connor¹, R. Fetterer¹, R. Peters², and D. Bannerman¹, ¹USDA-ARS, Beltsville, MD, ²University of Maryland, College Park.

CD14, the leukocyte receptor for lipopolysaccharide (LPS), is important in the response of PMN to infection by Gram-negative bacteria. IL-8 is a potent chemoattractant of PMN. The objective of the present study was to characterize bovine PMN cell surface expression and shedding of CD14 molecules, and its effect on secretion of IL-8 by PMN. PMN were isolated from blood collected from 16 lactating cows. PMN (5×10^6 /ml) were cultured in RPMI and stimulated with 0, 1, 10 and 100 $\mu\text{g/ml}$ of LPS for 20 h at 37°C. The percentage of PMN expressing membrane (m) CD14 was determined by flow cytometry. Concentrations of CD14 and IL-8 in RPMI were quantitated by ELISA. To determine the effect of cell density of PMN on release of CD14 and IL-8, varying concentrations of PMN were stimulated with either 0.1 or 10 $\mu\text{g/ml}$ of LPS, and supernatants assayed for CD14 and IL-8. Expression of mCD14 decreased from 35% (control PMN) to 25% after exposure to 100 $\mu\text{g/ml}$ of LPS. Secretion of CD14 increased with increasing cell density and with increasing concentrations of LPS, whereas secretion of IL-8 decreased. Results from quantitative real-time PCR indicated that CD14 gene expression did not increase after stimulation of PMN with LPS. Results from this study indicate that release of CD14 suppressed secretion of IL-8, and that the increase in CD14 resulted from either the shedding of mCD14 or originated from an intracellular pool of sCD14. The suppression of IL-8 by CD14 may be an important mechanism to control influx of PMN into the bovine mammary gland.

Key Words: CD14, IL-8, Neutrophil

T2 Assessing changes in gene expression in mammary tissue following experimental induction of *Staphylococcus aureus* mastitis using a cDNA microarray. J. Kelsey*¹, K. Bayles², L. Fox³, and M. McGuire¹, ¹University of Idaho, Moscow, ²University of Nebraska Medical Center, Omaha, ³Washington State University, Pullman.

To determine gene expression changes in the mammary gland following experimental induction of mastitis, two previously uninfected lactating Holstein cows were experimentally infected. Two consecutive daily 10 mL infusions containing 5000 CFU *S. aureus* 305 bacteria diluted

in PBS in one rear quarter of each cow induced the infection. The opposite rear quarter was infused with PBS and used as a control. Milk somatic cell count and *S. aureus* plate counts were monitored to determine if subclinical mastitis infections had occurred. Counts of *S. aureus* increased in the infected quarter of each cow to about 500 CFU/mL milk. Milk somatic cell counts also increased with each infected quarter 80% higher than the control. Two days following infusions, mammary biopsies were taken from both rear quarters, and tissue was immediately snap frozen. Total RNA was isolated, amplified, converted to cDNA and labeled with Cy3 or Cy5 dye before hybridization to the NBFGC bovine microarray (Michigan State University). Comparisons were made within cow, infected vs non-infected tissue. Total intensity values were background subtracted, log transformed, and normalized using a lowess normalization. Normalized values were then averaged for each gene and a t-test was conducted to determine which genes were changing significantly ($P < 0.05$). The genes that changed significantly ($P < 0.05$) were almost all up-regulated (about 750 genes). Some of these genes were associated with lipid metabolism including bile salt-stimulated lipase, lipase A and thioesterases. There were also many immune-related genes upregulated including MHC class I, cytokines, and immunoglobulins. This study demonstrates that *S. aureus*-induced mastitis leads to the induction of genes involved in lipid metabolism and immune function in the mammary gland.

Key Words: *S. aureus*, Mastitis, Gene expression

T3 High growth rate fails to enhance adaptive immune responses of neonatal calves and is associated with decreased T cell viability. M. Foote*¹, B. Nonnecke², W. Waters², D. Beitz¹, M. Fowler³, T. Johnson³, and B. Miller³, ¹Iowa State University, Ames, ²USDA, ARS, National Animal Disease Center, Ames, IA, ³Land O'Lakes Inc. Research Farm, Webster City, IA.

The objective of the study was to evaluate the effects of three targeted growth rates [No Growth (or maintenance, NG), Low Growth (LG), and High Growth (HG)] on adaptive (antigen-specific) immune responses of preruminant calves vaccinated with *Mycobacterium bovis*, strain bacillus Calmette Guerin (BCG) and ovalbumin (OVA) 3 wk after initiation of dietary treatments. Growth rates for NG (0.11 kg/d), LG (0.58 kg/d), and HG (1.16 kg/d) calves differed ($P \leq 0.001$) throughout the experimental period. Blood leukocyte populations from HG calves

had lower ($P \leq 0.05$) mononuclear leukocyte (MNL) percentages and higher ($P \leq 0.05$) granulocyte percentages than maintenance-fed (NG) calves. CD4 T cell percentages increased ($P \leq 0.05$) with age in NG and LG calves, typical of maturing calves, but failed to increase in HG calves. Growth rate did not affect ($P \geq 0.05$) percentages of CD45RO (memory) CD4 and CD8 T cells, OVA-specific serum IgG concentrations, or PPD-induced interferon- γ and inducible nitric oxide. Cutaneous delayed-type hypersensitivity responses of NG and HG calves to antigen were comparable and exceeded ($P \leq 0.05$) responses of LG calves. In resting and antigen stimulated MNL cultures, viabilities of CD4, CD8, and $\gamma\delta$ TCR T cells from HG calves were lower ($P \leq 0.05$) than those of T cell subsets from NG and LG calves. In conclusion, adaptive immune responses were affected minimally by growth rate. Results suggest that protein-energy malnutrition in the absence of weight loss is not detrimental to antigen-specific immune responses of pruruminant calves and that an increased growth rate does not enhance these responses. Negative effects of high growth rate on T cell viability may influence the resistance of the pruruminant calf to infectious disease.

Key Words: Calf nutrition, Adaptive immunity, Neonatal immunity

T4 Determination of endoparasites population in water buffaloes (*Bubalus bubalis*) in Magdalena Medio, Colombia. G. A. Prada-Sanmiguel*, *Universidad de La Salle, Facultad de Medicina Veterinaria, Bogotá, Distrito Capital, Colombia.*

The objective was to determine gastrointestinal, pulmonary, hepatic and hematic parasite populations in water buffalo (*Bubalus bubalis*) in La Suiza; a ranch located in Magdalena Medio, Colombia. 600 buffalo were evaluated in order to determine presence and prevalence of hemoparasites, and 150 buffalo were analyzed once per month to determine gastrointestinal, pulmonary and hepatic parasite populations. Techniques used in this study included: blood froths, fecal sedimentation-flotation, coproculture, MacMaster, Baermann and Dennis techniques. The hemoparasite prevalence found was the follows: *Anaplasma* spp 54.6%, *Trypanosoma* spp 1.2 % and *Babesia* spp 0.2%. The gastrointestinal parasites observed were: *Nematodirus* sp, *Cooperia* sp, *Ostertagia* sp, *Trichuris* sp, *Oesofagostomum* sp, *Bunostomum* sp, *Trichostrongylus* sp, *Strongyloides* sp, *Eimeria* spp, *Moniezia* sp, *Toxacara* sp and *Haemonchus* sp. Egg counts per gram of feces curves were also analyzed during the 12 months of 2004. No pulmonary or hepatic parasites were found in *B. bubalis* of Magdalena Medio, Colombia.

Key Words: *Bubalus bubalis*, Endoparasites, Colombia

T5 Lymphocyte, neutrophil, and mineral responses to *S. aureus* and *E. coli* mastitis. H. R. Springer¹, J. P. Goff², D. D. Bannerman³, and M. J. Paape³, ¹Iowa State University, Ames, ²USDA-ARS National Animal Disease Center, Ames, IA, ³Bovine Functional Genomics Laboratory, Beltsville, MD.

We hypothesized mastitis would elicit systemic immune suppression. Primiparous Holstein (n=10) and Jersey (n=10) cows were infected with 220 cfu of *S. aureus* in one quarter of the mammary gland. Blood and milk samples were taken at 6-24 hr intervals after infection. Infected quarters were treated with pirlamycin on day 10 for 9 days; clearing the infection in 16 cows. Seven wks later, in a separate study, the same cows were infected in a different quarter with 270 cfu of *E. coli* and blood and milk samples again taken. All cows cleared *E. coli* from the milk within 7 d without antibiotic. Time after *S. aureus*

infection had significant effect on IFN- γ production by lymphocytes ($P < 0.001$), with nadir in IFN- γ response at 24 hrs post infection. Neutrophil function, measured by neutrophil iodination, was not significantly depressed by *S. aureus* challenge, but was in *E. coli* infection ($P < 0.001$). No significant febrile response was elicited in response to *S. aureus* infection, but *E. coli* infection resulted in elevated rectal temperatures 12 and 18 hrs post-infection ($P < 0.0001$). Circulating lymphocyte populations showed a more pronounced drop with *E. coli* compared to *S. aureus* challenge ($P < 0.02$). Time after infection had significant, but opposite effects on blood neutrophil populations in the two infections ($P < 0.0001$). *E. coli* lowered this population while *S. aureus* increased it. Serum iron decreased significantly during infection; by 18 hrs with *E. coli* and by 24 hrs with *S. aureus*. Iron levels with *E. coli* infection decreased to a greater extent than with *S. aureus* ($P < 0.01$). *E. coli* infection caused a greater increase in unsaturated iron binding capacity than *S. aureus* ($P < 0.0001$). Both infections decreased plasma calcium ($P < 0.05$) with *E. coli* causing a greater reduction than ($P < 0.0001$). These data suggest that both *S. aureus* and *E. coli* mastitis elicit a systemic immune response with a stronger, earlier inflammatory response to *E. coli* infection.

Key Words: Mastitis, Immune response, *Staphylococcus aureus*

T6 Development of a ruminant fescue toxicosis model. S. S. Block*, P. H. Doane, and M. J. Cecava, *ADM Animal Nutrition Research, Decatur, IN.*

Sixteen male lambs (average weight 27.0 kg) were used to develop a fescue toxicosis model. Lambs were fed a pelleted diet containing 20% fescue seed during the study. Control diets used ergovaline-free fescue seed while the contaminated diet used fescue seed containing 2,800 ppb ergovaline. The complete diet fed to lambs during the toxin challenge period of the study contained 615 ppb ergovaline, 1041 ppb ergot alkaloids, and no additional ergotamines. Complete diets were supplemented with feed additives to assess whether the response to induced toxicity was affected by the presence of additives. The study was divided into four periods; adaptation (A), supplementation (S), elevated ambient temperature with supplementation (HS), elevated ambient temperature and fescue seed feeding with supplementation (HFS). Temperature and humidity were adjusted to maintain a relative heat index of 38°C. Supplements had no effect on any parameter measured during S. During the HS period, rectal temperature (RT), heart rate (HR), and breathing rate (BR) of lambs increased whereas feed intake decreased. Signs of toxicosis were apparent in HFS, including reduced feed consumption and weight gain ($P < 0.01$), elevated HR, BR, and RT ($P < 0.01$). Clinical markers of toxicosis included a significant reduction in circulating prolactin (477 ng/ml to 18 ng/ml; $P < 0.01$) after introduction of ergovaline-containing feed. Symptoms of toxicosis occurred only when the sheep were fed ergovaline-contaminated fescue seed in the presence of elevated ambient temperature. The inclusion of test supplements had no effects on the appearance of alkaloids in the urine ($P > 0.62$) or any parameters of fescue toxicity, with the exception of body temperature. Rectal temperature tended to be lower in animals consuming one supplement compared with control (40.5 vs. 40.7°C; $P < 0.11$). Induction of fescue toxicosis was successfully achieved, using a combination of high ambient temperature and inclusion of 20% ergovaline-contaminated fescue seed into the diet.

Key Words: Fescue, Ruminant, Toxicosis

T7 The relationship of copper and zinc with hematological parameters in beef cattle. M. Soch*¹, P. Srejberova², and J. Broucek³, ¹University of South Bohemia, Faculty of Agriculture, Ceske Budejovice, Czech Republic, ²Czech Beef Breeders Association, Praha, Czech Republic, ³SCPV, Nitra, Slovakia.

The objective of this study was to define the relationship between copper (Cu) and zinc (Zn) and the hematological parameters of hemoglobin (HB) and hematocrit (HT) in beef cattle. Seventy two (in spring and autumn seasons of 2004) blood (jugular), faeces (grab samples), and pasture (collected at the time blood was taken) samples were collected from two herds of beef cattle (Aberdeen Angus) from the Sumava (Czech Republic) mountains region (elevation=675-910 m above sea level). Blood was kept cold (+3°C) and analysed within 24 hours. The content of HB was estimated photometrically (540 nm) using a spectrometer UV/VIS Unicam 5625. HT was determined by the capillary microhematocrit method. The concentrations of Cu and Zn in plasma, feces, and pasture (DM) were analysed by flame atomic absorption (Spectrometer Unicam 969). The data were analyzed using STATISTIX 8. The normal distribution of data was evaluated by Wilk-Shapiro/Rankin Plot procedure. All data were normally distributed. Pearson Correlation was used for the evaluation of relationships. Concentrations of Cu and Zn in plasma (Cu 11.2 ± 3.87 mmol.L-1; Zn 13.01 ± 3.86 mmol.L-1) and feces (Cu 17.97 ± 10.17 mmol.L-1; Zn 113.02 ± 64.78 mmol.L-1) were below reference values (RfV). The lack of Cu and Zn in beef cattle was due to deficiency of both elements in the diet which provided only 86 % and 89 % of the needed Cu and Zn, respectively. Hematological parameters (HB, HT) were in the range of RfV (HB 110.90 ± 16.89 mmol.L-1; HT 0.32 ± 0.06 mmol.L-1). The low concentrations of Cu and Zn in plasma of cattle did not have negative influence on HB and HT. There were significant ($P < 0.05$) correlations between hematological parameters and mineral elements (HB:Cu, $r=0.622^*$; HB:Zn, $r=0.520^*$; HT:Cu, $r=0.606^*$; HT:Zn, $r=0.688^*$).

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Key Words: Microelements, Hematological parameters, Beef cattle

T8 Production of bacteriocins by bacterial isolates from dairy cattle. M. A. V. P. Brito*¹ and G. A. Somkuti², ¹EMBRAPA Dairy Cattle Research Center, Juiz de Fora, Brazil, ²Eastern Regional Research Center, USDA-ARS, Wyndmoor, PA.

A collection of 116 bacterial strains recovered from healthy cows in 41 dairy herds in Brazil was surveyed for the production of bacteriocins. The bacteria included 106 strains of staphylococci (87 coagulase positive and 19 coagulase negative) and 10 strains classified as streptococci. All cultures were grown in tryptic soy broth for 18 h at 37°C and cell-free supernatants were tested for antimicrobial activity against several target organisms by the agar diffusion method. Filtrates of 58 staphylococci and a culture identified as *Streptococcus uberis* showed strong activity against *Listeria monocytogenes* ScottA, whereas a *S. bovis* isolate was active against *S. agalactiae*. Filtrates of 53 staphylococci also inhibited the growth of *Staph. aureus* strain 305, a major causative agent of bovine mastitis in the United States. Although plasmids were apparently absent in the streptococcal isolates, the plasmid profiles of staphylococci invariably included an 8 kb plasmid. Staphylococcal isolates were tested for the production of aureocins A70 and A53, two bacteriocins of coagulase positive staphylococci known to be associated with 8 kb and 10.2 kb plasmids, respectively. The presence of either the A70 or A53 bacteriocin gene was checked by PCR techniques using forward and reverse primers flanking the

structural gene of each bacteriocin. Agarose gel analysis of amplified PCR products of plasmid templates from all 58 isolates showed only a 525 bp fragment that corresponded to the structural gene of the bacteriocin aureocin A70. The results indicated that the apparently widespread association of A70-producing staphylococci with healthy cows in Brazil may be beneficial in controlling undesirable bacteria in dairy herds.

Key Words: Bacteriocins, Aureocin A70, *Staphylococcus aureus*

T9 Evaluation of *C. elegans* as a pharmacogenetic model to study antihelminthic drugs. M. Worku*, C. Gerard, O. Alexander, I. Abdus-Saboor, and P. Matternson, North Carolina Agricultural and Technical State University, Greensboro.

Parasite drug resistance is recognized globally as one of the greatest threats to the health of grazing livestock. Macrocytic lactones are chemical compounds that represent the main treatment. The free-living nematode *Caenorhabditis elegans* (*C. elegans*) is a well established biological model. Chemotaxis is an important behavior in enabling it to locate food sources such as *E.coli*. This study evaluates the effects of Moxidectin exposure on the life cycle and chemotactic behavior of *C. elegans*. A ring of bacteria (food) on NGM agar medium served as attractive signals to encourage *C.elegans* to move. Nematodes were placed in the center of the agar plate in 0, 0.25 or 0.50 micromoles of Moxidectin. Over the three day life cycle the reproduction (number of worms), movement (yes or no) and chemotaxis (Number migrating to the ring of bacteria through the Moxidectin) was recorded. Nematodes that had reached the food were picked individually to new seeded plates and allowed to recover and reproduce. The progeny of were tested for Moxidectin sensitivity to determine if the apparent Moxidectin resistance of the parent had bred true. Averages of three experiments are presented. There was a 40 % reduction in total number of worms following first time exposure. A 60% reduction was observed in the second generation. Migration of worms to a food source was reduced by 10% on first time exposure; exposure to 25micromoles of Moxidectin and 25% reduction for second time exposure in treated versus control nematodes. Exposure to 50 micromoles of Moxidectin killed all nematodes. Exposure to Moxidectin affected the life cycle, inhibited chemotaxis to a food source and resulted in the development of resistant phenotypes. This *C. elegans* model can be used to better understand the molecular basis of resistance to anti-helminthics, drug screening and for identifying molecular targets or biochemical pathways mediating resistance.

Key Words: *C. elegans*, Cydectin, Drug resistance

T10 Effects of source of supplemental Se on health and immune status of periparturient dairy cows. H. M. Rutigliano*¹, R. L. A. Cerri¹, F. S. Lima¹, L. F. Vettorato¹, D. B. Araujo¹, J. Hillegass¹, W. W. Thatcher², and J. E. P. Santos¹, ¹University of California Davis, Tulare, ²University of Florida, Gainesville.

Objectives were to determine the effect of source of supplemental Se on postpartum health, immune responses and Se status of periparturient Holstein cows. Treatments were sodium selenite (SS, n=291) or Se yeast (SY, Sel-Plex[®], n=286) supplemented at 0.3 ppm from d 25 prior to calving to 80 d in milk. Health of dairy cows was monitored daily in the first 80 d in milk, and rectal temperature was taken for the first 10 d postpartum. A subset of 15 primiparous and 24 multiparous in the SS group and 10 primiparous and 26 multiparous in the SeY group was used to evaluate cellular and humoral immune responses. A colostrum

sample at the first milking after calving was analyzed for total IgG concentrations. Concentrations of Se in plasma were determined at -45, 0, 21, 42 and 60 d relative to calving. Glutathione peroxidase activity in plasma, neutrophil phagocytic activity and its oxidative metabolism were determined on days 0 and 42 postpartum. Each animal received an i.m. injection of 1 mg of ovalbumin at -45, -25 and 0 d relative to calving. Anti-ovalbumin IgG concentrations in serum were analyzed at every injection and at 21 and 42 d postpartum. Concentration of Se in plasma was similar ($P = 0.38$) for SY and SS throughout the study (0.107 vs 0.101 $\mu\text{g/mL}$). Glutathione peroxidase activity in plasma was not affected ($P = 0.70$) by source of Se. Concentration of IgG in colostrum was similar ($P = 0.24$) for SY and SS (60.9 vs 71.0 g/dL). Phagocytic and killing activities of neutrophils were influenced ($P <$

0.01) by days postpartum, but not ($P > 0.10$) by source of Se. Similarly, the ability of neutrophils to reduce nitroblue tetrazolium was not ($P > 0.10$) influenced by source of Se in stimulated and nonstimulated neutrophils. Incidence of retained placenta (SY=9.4 vs SS=8.6%), fever (SY=47.0 vs SS=44.7%), clinical ketosis (SY=22.1 vs SS=22.3%), displacement of abomasum (SY=2.5 vs SS=3.8%), and mastitis (SY=27.3 vs SS=25.1%) were not affected ($P > 0.10$) by source of supplemental Se, but a greater ($P < 0.01$) proportion of cows fed SY experienced acute metritis (21.3 vs 13.4%). Source of Se did not influence health or immunological status of periparturient dairy cows.

Key Words: Selenium, Health, Dairy cow

Breeding & Genetics II

T11 The effect of inbreeding on litter size in Chicago miniature pigs. Y.-C. Jung¹, S.-H. Oh^{*2}, M. T. See², T. E. del Rosario¹, and Y.-B. Kim³, ¹Jung P&C Institute, Seongnam, Gyeonggi, South Korea, ²North Carolina State University, Raleigh, ³Rosalind Franklin University of Medicine and Science/Chicago Medical School, North Chicago, IL.

Pedigree and litter size data for a miniature pig population were collected from 1968 to 2004. The objectives of this study were to investigate the genetic characteristics of the miniature pig population maintained at the Chicago Medical School, and to calculate and estimate inbreeding effects on litter size as well as estimate heritability and breeding values by year and generation. A single trait animal model was used to estimate genetic parameters. The model for litter size records included year and parity as fixed effects, and the random genetic effect of animal. Variance and covariance components were estimated by a derivative-free REML algorithm using the MTDFREML computer programs. As a result of analysis of 2227 individuals, inbreeding coefficients ranged from 0 to 0.43, and averaged 0.10 ± 0.08 over 29 generations. Estimation of variance components for litter size resulted in 0.63 and 3.50 for genetic and environmental variances, respectively. Heritability of litter size was estimated as 0.15 ± 0.04 . As a result, from inference through the analyses in this study, inbreeding in the Chicago miniature pig population increased on average 0.0068 per year, phenotypic litter size decreased 0.0781 per year, and breeding value of litter size decreased 0.0168 per year. In other words, a 10% increase in inbreeding resulted in 0.25 pig reduction in breeding value and 1.148 pig decrease in litter size.

Key Words: Miniature pigs, Inbreeding, Litter size

T12 Relationship between sire tenderness EPD and progeny carcass performance. J. W. Bolsen^{*}, J. Minick Bormann, D. W. Moser, and T. T. Marston, Kansas State University, Manhattan.

The objectives of this study were to determine how well a bull's tenderness Expected Progeny Differences (EPD) actually predicted his progeny's carcass performance, and to evaluate the effect of selection for tenderness EPD on other carcass measurements. In 2002, eight Hereford bulls with divergent tenderness EPD were mated randomly to crossbred cows. These EPD were developed from the NCBA Carcass Merit Project, and the accuracies ranged from 0.20 to 0.43. Steers, bulls, and cull heifers that were weaned in two groups were fed out

and harvested with complete carcass data collected. Measurements collected on all cattle ($n = 91$) included feedlot in-weight (IW), final weight (FW), dressing percent (DP), hot carcass weight (HCW), ribeye area (REA), 12-13th rib fat thickness (FT), marbling score (MS), kidney pelvic heart fat (KPH), and yield grade (YG). A sub-set of cattle ($n = 39$) were evaluated for tenderness and sensory traits, including Warner-Bratzler shear force (WBSF), myofibril tenderness (MT), overall tenderness (OT), color (CO), purge loss (PL), juiciness (JU), flavor (FL), and average pH (PH). Data were analyzed using the GLM procedure of SAS. The model for all carcass and sensory traits included fixed effects of weaning group, sex, kill group, and sire EPD level. Sire tenderness EPD level did not have an effect ($P > 0.05$) on WBSF, MT, OT, CO, PL, JU, FL, or PH. Low accuracies on the sire EPD and small progeny numbers probably contributed to the lack of difference in tenderness between EPD levels. The regression of actual sire tenderness EPD on progeny WBSF was 0.32 ± 0.44 . In the larger data set, IW, FW, DP, HCW, REA, FT, MS, KPH, and YG were unaffected ($P > 0.05$) by sire tenderness EPD level. These results from a larger sample of progeny indicate that selection on tenderness EPD should not affect other carcass traits.

Key Words: Tenderness, EPD, Carcass traits

T13 Carcass characteristics of different breeds on beef cattle. A. A. Souza^{*}, L. Sugisawa, H. N. Oliveira, and A. C. Silveira, São Paulo State University, Brazil.

Different breeds of beef cattle may show different carcass composition, so it's possible to combine breed development and markets. Beef consumers from Europe have preference for thinner cuts than Americans and Japanese consumers do. Other point is the worrying about health. People look for thinner cuts to avoid saturate fat consume. So, we could work with specific breeds for specific markets and consumers, optimizing production and the satisfaction of consumers. Forty two bullocks approximately 8 months and 240 kg, from Nellore, Angus, Angus Nellore crossbred, Brangus, Simmental x Nellore crossbred, Simbrasil and Simmental were evaluated for liveweight, ribeye area (REA), backfat thickness (BF), marbling and intramuscular lipids. Animals were housed with high concentrate diet and slaughtered at an approximate 3 mm of backfat thickness. Angus and its crossbred had thicker backfat and marbling, but smaller ribeye area than Simmental and its crossbred, and Nellore showed intermediate values.

Table 1. Carcass characteristics of different breeds

Breeds	LW (kg)	REA (cm ²)	REA/100 kg (cm ²)	BF (mm)	BF/100 kg LW	Marbling (1-6)	lipids (%)
Angus	479 ^{ab}	69.9 ^a	14.5 ^a	3.7 ^b	0.78 ^b	2.54 ^b	2.98 ^b
Brangus	477 ^{ab}	74.0 ^{ab}	15.6 ^{ab}	3.7 ^b	0.73 ^b	2.50 ^b	2.36 ^{ab}
½ Angus							
Nellore	506 ^{bc}	88.5 ^b	17.5 ^b	4.0 ^b	0.83 ^b	2.40 ^b	1.56 ^{ab}
Nellore	445 ^a	72.5 ^a	16.3 ^{ab}	3.2 ^{ab}	0.70 ^{ab}	1.44 ^a	1.50 ^{ab}
½ Simmental							
x Nellore	500 ^{bc}	85.7 ^b	17.2 ^b	2.4 ^a	0.49 ^a	1.08 ^a	1.17 ^a
Simbrasil	488 ^{bc}	83.4 ^b	17.0 ^b	2.5 ^a	0.53 ^a	1.16 ^a	0.76 ^a
Simmental	520 ^c	86.0 ^b	16.6 ^{ab}	2.4 ^a	0.47 ^a	1.05 ^a	0.98 ^a
SEM	0.07	0.11	0.10	0.23	0.22	0.27	0.49

*Means with unlike superscripts are different ($P < 0.05$)

Key Words: Carcass composition, Beef cattle, Breeds

T14 Estimation of genetic parameters for growth traits and image analysis traits of carcass cross section in Japanese Black steers.

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M. trapezius is not evaluated in the grading process for beef in Japan, although this muscle greatly affects the carcass unit price. The relationship between growth traits and *M. trapezius* has hardly been reported. The purpose of this study was to estimate the genetic parameters for growth traits and image analysis traits of rib eye and *M. trapezius* with computer image analysis for the carcass cross section in Japanese Black steers. 1,185 Japanese Black steers in progeny testing were used. The growth traits consisted of initial body weight at the beginning of the 364 d fattening period (IBW), final body weight at the end of the 364 d fattening period (FBW), and average daily gain during the 364 d fattening period (ADG). Digital images of the carcass cross section were taken between the 6-7th rib with photography equipment. Muscle area (MAREA), fat area ratio (FATPER), overall coarseness of marbling (O_COARSE), and coarseness of the largest marbling particle (M_COARSE) in the rib eye and *M. trapezius* were calculated as image analysis traits. Genetic parameters for these traits were estimated with the REMLF90 program using an animal model. Included in the model were herd-year-season and birthplace as fixed effects, age at the beginning of the fattening period as a covariate, and random animal genetic effects. Pedigree records were traced back four generations, and the number of animals in the pedigree file was 7,476. For growth traits, the heritability estimates were 0.65, 0.77 and 0.54 for IBW, FBW and ADG, respectively. For the rib eye and *M. trapezius*, the heritability estimates for image analysis traits were 0.09~0.59 and 0.11~0.74. Genetic correlations between IBW and image analysis traits (MAREA, FATPER, O_COARSE and M_COARSE) were 0.35, -0.10, 0.29 and .028 for the rib eye and 0.32, -0.12, 0.08 and 0.02 for *M. trapezius*, respectively. Genetic correlations between ADG and the above image analysis traits were 0.54, 0.15, 0.56 and 0.79 for the rib eye and 0.43, -0.02, 0.24 and 0.09 for *M. trapezius*, respectively.

Key Words: Japanese Black, Growth traits, Image analysis

T15 Genetic parameters estimation of birth weight for cashmere goat in southern Khorasan province of Iran. H. Naeemipour*, H. Farhangfar, and M. R. Asghari, *Birjand University, Birjand, Iran*.

A total of 524 birth weight records obtained from cashmere goat in southern Khorasan province during 2000 - 2003 was used to estimate

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genetic parameters. The number of kids was 524 representing 21 sires and 230 dams. A set of univariate animal models including additive and maternal genetic effects and maternal permanent environmental effect (as random effects) as well as the fixed effects of year and month of birth, sex, birth type and covariate of dam age (up to quadratic order) were utilized. Variance and covariance components were estimated by restricted maximum likelihood procedure using Powel algorithm applied in DFREML software. The results obtained at the present research showed that the effect of maternal permanent random effect contributed a significant part of total variance for birth weight. For the birth weight trait, model six, in which all random effects were included, was recognized as the best model. Based upon the model six, direct and maternal heritabilities were found to be 0.09 and 0.05 respectively. The ratio of permanent maternal variance to total variance was 0.12 and genetic covariance between direct and maternal effects was 0.01.

Key Words: Goat, Genetic parameters, Birth weight

T16 Genetic analysis of weight records at different ages in Baluchi sheep breed of Iran. M. Mollaei¹, H. Farhangfar*², and H. Naeemipour², ¹*Zabol University, Zabol, Iran*, ²*Birjand University, Birjand, Iran*.

A total of 19813 weight records belonging to Baluchi sheep breed of Iran was used to estimate genetic parameters. The traits were birth weight, weaning weight, weight at ages 6, 9, and 12 months, average daily gain at age interval 0-3 and 3-6 months. Genetic and environmental variance and covariance components were estimated by REML method. In order to estimate genetic parameters total six different models were applied. For birth weight and weaning weight, model 2 (additive genetic + maternal permanent environment) was considered to be more appropriate than the other models. The estimates of ht₂, c₂ were 0.058 ± 0.018 and 0.212 ± 0.017 for birth weight and 0.0254 ± 0.0197 and 0.086 ± 0.017 for weaning weight respectively. The best model for the weight at age 6, 9, 12 months was model 1 and the estimates of ht₂ were 0.0423 ± 0.0211, 0.055 ± 0.03, and 0.0549 ± 0.033 respectively. For average daily gain at age 0-3 months, model 2 was more appropriate and the estimates of ht₂, c₂ were 0.0273 ± 0.02 and 0.0844 ± 0.017 respectively. For average daily gain at age 3-6 month model 5 (additive genetic + maternal genetic + permanent environment) was more appropriate and the estimates of ht₂, hm₂ and c₂ were 0.0358 ± 0.012, 0.0099 ± 0.018 and 0.0009 ± 0.08 respectively. The genetic and phenotypic correlations among weight at different ages were also estimated using model 6 (additive genetic + maternal genetic + permanent environment + covariance between additive and maternal genetic effects). The genetic correlations were all positive and ranged between 0.32 and 1.00. The phenotypic correlations were positive and ranged between 0.25 and 0.8.

Key Words: Baluchi sheep, Variance-covariance components, Genetic and phenotypic correlations

T17 Estimation of genetic parameters for weight at different ages in Lori-Bakhtiari sheep breed of Iran. B. Zinvand² and H. Farhangfar*¹, ¹*Birjand University, Birjand, Iran*, ²*Zabol University, Zabol, Iran*.

To estimate genetic parameters for weights at ages 0 (birth), 3 (weaning), 6, 9, and 12 (in month) as well as average daily gains at age interval 0-3 and 3-6, a total of 7038 weight records belonging to 1940 lori-bakhtiari sheep breed of Iran was used. The results of analysis

of variance (GLM) showed that sex, birth year-season and lamb age were significant statistically. Total six different models were applied to estimate genetic parameters using REML statistical method. For birth weight model 2 (additive genetic + maternal permanent environment) was considered to be more appropriate than the other models. The estimates of h^2 , c^2 were 0.19 ± 0.05 and 0.273 ± 0.03 respectively. For weaning weight as well weight at age month 6, model 5 (additive genetic + maternal genetic + permanent environment) was considered to be the best model. The estimates of h^2 , hm^2 and c^2 were 0.009 ± 0.003 , 0.1 ± 0.03 and 0.07 ± 0.003 respectively. The corresponding estimates for weight at age month 6 were 0.1 ± 0.05 , 0.031 ± 0.005 and 0.03 ± 0.005 respectively. The best model for weight at age month 9 was model 6 (additive genetic + maternal genetic + permanent environment + covariance between additive and maternal genetic effects) and the estimates h^2 , hm^2 , c^2 were 0.09 ± 0.05 , 0.05 ± 0.02 , 0.313 ± 0.05 respectively. For weight at age month 12 and average daily gain (0-6), model 1 was found to be the best and the estimates of h^2 were 0.17 ± 0.08 and 0.153 ± 0.06 respectively. For average daily gain 0-3 model 5 was the best model and the estimates of h^2 , hm^2 and c^2 were 0.016 ± 0.06 , 0.1865 ± 0.03 and 0.0394 ± 0.04 respectively.

Key Words: Lori-bakhtiari sheep, Variance-covariance components, Genetic parameters

T18 Genetic analysis of average daily gains in Lori - Bakhtiari sheep breed of Iran using orthogonal legendre polynomials. H. Farhangfar^{*1}, H. Naeemipour¹, M. Zinvand², and M. Hosseini¹, ¹Birjand University, Birjand, Iran, ²Zabol University, Zabol, Iran.

A random regression model including fixed effects of year-season of birth, sex, birth type, dam age and random effects of direct, maternal additive genetic and permanent environment was used to estimate (co)variance components, heritabilities, and additive genetic correlations among average daily gains using a total of 10876 records belonging to 1828 lambs born between 1995 and 2001 in a single large-size flock of Lori-Bakhtiari sheep breed of Iran. Records for lambs were taken as repeated measurements and also a single measurement error variance was also assumed to be constant for all age groups. Orthogonal legendre polynomial regression order 4 was used to model the genetic and permanent environmental (co)variances structure throughout the growth trajectory. Direct and maternal heritability estimates of average daily gains ranged from 0.011 to 0.131 and 0.008 to 0.181 respectively in which pre-weaning average daily gain (0-3) had the lowest and highest direct and maternal heritability estimates among the other age groups.

Key Words: Average daily gain, Random regression, Lori-bakhtiari sheep breed

T19 Genetic analysis of weight records in Zel sheep breed of Iran. A. Vafadar^{*1}, H. Farhangfar², and H. Naeemipour², ¹Zabol University, Zabol, Iran, ²Birjand University, Birjand, Iran.

In this research a total of 4002 weight records obtained from 1767 lambs of Zel breed was used to estimate genetic parameters. The number of flocks was 18 in Mazandaran province of Iran. The fixed environmental factors including flock, year and season of lambing, sex and birth type were statistically significant on weight records at all ages (0,3 and 6 months). (CO)variance components of direct and maternal genetic effects, maternal permanent effect and residual were estimated by REML method by using 6 different model based upon

including or excluding random effects. For birth weight using model 5 (including direct and maternal genetic, and maternal permanent effects) the estimated direct and maternal heritability were 0.0001 and .098 respectively. The corresponding estimates for weight at age 3 were found to be 0.004 and 0.2 respectively using model 6 (as the model 5 plus covariance between direct and maternal genetic effects). The heritability of weight at age 6 was 0.26 as the model 1 (including only direct genetic effect) was applied.

Key Words: Zel breed, Genetic parameter, Growth traits

T20 Correlation of DGAT1 genetic variants with fat content in the Cal Poly Herd. A. Laubscher^{*1}, S. Henderson¹, J. F. Medrano², G. Rincón², and R. Jiménez-Flores¹, ¹California Polytechnic State University, San Luis Obispo, ²University of California, Davis.

The selection of dairy cattle is dictated by improvement of yield and composition of milk. Genotyping tests give breeders the opportunity to use previously unavailable information to increase the frequency of beneficial alleles in their herds. DGAT1 catalyzes the last step in triglyceride biosynthesis. We have analyzed a polymorphisms in exon VII of the DGAT1 gene that produces a K232A substitution (lysine to alanine amino acid change) in the protein. This mutation has been associated with milk production traits and has a significant effect on milk fat content. The two nucleotide polymorphisms in exon VII (AA → GC) give rise to an MwoI restriction fragment length polymorphism (RFLP). The genotype AA of the DGAT1 gene seems to be associated with higher milk fat content. The objective of this study was to examine the association of DGAT1 genotypes with fat content in the Cal Poly Herd. 232 blood samples from 109 Holstein and 123 Jersey cows were analyzed. DNA was extracted from 200 μL of blood using the MoBio Blood Spin Kit. Samples containing 50 ng of DNA were PCR amplified in a total volume of 25 μL for 35 cycles at 94°C, 58°C and 72°C for 30 s at each temperature. A 285 bp fragment from exon VII to intron VIII of the DGAT1 gene was amplified and digested with 5 units of MwoI. Digestion products were separated by electrophoresis on a 3.5% agarose gel stained with ethidium bromide. Comparing the breed difference, the genotype distributions for Holsteins were .06 (AA), .41 (AG) and .53 (GG) (frequency of A=.265, G=.735) vs Jerseys .19 (AA), .49 (AG) and .32 (GG) (frequency A=.435, G=.565). Genotype frequencies were in Hardy-Weinberg equilibrium for both breeds. Our results confirmed that allele A has a significant effect increasing milk fat content in Holstein and Jersey cows as shown in the table below. In addition we detected a significant difference in the phospholipid content between different genotypes.

Table 1. 305-day average % milk fat content in Holstein and Jersey cows in relation to DGAT1 genotypes

Breed	N	AA	AG	GG
Holstein	55	3.7	3.4	3.3
Jersey	60	4.7	4.4	3.9

Key Words: DGAT1, Fat%, Genotyping

T21 Bioinformatics analysis of bovine neuropeptides. A. N. Tegge^{*}, B. R. Southey, A. Andinet, J. V. Sweedler, and S. L. Rodriguez-Zas, University of Illinois, Urbana.

Neuronal communication relies on the release of chemical messengers, or neurotransmitters. Neuropeptides are relatively large neurotransmit-

ters (typically 3 to 39 amino-acids long) that tend to modulate slower, ongoing synaptic functions and activity in the brain or in peripheral target tissues. Using the bovine central nervous system, several studies have reported the effects of neuropeptides on fertility, feed intake, growth (e.g. neuropeptide Y), and milk production (e.g. oxytocin). Neuropeptides are synthesized from larger proteins called prohormone precursors, with the peptides formed from the precursors via a number of enzymatic processing steps. The cleavage of neuropeptides from the prohormone precursors by prohormone convertases is a complex process influenced by multiple factors and the availability of experimental data on bovine neuropeptides is variable. The objective of this study was to integrate the recently available bovine genome sequence, experimental and sequence information from other species and bioinformatics tools to identify prohormone cleavage sites and neuropeptides in the bovine. A total of 27 prohormone sequences were compiled and a logistic regression model based on sequence and experimental information from bovine and other mammals available in NeuroPred (<http://neuroproteomics.scs.uiuc.edu/neuropred.html>) was used to predict cleavage. The average number of neuropeptides per prohormone was 2.4, and ranged from 1 to 9. Of the reported cleavages, 68 cleavages were predicted and 16 cleavages were missed meanwhile 35 non-reported cleavages were predicted. These results suggest that the model offers an adequate description of the bovine prohormone processing. Further comparison of the observed and predicted cleavages indicates that our bioinformatics approach can be used to identify prohormone regions likely to harbor neuropeptides and thus aid the experimental verification.

Key Words: Neuropeptide, Prohormone, Bioinformatics

T22 The allele and genotype frequencies of bovine pituitary-specific transcription factor and leptin genes in Iranian cattle and buffalo populations using PCR-RFLP. A. Javanmard^{*1}, N. Asadzadeh², M. H. Banabazi³, and J. Tavakolian³, ¹*West and North-West Agriculture Biotechnology Research Institute (ABRII-T), TABRIZ, East Azarbyjan, Iran*, ²*Department of Animal Production and Management, Animal Science Research Institution of Iran (ASRI), Tehran, Karaj, Iran*, ³*Department of Biotechnology, Animal Science Research Institution of Iran (ASRI), Tehran, Karaj, Iran*.

The use of polymorphic markers in breeding program could make selection more accurate and efficient. A total of 324 individuals from six Iranian cattle populations (Sarabi, Golpayegani, Sistani, Taleshi, Mazandarani, Dashtiyari), F1 Golpayegani x Brown Swiss and Iranian buffalo populations were genotyped for the Pit-1 *Hinf*I and leptin *Sau*3AI polymorphisms by the polymerase chain reaction and restriction fragment length polymorphism (PCR-RFLP). The genotype and gene frequencies for each breed were determined and shown to be quite variable among the breeds. The highest frequencies of allele B for the leptin gene and allele A for the Pit-1 gene were found in Dashtiyari and Sistani cattle, respectively. According to our results, the highest AB genotype frequencies were found in the Taleshi and F1 Golpayegani x Brown Swiss cross for the leptin and Pit-1 genes, respectively. These allele frequencies were comparable to previously published data on exotic breeds. The highest and lowest heterozygosities were found in Taleshi and Dashtiyari cattle for the leptin gene and in F1 Golpayegani x Brown Swiss cross and Sistani cattle for the Pit-1 gene, respectively. The possible association between molecular polymorphisms within these candidate genes and economic traits for the studied populations should be further investigated.

Key Words: Pit-1, Leptin, PCR-RFLP

T23 Polymorphism of bovine lymphocyte antigen DRB3.2 alleles in Iranian Holstein cattle. M. Pashmi^{*1}, A. Salehi¹, A. Ghorash², M. R. Mollasalehi³, and A. Javanamrd⁴, ¹*Department of Animal Science, University of Tehran, Aborahan, Tehran, Iran*, ²*National Research Center for Genetic Engineering and Biotechnology, Tehran, Tehran, Iran*, ³*National Animal Breeding Center, Karaj, Iran*, ⁴*North West and West Agriculture Biotechnology Research Center (ABRII), Tabriz, Iran*.

Breeding goals for dairy cattle have focused mainly on increasing productivity and have ignored disease resistance. Molecular techniques have been developed for identification of bovine genes responsible for production traits and host immunity. In addition, these techniques have been used to clarify the potential association of bovine major histocompatibility (MHC) or bovine leukocyte antigen (BoLA) alleles with disease resistance and production. In this study polymorphism of the second exon of BoLA-DRB3 gene of 96 Iranian cattle was investigated. Genomic DNA extracted from whole blood samples and two-step polymerase chain reaction (PCR) was carried out in order to amplify a 284 bp fragment of target gene. Nested-PCR products were digested with three restriction endonucleases *Rsa*I, *Bst*YI and *Hae*III. Digested fragments were analyzed by Polyacrylamid gel electrophoresis. Twenty-two BoLA-DRB3 alleles were distinguished with frequencies ranging from 0.5 to 19.3%. Identified alleles include: BoLA-DRB3.2*3, *6, *7, *8, *9, *10, *11, *12, *13, *14, *15, *16, *20, *21, *22, *23, *24, *25, *27, *28, *32 and *51. Their frequencies found to be 2.6, 2.6, 1.0, 13.5, 0.5, .05, 13.0, 1.6, 1.6, 0.5, 2.6, 14.1, 0.5, 1.6, 7.3, 5.2, 19.3, 2.1, 2.1, 1.6, 0.5 and 5.7% respectively. The most frequent alleles (BoLA-DRB3*8, *11, *16, *22 and *24) accounted for 67.2% of the observed alleles. Results of this study indicate that BoLA-DRB3 locus is highly polymorphic among tested Animals.

Key Words: Bovine leukocyte antigen (BoLA), Polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP), Iranian Holstein cattle

T24 Estimation of genome wide haplotype effects in half-sib designs. D. Kolbehdari^{*1,2}, L. R. Schaeffer², and J. A. B. Robinson², ¹*University of Tehran, Tehran, Iran*, ²*University of Guelph, Guelph, Ontario, Canada*.

Methods of scoring haplotype transmission in half-sib designs combined with linear mixed haplotype model were proposed to locate and estimate QTL effects within a 100 cM region of DNA. Precision, average of absolute effects of haplotypes, and correlation between estimated and true breeding values were used to compare scenarios via Monte Carlo simulation of granddaughter designs. Factors studied were the size of QTLs, heritability of quantitative trait, and the positions of QTL. Markers and QTLs were assumed to be bi-allelic. One hundred equally spaced markers (1 cM) with ten QTLs located between markers were simulated. Marker haplotypes were constructed for each pair of contiguous markers. Scores were used to indicate haplotype transmission from sire to son based on marker haplotypes. The scores were used in a linear mixed model across the population. The linear mixed haplotype model was successful model to estimate and locate effects of QTL in granddaughter designs. QTLs of equal magnitude gave slightly higher precision than QTLs of unequal size. Correlations between estimated and true breeding values ranged from 0.72 to 0.85. The linear mixed haplotype model could be used to estimate QTL positions and effects within intervals of 1 cM.

Key Words: Haplotype effects, QTL mapping, QTL detection

T25 Genetic diversity in piracanjuba populations *Brycon orbignyanus* with the random amplified polymorphic DNA (RAPD) markers. N. M. Lopera Barrero*¹, R. P. Ribeiro¹, R. N. Sirol², J. A. Povh¹, P. Gomes¹, L. Vargas¹, and D. P. Streit Jr.¹, ¹*Universidade Estadual De Maringá, Maringá, Paraná, Brazil*, ²*Duke Energy International, Geração Paranapanema, Salto Grande, São Paulo, Brazil*.

Brycon species are the most important local fishing source, wherever found, and therefore, are seen as having great economical value. Based on the amplification of genomic DNA by PCR (Polymerase Chain Reaction) with arbitrary nucleotide sequence primers, RAPD can detect high levels of DNA polymorphisms and can produce fine genetic markers. Nowadays, the main concern of researchers and scientific studies, regarding genetics and improvement of fish lineage in Brazil, has been directed to the organization and characterization of genetic banks to study native populations. In order to contribute to restock programs and deeply understand the framework of the piracanjuba *Brycon orbignyanus* the genetic divergence and variability of these stocked populations were estimated by using the RAPD markers. The population of piracanjuba reproducers from Castilho (São Paulo - Brazil) and Porto Ferreira (São Paulo - Brazil) and their offspring were evaluated. Jaccard's similarity coefficient matrix was used in order to elaborate a dendrogram, and the genetic divergence among populations was determined by Mantel's test. The genetic variability was estimated by using both Shannon's index and the polyphormic loci percentage. The genetic divergence in Castilho's population (0.1551) and its offspring (0.1889) and the genetic variability (Shannon's index: 0.3184 in Castilho's population and 0.3433 in offspring; polyphormic loci percentage: 54.02% and 57.47% respectively) were similar, indicating that the control of non-intentional selection was efficient in maintaining reproducers genetic diversity. Porto Ferreira's population showed similar values of genetic divergence (0.1987 and 0.1970) and variability (Shannon's index: 0.3687; polyphormic loci percentage: 58.62%) to Castilho's population and its offspring respectively, therefore, the values of genetic divergence and genetic variability remained uniform, which means that, basically, there was no populations or progeny genetic changes, despite being geographically separated one from the other.

Key Words: Fish, Genetic divergence, Genetic variability

T26 Handling inbreeding and overlapping generations within QTL-mapping. G. Freyer¹ and N. Vukasinovic*², ¹*Research Institute for the Biology of Farm Animals (FBN), Dummerstorf, Germany*, ²*Monsanto Animal AG, St. Louis, MO*.

Approaches of QTL- mapping which are able to deal with complicated pedigrees in dairy cattle such as inbreeding and overlapping generations have hardly been reported so far. Most designs ignore such relationships within a pedigree, simplifying computations but also losing power of QTL detection. A more precise QTL- estimate is expected when inbreeding is accounted for as it occurs. A four-generational pedigree originating from two unrelated great-grand sires was simulated. One of them produced itself 52 out of 420 final offspring, therefore creating a pedigree with overlapping generations. Three different pedigree structures were considered: (a) without inbreeding, (b) with mild inbreeding, where one sire originates from a aunt-nephew-mating, (c) containing a highly inbred sire, originating from a halfsib- mating. These pedigree structures were intended to mimic structures common in dairy populations. In (b) and (c) the number of offspring from

an inbred sire was > 18%. A single QTL explaining 15% of the phenotypic variance was simulated. QTL mapping was considered within a chromosomal segment of 55 cM covered by 11 markers, carrying 2, 4, or 6 alleles, with fine mapping-like marker density around the QTL position for four marker maps. QTL analysis was conducted using varying amount of information content within the data. All analyses were performed by maximum likelihood techniques, mainly by extending the method for calculating identical-by-descent (IBD)- probabilities by Pong Wong et al. (2001) and ASREML. The most precise estimates of QTL location were obtained from the pedigree with mild inbreeding. High level of inbreeding often caused computation problems, likely because of high correlations of IBD values among inbred animals. The results show that taking into account inbreeding and overlapping generations in complicated pedigrees, especially if coupled with increased map density and marker polymorphism, leads to more precise estimates of QTL position and higher power of QTL detection. The benefits of improved precision of QTL mapping are likely to exceed increased computation costs associated with considering all relationships in a pedigree.

Key Words: QTL mapping, General pedigree analysis, Inbreeding

T27 Comparison of the performance of two-dye microarray platforms to characterize gene expression patterns. S. L. Rodriguez-Zas*, R. E. Everts, B. R. Southey, J. K. Drackley, J. J. Looor, and H. A. Lewin, *University of Illinois, Urbana*.

Microarray technology is a well-established tool to simultaneously measure the expression of thousands of mRNA sequences. The objectives of this study were to compare the performance of bovine cDNA and long-oligonucleotide spotted microarray platforms, and to evaluate the impact of various sources of variation. The two platforms considered were a double spotted 7,872 element cDNA array (NCBI GEO GPL2864) and a double spotted 13,257 element long (70-mer) oligo array (NCBI GEO GPL2853). Two experiments using liver biopsies from multiparous cows at 14 DIM in a reference microarray design with reverse labeling were analyzed. The gene expression data were filtered, normalized and described using a mixed effects model including the effects of dye, treatment (ketosis and control), cow, and array. The estimates and significance probability values of 4,791 elements with one-to-one matches between platforms and the ability of selected probes to detect reported differential expression were evaluated. In the first experiment, the correlation between microarrays with reverse labeled samples ranged between 0.93 and 0.95 for the cDNA microarray and between 0.83 and 0.85 for the oligo microarray. The correlation between the log₂ sample-to-reference ratio estimates between platforms ranged from 0.70 to 0.75 in both experiments and increased when elements with high differential expression were considered. The estimates of the log₂ ratios within experimental treatment level from the oligo platform were more dispersed than the estimates from the cDNA platform, however the estimates of the log₂ ratios across treatment levels studied were consistent across platforms. These results indicate that the oligo elements may be more sensitive to variations in gene expression intensity across the conditions studied. The results from selected oligo-probes were more consistent with reported values than the results from the corresponding cDNA-probes.

Key Words: Microarray, cDNA, Mixed model

T28 Relationship between calpastatin gene polymorphism and beef cattle growth, carcass and meat quality traits. L. Suguisawa, A. A. Souza*, H. N. Oliveira, A. C. Silveira, and R. A. Cury, *São Paulo State University, Brazil.*

The Calpastatin polymorphism was associated with performance and meat quality traits, by Chung et al. (2001) methodology, in 300 bullocks. To validate this finding, we looked at a group of animals (126 Angus Nellore, 10 Angus, 18 Brangus, 24 Simmental Nellore, 12 Simmental, 11 Simbrasil, 17 Santa Gertrudes Nellore, 18 Brown Swiss x Nelore, 12 Canchim, 16 Brahman Nellore and 36 Nellore). The animals were weaned at 7 months old at the creep-feeding and raised at the feedlot system for 120 days. The animals were harvested with 450 kg live weight, 3 millimeters of ultrasound fat thickness and 12-15 months old age. The gene polymorphism was analyzed by PCR-RFLP. The animals were classified at three genotypes forms: AA, AB and BB. The higher frequency of AA genotype was from Angus Cattle. Nevertheless, the higher frequency of BB genotype was from Nellore and Brahman Nellore cattle. The genotypes effects on traits were analyzed by General Linear Model of SAS and the Least Square Means of the genotypes were compared by Tukey test. The model included genotype, genetic group x year of feedlot x ranch and interactions. The collected growth traits were: initial and final live weight, average daily gain, ultrasound ribeye area, ultrasound fat thickness and ultrasound rump fat thickness. The collected carcass and meat traits were: dressing percentage, hot carcass weight, carcass ribeye area, carcass fat thickness and Warner Bratzler shear force. Because almost all genetics groups of this research were Zebu crossbreed, these animals could have high Calpastatin quantity. Despite of that, there were not found any relationship between any Calpastatin genotypes and all traits evaluated. The lack of effects of this Calpastatin gene polymorphism indicates that this polymorphism could not be used as a selection tool for improving Animal Breeding.

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Key Words: Calpastatin gene, Meat quality, Cattle growth

T29 Corn oil or Corn grain supplementation to forage-finished steers. IV. Effects on gene expression of lipogenic enzymes in the s.c. adipose tissue. E. Pavan*^{1,2}, S. Joseph¹, K. Robbins¹, S. Duckett³, and R. Rekaya¹, ¹University of Georgia, Athens, ²INTA, Balcarce, Bs. As., ³Clemson University, Clemson, SC.

Samples of s.c. fat were obtained from 28 Angus steers after slaughter to determine the effect of energy supplementation of steers grazing tall fescue pastures. Steers (n = 8/ treatment; 289 ± 3.8 kg) were supplemented with either corn grain (0.52% BW; PC) or soybean hulls plus corn oil (0.45% BW + 0.10% corn oil; PO). Negative (pasture only; P) and positive (85% concentrate/15% roughage; C) controls were also included in the study. RNA was extracted from the s.c. adipose tissue using TRIzol reagent (Gibco Invitrogen Corp.). RNA from each treatment was pooled (10 µg/steer) and five replicates from the same RNA pool were used for microarray hybridization. GeneChip Bovine Genome array (Affymetrix) was used for hybridization of the extracted mRNA's according to the Affymetrix protocol. The data was normalized and analyzed using a simple linear (ANOVA) model. Treatments effects were compared using non-orthogonal contrasts between all possible comparisons, the Benjamini and Hochberg method of false discovery rate (FDR) was used to control the experimentwise error rate. Genes were identified as being differentially expressed using a FDR of 0.05. At a FDR of 0.01 a total of 89, 39 and 1133 genes were detected to be differently expressed between P and PO, P or C, respectively, 757 and 113 between C and PO or PC, and 183 between PO and PC. Lipoprotein lipase was differently ($P < 0.01$) expressed between PO and C and acetyl-coA carboxylase ($P < 0.01$) between P and C. Fatty acid synthase was differently expressed ($P < 0.01$) between C and either P or PO. Stearoyl-coA desaturase was differently expressed ($P < 0.01$) between PC and P, C or PO and between C and P, whereas did not differ (FDR > 0.05) between PO and either P or C. The gene encoding the soluble form of isocitrate dehydrogenase was differently expressed ($P < 0.01$) between PO and P, PC and C as well among C and either PC or P. The expression of glycerol phosphate acyltransferase differ ($P < 0.01$) between all comparison evaluated. Gene expression of the adipocyte lipogenic enzymes from beef steers may be manipulated through diet.

Key Words: Bovine, Lipogenic enzymes, Gene expression

Companion Animals: Nutrition & Health

T30 Identification of canine markers related to obesity. R. Yamka* and K. Friesen, *Hill's Pet Nutrition, Inc., Topeka, KS.*

Thirty lean and thirty obese neutered/spayed beagles (average age = 7.5 ± 0.7 years) were identified for this study. Fifty percent of the dogs were female (15 lean and 15 obese) and fifty percent were male (15 lean and 15 obese) in order to determine if gender played a role in marker differences. Animals were weighed, given a body condition score (1=lean, 3=ideal and 5=obese) and a blood sample was drawn. Average body condition scores were 4.7 and 2.5 for the obese and lean groups, respectively. Average body weights were 17.3 ± 0.4 and 11.2 ± 0.4 kg for the obese and lean groups, respectively. Serum was analyzed for chemistry screens, obesity markers, thyroid markers and arthritis markers. The obese group had higher levels of alkaline phosphatase ($P = 0.04$), cholesterol ($P = 0.04$), triglycerides ($P = 0.06$), total protein ($P < 0.01$), albumin ($P < 0.01$), thyroxine ($P = 0.05$), calcium ($P < 0.01$), phosphorous ($P = 0.04$), glucose ($P < 0.01$), insulin ($P < 0.01$), insulin like growth factor-1 ($P < 0.01$), low density lipoprotein (P

< 0.01), leptin ($P < 0.01$) and type 2 cartilage synthesis ($P < 0.01$). The obese group had lower levels of creatinine ($P = 0.01$), serum urea nitrogen ($P < 0.01$), chloride ($P < 0.01$) and obese males had lower levels of testosterone ($P = 0.04$). These data indicate that obesity is directly related to other disease states in dogs (i.e. dyslipidemia, arthritis and diabetes). Thus, managing obesity through weight loss and/or calorie restriction may alleviate or prevent the differences observed between lean and obese blood markers.

Key Words: Canine, Obesity, Marker

T31 Identification of feline markers related to obesity. R. Yamka* and K. Friesen, *Hill's Pet Nutrition, Inc., Topeka, KS.*

Thirty lean and thirty obese domestic short hair cats (average age = 7.4 ± 0.5 years) were utilized for this the study. Animals were weighed, given a body condition score (1=lean, 3=ideal and 5=obese) and a

blood sample was drawn. Average body condition scores were 4.2 and 2.5 for the obese and lean groups, respectively. Average body weights were 5.8 ± 0.2 and 3.2 ± 0.2 kg for the obese and lean groups, respectively. Serum was analyzed for chemistry screens, obesity markers, thyroid markers and arthritis markers. The obese group had higher levels of alkaline phosphatase ($P = 0.07$), triglycerides ($P = 0.05$), total protein ($P < 0.01$), albumin ($P < 0.01$), potassium ($P = 0.03$), magnesium ($P < 0.01$), sodium: potassium ($P = 0.02$), glucose ($P = 0.02$), leptin ($P < 0.01$) and thyroxine ($P = 0.02$). The obese group had lower levels of thyroid stimulating hormone ($P = 0.02$) and ghrelin ($P = 0.06$). These data indicate that obesity is closely related to other disease states in cats (i.e. dyslipidemia, diabetes and hyperthyroidism). Management of obesity may prevent the early onset of other diseases in cats.

Key Words: Feline, Obesity, Markers

T32 Impact of age on gene expression profiles of canine brain tissue. K. Swanson*, C. Apanavicius, B. Vester, and N. Kirby, *University of Illinois, Urbana.*

Many anatomical changes occur in brain tissue of aged dogs, many of which are correlated with decreased cognitive function. Factors responsible for these changes are largely unknown. To identify genes and biological pathways altered due to old age, gene expression profiles of brain tissue from healthy young adult and geriatric dogs were compared. Six geriatric (11 yr-old at baseline) and 6 weanling (8 wk-old at baseline) female beagles were randomly assigned to one of two diets and fed for 12 months: 1) Animal-protein based diet (APB; 28% protein, 23% fat, and 5% fiber); or 2) Plant-protein based diet (PPB; 26% protein, 11% fat, and 15% fiber). RNA was isolated from cerebral cortex tissue using Trizol and hybridized to Affymetrix GeneChip Canine Genome Arrays as per manufacturer's instructions. Following array normalization, data were analyzed using the mixed models procedure of SAS. Transcripts having a $P < 0.05$ (following a false discovery rate adjustment) and > 1.5 -fold change were considered significantly different among groups. 286 transcripts (corresponding to 74 up-regulated and 28 down-regulated genes) were differentially expressed in old vs. young dogs consuming the APB diet. Old vs. young dogs consuming the PPB diet had 281 differentially expressed transcripts (54 up-regulated and 44 down-regulated genes). Old dogs on both diets tended to have expression profiles indicative of inflammation, oxidative stress, or acute phase response. Genes associated with neuropeptide signaling (e.g., somatostatin, corticotropin-releasing hormone, neuropeptide Y, etc.) were also decreased in old dogs. The current study has identified numerous genes and pathways altered in aged brain tissue. These results may be used for future experiments focused on preventing or treating age-related cognitive decline via dietary intervention. This research was funded in part by the National Center for Supercomputing Applications and the University of Illinois, under the auspices of the NCSA/UIUC Faculty Fellows Program, and by Pyxis Genomics, Inc.

Key Words: Canine, Aging, Microarray

T33 Age impacts skeletal muscle gene expression profiles of young adult and geriatric dogs fed either an animal- or plant-protein based diet. L. Karr-Lilienthal*, C. Apanavicius, B. Vester, and K. Swanson, *University of Illinois, Urbana.*

Aging is associated with loss of muscle mass and increased oxidative damage, both having significant health implications. The objective

of this study was to measure gene expression differences in skeletal muscle of young adult and geriatric dogs. Six geriatric (11 yr-old at baseline) and 6 weanling (8 wk-old at baseline) female beagles were randomly assigned to one of two diets: Animal-protein based (APB; 28% protein, 23% fat, and 5% fiber) or Plant-protein based (PPB; 26% protein, 11% fat, and 15% fiber) for 12 months. RNA, isolated from skeletal muscle samples using Trizol, was hybridized to Affymetrix GeneChip Canine Genome Arrays as per manufacturer's instructions. Following microarray normalization, data were analyzed using the mixed models procedure of SAS. Transcripts having a $P < 0.05$ (following a false discovery rate adjustment) and > 1.5 -fold change were considered different among groups. Gene expression changes were noted in old dogs fed either APB (205 transcripts, corresponding to 115 identified genes) or PPB (415 transcripts; 216 identified genes). Regardless of diet, old dogs had decreased expression of genes associated with carbohydrate metabolism compared with young dogs. Old vs. young dogs fed APB had increased expression of genes associated with immunity and stress response and decreased expression of genes associated with energy and lipid metabolism and muscle contraction. While more genes were differentially expressed in dogs fed PPB, the responses were mixed. Increased expression of genes associated with signal transduction and nucleotide metabolism was noted. Overall, aging increased expression of stress response genes and decreased those associated with energy metabolism, many of which were most prominent in dogs fed APB. This research was funded in part by the National Center for Supercomputing Applications and the University of Illinois, under the auspices of the NCSA/UIUC Faculty Fellows Program, and by Pyxis Genomics, Inc.

Key Words: Canine, Aging, Microarray

T34 Diet impacts colonic gene expression profiles of young adult and geriatric dogs fed either an animal- or plant-protein based diet. B. Vester*, C. Apanavicius, L. Karr-Lilienthal, and K. Swanson, *University of Illinois, Urbana.*

We have previously reported diet-related differences in intestinal morphology and fermentative end product concentrations in geriatric and young dogs. Mechanisms responsible for these differences however are unknown. Thus, the objective of this study was to measure gene expression differences in the proximal colon of healthy young adult and geriatric dogs consuming two distinct dog foods. Six geriatric (11 yr-old at baseline) and 6 weanling (8 wk-old at baseline) female beagles were randomly assigned to one of two diets for 12 months: animal-protein based (APB; 28% protein, 23% fat, and 5% fiber) or plant-protein based (PPB; 26% protein, 11% fat, and 15% fiber). RNA was isolated from colon samples using Trizol and hybridized to Affymetrix GeneChip Canine Genome Arrays. Following normalization, data were analyzed using the mixed models procedure of SAS. Transcripts having a $P < 0.05$ and > 1.5 -fold change were considered different among groups. Diet manipulated gene expression in both young adult (144 transcripts) and geriatric dogs (166 transcripts). Colonic tissue of young dogs fed APB had a higher metabolic activity, with genes associated with carbohydrate metabolism being expressed in greater quantities than young dogs fed PPB. Sodium potassium transporters were increased in young dogs fed APB while unchanged in old dogs. Genes associated with neurotransmitter degradation (MAOA and MAOB) were decreased in old dogs and increased in young dogs fed APB. Dipeptidyl peptidase IV, a gene involved in the break-down of GLP-1 was increased in young dogs fed APB. This research was funded in part by the National Center for Supercomputing Applications and the University of Illinois, under the auspices of the NCSA/UIUC Faculty Fellows Program, and by Pyxis Genomics, Inc.

T35 Screening of epitopes of canine enteropathogenic viruses for the production of IgY. S.-E. Woo*¹, S.-O. Shin¹, J.-W. Kim², A.-R. Lee², S.-O. Shin², and S.-Y. Yang¹, ¹Danbiotech. Inc, Cheonan, Chungnam, Rep. of Korea, ²Dankook University, Cheonan, Chungnam, Rep. of Korea.

This study was carried out for the screening of epitope region of canine enteropathogenic viruses (CPV, CCV, CAV and CRV) for the production of IgY (egg yolk immunoglobulins). VP2, a part of the CPV (canine parvovirus) capsid protein, was expressed into 7 segments (pCPV2a through pCPV2g) with glutathione S-transferase fused pGEX 4T. The expressed proteins were immunoblotted with sera of CPV infected dog. It was revealed that the most immunoreactive regions were CPV2d, CPV2e and CPVsf. Results of neutralization test using rabbit antiserum, anti-CPV2e showed the highest neutralizing activity against CPV protein. CCV (canine coronavirus) spike protein was expressed into 6 segments (pCCVsa ~ pCCVsf) with pMAL vector. For the screening of epitope of CCV, the heterologous antisera against the 6 segments and spike protein were tested for neutralizing effect against CCV. CAV (canine adenovirus) fiber protein was expressed into 7 segments (pCAVfa~pCAVfg) with expression vector. For the screening of epitope of CAV, the heterologous antisera against the 7 segments and fiber protein were tested for neutralizing effect against CAV. CRV (canine rotavirus) VP4 was expressed into 9 segments (pCRVva~pCRVvi). For the screening of epitope of CRV, the heterologous antisera against the 9 segments and VP4 were tested for neutralizing effect against CRV. Selected epitopes of 4 viruses were expressed and immunized to laying hens for the production of specific IgY. All the antibody titers were detected after two weeks of immunization and reached the highest level (100,000~500,000) at 6 weeks after immunization, in general.

Key Words: IgY, Canine parvovirus, Canine coronavirus

T36 Comparison of yeast culture and brewers dried yeast as palatability enhancers in dry cat food. J. W. Jones*¹, B. Leiner¹, and H. M. Sullivan², ¹Western Yeast Company, Chillicothe, IL, ²New Mexico State University, Las Cruces.

Brewer's dried yeast is the preferred additive for increasing palatability in cat rations in the pet food industry. In this study, yeast culture (the dried product composed of yeast and the media on which it was grown) and brewers dried yeast (the dried non-fermentative, non-extracted yeast resulting as a byproduct from the brewing of beer and ale) were offered to cats to determine palatability preference. Yeast culture and brewer's dry yeast was included in a 32% protein, 20% fat cat food and offered to a panel of cats on two consecutive days. Twenty adult domestic long and short-haired cats with a median age of six were randomly assigned to the panel. Cats were housed at a commercial nutrition laboratory. The yeast products were added to the diets, prior to extrusion, at 1.25% of the ration dry matter. One hundred fifty grams of each ration was offered to the cats and bowl position was reversed daily to prevent 'left-right' bias. The brewer's dry yeast was approached first on 19 of 40 occasions, but only consumed first on 10 of those 40 occasions. Total daily consumption was not statistically different between the two yeast products with the yeast culture ration consumed an average of 22.25 ± 13.4 g day and the brewers yeast ration 27.05 ± 13.7 grams per day. Cats tended to consume more of the yeast culture ration per kg of body weight ($P = 0.08$). The brewer's dry yeast ration was consumed at 5.6 ± 2.55 g/kg of body weight and yeast culture ration at 7.58 ± 4.24 g/kg. Additionally, the yeast culture was preferred by 11 of the 20 cats based on total consumption. Total

daily consumption averaged 445.5 g for the brewer's dry yeast ration and 541 g for the yeast culture ration. In conclusion, there was no statistical difference between intake of cat food containing brewer's dry yeast and yeast culture, however, intake per kg of body weight tended to be higher for yeast culture.

Key Words: Feline, Nutrition, Yeast

T37 Characterization of strains of *Lactobacillus reuteri* as potential probiotics for dogs. S. McCoy* and S. E. Gilliland, Oklahoma State University, Stillwater.

Because of the need to control pathogenic microorganisms in the intestinal tract of dogs, there is interest in using probiotics such as species of *Lactobacillus* as dietary supplements. For successful use, the *Lactobacillus* species should be of canine intestinal origin since this species exhibits host specificity. Serial dilutions of freshly voided dog feces (from various breeds owned by laboratory personnel or their friends) were plated on Lactobacillus Selection (LBS) agar to isolate the cultures. Isolates were identified based on Gram stain, Catalase test, and fermentation patterns using API 50 CH kits. All potential isolates were compared for bile resistance based on relative ability to grow in broth containing 0.3% Oxgall, and for the ability to inhibit *Salmonella* Typhimurium in associative broth cultures. Of the lactobacilli isolated, *Lactobacillus reuteri* was the dominant species. We found variations among isolates of *L. reuteri* with respect to bile tolerance. There also were variations in the ability to inhibit growth of *S. Typhimurium*. The inhibition by *L. reuteri* may have been caused by the production of the anti-microbial substance, reuterin. Comparisons of the amount of reuterin produced were made and the isolate of *L. reuteri* that produced the most reuterin (X-18) also caused the greatest inhibition of *S. Typhimurium*. Further research has been done using isolate X-18 to determine stability of the chosen culture during frozen storage of pet food. After 35 days of frozen storage in pet food, there was approximately one-half log cycle decrease in CFU/gram of pet food. Stability during frozen storage is necessary for successful commercial adaptation of a culture for use as a probiotic in frozen dog food.

Key Words: Lactobacillus, Probiotics, Dogs

T38 Genetic differentiation by restriction fragment length polymorphism (RFLPs) in isolates of *Giardia* spp. in humans and dogs. S. C. Cota-Guajardo*¹, S. M. Gaxiola¹, J. J. Portillo¹, F. Juarez¹, and S. Velarde², ¹FMVZ-Universidad Autonoma de Sinaloa, Culiacan, Sinaloa, Mexico, ²Hospital Infantil Federico Gomez, Distrito Federal, Mexico.

Giardia spp is considerate one of the ancient eukaryotes. Its importance as a causative pathogen of diarrhea in humans has been mentioned by the World Health Organization (WHO). There is also information about the importance of *Giardia* spp as a causative diarea agent in dogs. Its zoonotic potential has been established using molecluar biology, discovering strains that can affect both humans and dogs. In order to differentiate *Giardia* spp. found in dog and human feces utilizing PCR techniques and Restriction Fragment Length Polimorphism (RFLPs) in the β -giardin gene, stool samples from dogs of different ages, breeds and both sexes from were collected in Culiacan, Sinaloa, in Mexico; likewise stool samples of children from 45 days to 3 years old, both sexes, were collected from two child care centers located in the above mentioned city. Stool samples from adults and children from the same city were also collected. The samples were analyzed using the zinc

sulfate flotation technique. Samples in which *Giardia* spp cysts were present were considered positive. PCR of the β -giardin gene was performed on 40 positive samples each of humans and dogs, obtaining 24 and 20 amplified of each origin respectively. RFLPs were obtained by digesting the amplified with *Hae III* nuclease in two percent agarose gels. Regarding the obtained RFLPs of each species, it was possible to demonstrate the existence of two different strains of *Giardia* spp., of which one of them had the same pattern for both humans and dogs. It is concluded that, in Culiacan, Sinaloa, Mexico, humans and dogs share at least one causative diarrhea strain of *Giardia* spp., suggesting the possibility of cross-transmission.

Key Words: *Giardia*, PCR technique, β -giardin gene

T39 Presence of eggs *Toxocara* spp. in soil of public parks in Culicán, Sinaloa. M. C. Rubio Robles*, S. M. Gaxiola camacho, N. Castro del Campo, B. N. Verduzco, and M. N. López, *Universidad Autonoma de Sinaloa, Culiacan, Sinaloa, México.*

Toxocariasis is a zoonotic infection caused by the parasitic *Toxocara* spp. commonly found in the intestine of dogs and cats. Disseminated for defecate in parks and public areas. Toxocariasis can result in a condition known as visceral and or ocular larval migrans, which is associated with inflammation of body organs and or the central nervous system. Symptoms of which are caused by the movement of the worms

through the body, include fever, coughing, asthma, or pneumonia. Toxocariasis most often occurs in children, who often play or eat (pica) dirt that potentially is contaminated with *Toxocara* spp. eggs. The eggs of *Toxocara* spp. are extremely resistant to adverse environmental conditions, capable of surviving in soil for many months. The objective of the work was to determine the presence of eggs of *Toxocara* spp. in the soil of the children play area in public parks of the city of Culiacan, Sinaloa. Egg presence was determined by means 291 soil samplings in 23 public parks of the city. Established by random stratified samplings, and collecting soil samples using the technique of double W; We took surface soil scraping of 100 grams of earth for each sample and deposited it in previously identified plastic bags. The samples were later transferred to the laboratory of parasitology of the FMVZ-UAS to be analyzed by means of the sedimentation and flotation techniques. The samples indicate that of the 23 parks analyzed 13 (54%) contained eggs of *Toxocara* spp.; We conclude that the contamination with eggs of *Toxocara* spp.; shows up in a percentage in the area of children play areas in the public parks of the city of Culiacan, Sinaloa. Knowing the danger this parasite represents for the public health, indicates to us the risk to which are exposing especially our children, mainly if they frequently use these recreation places. Therefore the necessity arises of implementing control strategies and education for the prevention of the infections by fecal origin in public parks.

Key Words: *Toxocara*, Public parks, Parasites

Dairy Foods: Chemistry and Microbiology

T40 Partition coefficients for toxic agents in multiple phase foods: Separation of raw whole milk. J. E. Schlessner¹, J. E. Jablonski¹, and P. Mariappagoudar², ¹*FDA, National Center for Food Safety, Summit, IL*, ²*Illinois Institute of Technology, National Center for Food Safety, Summit, IL.*

Contamination of milk with toxic compounds may be accidental or intentional. Since milk consists of skim milk and cream phases, it is of interest to determine into which phase the toxin will partition. Aconitine, nicotine and strychnine were chosen as model toxin contaminants. An HPLC method for analysis of aconitine, nicotine, strychnine from milk products was developed. Sample clean up techniques consisted of liquid-liquid partitioning (hexane/water-acetonitrile), solid phase extraction (OASIS HLB), and manipulation of pH of sample to avoid volatility and hydrolysis losses. Analysis was conducted with an HPLC with dual band UV detector. Nicotine and strychnine levels were measured at 260nm and aconitine at 232nm. Centrifugation of whole milk was used to simulate commercial separation. Whole milk was placed into 50 ml centrifuge tubes, spun for 30 minutes at 2000 x g and 5°C. Skim milk from tubes were decanted and mixed. Cream layer adhering to the side of bottles was dissolved and mixed together. The mixed samples were used for fat testing or if spiked, for testing of toxins. Centrifugations were conducted at 30 minutes and 5 days after spiking to simulate contamination in the plant and on the farm, respectively. Mean recoveries for the three analytes in skim milk, whole milk and cream ranged from 72.1% to 89.2%. Centrifugation of 3.25% whole milk resulted in a fat content of 39.5% and 0.07% for cream and skim milk

respectively. Whole milk was spiked with 1 ppm of each of the three toxins. Aconitine, nicotine and strychnine were found in both cream and skim milk streams. Initial partition coefficient for aconitine was 0.769 in cream, and increased to 1.121 by day 5. Initial partition coefficient for nicotine was 0.49 in cream, and increased to 0.761 by day 5. Initial partition coefficient for strychnine was 1.064 in cream, and increased to 1.135 by day 5. Between day 0 and day 5, partition coefficients for the toxic compounds in skim milk decreased.

Key Words: Aconitine, Nicotine, Strychnine

T41 Modelling of the high-pressure and temperature induced pH change in whey protein isolate solutions. H. Hernández-Sánchez¹, J. O. Rodiles-López¹, M. E. Jaramillo-Flores¹, and G. V. Barbosa-Cánovas², ¹*Depto. Grads. Alimentos, Escuela Nacional de Ciencias Biológicas, Instituto Politecnico Nacional, Mexico, DF, Mexico*, ²*Washington State University, Pullman.*

High hydrostatic pressures (HHP) can lead to greater ionization in certain biological systems resulting in a temporary decrease in pH while under pressure. It has been reported that in some cases, the HHP-induced denaturation of whey proteins is decreased when the pH during the treatment is less than 7. The objective of this study was to evaluate and model the effect of high hydrostatic pressure and temperature on the final pH of whey protein isolate (WPI) solutions. WPI solutions at a concentration of 5% (w/v) were treated with HHP of 200, 400 and 600 MPa at different temperatures (25, 40 and 55°C)

for holding times of 0, 0.1, 5, 10 and 15 min in a warm isostatic press with a cylindrical pressure chamber (height = 0.25 m, diameter = 0.10 m). The pH of the samples was measured 2 h after the pressure was released. A Box-Behnken experimental design for the three experimental variables was used for the study. The WPI solution had an initial pH value of 6.9 and decreased to average values of 6.74 ± 0.12 , 6.67 ± 0.12 and 6.65 ± 0.15 for 200, 400 and 600 MPa, respectively. The regression analysis produced the following equation: $\text{pH} = 3.73 \exp(0.000152 t) / (P^{0.00676} T^{0.31449})$ where t is the holding time in min, P is the pressure in MPa and T is the temperature in K. The model implicates an increase in pH with the holding time but a predominant decrease of this parameter with both pressure and temperature. It can be concluded that the HHP treatment at the temperatures tested in this study create favorable pH conditions that could decrease the denaturation of the whey proteins. This conclusion only involves the effect of HHP and temperature on the pH and does not include the effect of these parameters *per se* on the denaturation process of the whey proteins.

Key Words: High hydrostatic pressures, Whey protein isolate, pH

T42 The impact of β -glucan on the stability of model dairy protein dispersions. J. E. Bock, K. A. Schmidt*, and G. E. Milliken, *Kansas State University, Manhattan*.

β -Glucan (BG) has shown promise as an immunomodulatory agent. Inclusion of BG in dairy-based beverages may benefit immunocompromised consumers, but the effect on beverage stability is uncertain. The objective of this study was to determine the impact of BG on the stability of model dairy protein dispersion systems. Model dispersions were created using ratios of 25:75, 50:50, or 75:25 sodium caseinate to whey protein isolate; 1% or 5% protein content; pH 7, 5, or non-adjusted; and BG at 100 $\mu\text{g}/\text{mL}$. Particle size distributions, apparent viscosity, and dispersion stability were measured within 24 h post-mixing. A four factor factorial experimental design was used with ANOVAs to determine significant factors. LSD mean differentiations were performed with significance at $\hat{I} \pm 0.05$. Cluster analysis characterized additional relationships among dispersion formulation, stability, particle size distribution, and apparent viscosity. BG inclusion resulted in a smaller mean particle size (121.2 μm vs. 147.2 μm) but did not affect stability. BG affected viscosity (1 sec^{-1}) but only as a $\text{pH} \times \text{protein content} \times \text{BG}$ interaction. BG increased the viscosity of non-adjusted pH dispersions at both protein contents but decreased viscosity in pH 5 dispersions at 1% protein and pH 7 dispersions at 5% protein. Stability was greatest (>95%) for dispersions at pH 7 with a mean particle size around $\sim 225 \mu\text{m}$ and a large particle size distribution spread around the mean. Mean particle sizes tended to decrease and form more compact particle size distributions as pH decreased, resulting in less stability. At a 5% protein level, non-adjusted and pH 7 dispersions had similar attributes as casein content increased. The results indicate that BG does not affect dispersion stability but that pH, protein content, and protein ratio are important factors. The evidence suggests that dairy protein beverages with a range of protein contents and viscosities could be feasible vehicles for BG delivery.

Key Words: β -glucan, Proteins, Dispersions

T43 The stability of a functional dairy based beverage. K. A. Schmidt*, *Kansas State University, Manhattan*.

Functional beverages are growing in popularity. However the addition of a functional ingredient to a dairy-based beverage may lead

to instability, which could decrease consumer acceptance. In the past, β -glucan (BG) has demonstrated immune-modulating effects under certain conditions and has been incorporated in a dairy-based dispersion; however the stability of such of a beverage is unknown. Thus, the objective of this study was to determine the impact of BG on the storage stability of dairy beverages. NDM (11% w/v) beverages were prepared with and without BG (100 $\mu\text{g}/\text{mL}$), heat-treated to 95°C for 5 min, then filled into containers. Products were stored at 4°C for up to 57 d and tested bi-weekly for particle sizes, sedimentation, stability, and total plate counts. Three replications were done. A two-factorial design was used and data were analyzed with ANOVAs to determine significance ($\alpha = 0.05$). All significant means and interactions were differentiated by the LSD test. Results showed that BG addition did not affect the particle size ($\sim 0.172 \mu\text{m}$) if the sample was well-mixed prior to analysis. However, if analyzing the particle sizes at the bottom of a quiescently-stored container, the particle sizes increased (~ 0.172 – $0.22 \mu\text{m}$) during the first month of storage, indicating that beverages regardless of BG addition exhibited some association and settling of larger-sized particles. Sedimentation in the BG-containing beverages was observed after 1 d of storage, but by d 29, all beverages had equivalent sedimentation. Beverage stability decreased ($\sim 1.2\%$) from d 1 to d 29, and then remained constant throughout the storage period. At d 57, the pH and total plate counts were still within acceptable ranges for beverages formulated at native pH. These results provide evidence that NDM-based functional beverages can be formulated and stored at 4°C for 2 months with minimal changes in particle sizes, sedimentation, or stability.

Key Words: β -glucan, Dairy beverages, Stability

T44 Electrophoretic characterization of protein aggregates formed by high pressure treatment of whey protein concentrate solutions.

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The objective of the present investigation was to characterize pressure-induced aggregates of whey proteins using tailor-made combinations of various polyacrylamide gel electrophoresis (PAGE) techniques. Whey protein concentrate (WPC) solutions were pressure treated in the range from 200 to 800 MPa for 30 min. The protein aggregates formed as a result of these pressure treatments were characterized using various one-dimensional and two-dimensional (2D) PAGE techniques in the absence or presence of a disulfide-bond reducing agent. It was found that pressure treatment of WPC solutions generated both hydrophobic and disulfide-linked protein aggregates consisting of immunoglobulin, lactoferrin, bovine serum albumin, β -lactoglobulin (β -LG), and α -lactalbumin (α -LA), as identified by native and then non-reduced sodium dodecyl sulfate (SDS) 2D PAGE and SDS and then reduced SDS 2D PAGE, respectively. Only disulfide-linked β -LG dimers were observed at 200 MPa, whereas more severe pressure treatment generated dimers, trimers, tetramers, and higher polymers and 1:1 complexes of β -LG and α -LA. The amount of high molecular weight aggregates not dissociated by SDS increased with the severity of the pressure treatment. It was found that in addition to disulfide-linked aggregates, hydrophobic-bonded dimers, trimers, tetramers, etc. of the whey proteins were also observed on native and then non-reduced SDS 2D PAGE.

Key Words: Whey protein concentrates, 1D and 2D PAGE, Disulphide-bonded aggregates

T45 Comparison of whey protein nitrogen index and aggregation of proteins in low-, medium-, and high-heat skim milk powders.

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Various types of skim milk powders are used in the recombined milk industry. These skim milk powders are broadly classified as low-, medium-, and high-heat powders. This classification is usually based on the whey protein nitrogen index (WPNI), which is the amount of undenatured whey protein present in the powder and is related to the heat treatments that are used during the manufacture of milk powders, particularly during evaporation and the so-called pre-heat treatments. In the present study, we compared the WPNI measured in a series of powders with the aggregation of proteins as analyzed by various polyacrylamide gel electrophoresis (PAGE) and capillary electrophoresis techniques. Non-reduced sodium dodecyl sulfate (SDS) and then reduced SDS two-dimensional PAGE gave an indication of the type, composition, and amount of whey proteins involved in the disulfide-linked protein aggregation in three different skim milk powders. It was found that the resultant loss of native protein content (as analyzed by PAGE and capillary electrophoresis) correlated well with the WPNI. The results of this preliminary study suggest that the WPNI gives a method that could be used to predict the extent of protein aggregation. Conversely, protein aggregation could be used to estimate the WPNI values.

Key Words: Protein aggregation, Disulfide-linked aggregation, WPNI

T46 Comparison of the effects of heat and high hydrostatic pressure treatments on the aggregation of proteins in fresh skim milk.

H. A. Patel^{*1,2}, H. Singh³, S. G. Anema^{2,3}, and L. K. Creamer², ¹*Institute of Food, Nutrition and Human Health, Massey University, Palmerston North, New Zealand*, ²*Fonterra Research Centre, Palmerston North, New Zealand*, ³*Riddet Centre, Massey University, Palmerston North, New Zealand*.

Various heat treatments (e.g. pasteurization and sterilization) have been used for the preservation of milk and milk products. These heat treatments were compared with a range of high pressure treatments up to 800 MPa using various polyacrylamide gel electrophoresis techniques developed for the purpose. It was found that each of the whey proteins responded differently to heat and pressure treatments. Pasteurization aggregated some of the whey proteins and incorporated some of the κ -casein. Sterilization aggregated most of the whey proteins. Both hydrophobic and disulfide-linked protein aggregates of various sizes were formed by heat and pressure treatments. Heat (or pressure) exposed a Cys residue of β -lactoglobulin, which catalyzed the formation of new disulfide bonds, leading to aggregation of the whey proteins. These aggregates then reacted with κ -casein and possibly with α ₂-casein to give cross-linking of casein and whey proteins. These changes were not completely reversed when the environment reverted to the native environment. Comparatively larger protein aggregates were formed by heat treatment than by pressure treatment. The stability of the native structure is also explainable in structural terms. From the results, it is concluded that pressure and heat affect the individual proteins differently so that there are benefits in each of the treatments when applied to mixtures of proteins. This poster will demonstrate that there are some important differences and many similarities in the

protein aggregation in heat- and pressure-treated samples, which may have implications on the quality of the final product.

Key Words: Skim milk, Protein interactions, Heat treatments

T47 Effects of protein concentration and pH on the pressure-induced aggregation of whey proteins in whey protein concentrate solutions.

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The objective of the present investigation was to study the effects of protein concentrations on pressure-induced denaturation and aggregation of whey proteins. Various one-dimensional and two-dimensional polyacrylamide gel electrophoresis techniques showed that several intermediate species, such as non-native monomers of β -lactoglobulin (β -LG) and α lactalbumin (α -LA), β -LG dimers, α -LA dimers etc., were formed when dilute whey protein concentrate (WPC) solutions (0.5 and 2% w/v) were pressure treated. Very high molecular weight aggregates and particulates that could not penetrate the gel were formed when concentrated WPC solutions (12 % w/v) were subjected to the same pressure treatments. The effect of pH on the solubility of the whey protein aggregates was also determined by adjusting aliquots of the high-pressure-treated WPC solutions to different pHs between pH 3.5 and pH 7.2 and centrifuging them. Very little polymeric protein was found in the supernatant at pHs between 4.9 and 5.3, whereas significant amounts of polymeric proteins were present in the supernatant at higher and lower pHs. This behaviour was similar to that of heat-treated WPC solutions, reported in the literature. After high pressure treatment, the relative loss of the native structure of β -LG was greater than that of bovine serum albumin at all concentrations used in present study, whereas α -LA was the most pressure resistant among all the whey proteins. This was found to be in converse to the response of these proteins to heat treatment. It may be possible that the hydrophobic cavity in the structure of β -LG was responsible for its apparently anomalous behaviour as a result of pressure treatment.

Key Words: Whey protein concentrates, α -Lactalbumin, β -Lactoglobulin

T48 Impact of trisodium citrate on rheology and microstructure of yogurt.

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Casein micelles are disaggregated by removal of colloidal calcium phosphate (CCP) with Ca-chelating agents, such as, trisodium citrate (TSC). Objectives of this research were to investigate the effect of TSC on the physical properties of yogurt. Reconstituted skim milk was heated at 85°C for 30 min and various concentrations (5 to 40 mM) of TSC were added to milk. pH was re-adjusted to 6.50. Milk was inoculated with 2% yogurt culture and incubated at 42°C, until pH was 4.6. Acid-base titration was used to determine changes in the state of CCP of milk. Total and soluble Ca contents of milk were determined. Gel formation was monitored by dynamic low amplitude oscillatory rheology. Microstructure of yogurt was observed using confocal scanning laser microscopy and whey separation was also determined. Addition of TSC reduced casein-bound Ca while increasing solubilization of CCP. The G' value of gels increased with addition of low levels of TSC and highest G' values were observed in samples with 10-20 mM TSC; higher (>20 mM) TSC concentrations resulted in a

large decrease in G' values. At low TSC levels, the removal of CCP crosslinks may have facilitated greater rearrangements and partial disruption of the micelle structure; both of which may help to increase G' and loss tangent (LT) values. At high TSC concentrations, micelles were completely disrupted and CCP crosslinks were dissolved, both of which resulted in weak yogurt gels with large pores. Gelation pH and yield stress significantly decreased with high TSC levels. No maximum in LT at pH ~5.1 was observed during gel formation in yogurts made with high TSC levels as CCP was completely dissolved prior to gelation. Lowest whey separation levels were observed in yogurt made with 20 mM TSC and whey separation greatly increased at > 25 mM TSC. In conclusion, low concentrations of TSC improved several important yogurt characteristics whereas the use of levels that disrupted casein micelles resulted in poor gel properties.

Key Words: Yogurt, Trisodium citrate, Rheology

T49 Identification of off-flavor compounds in Whey protein concentrate using head space solid phase microextraction-gas chromatography-olfactometry -mass spectrometry. I. Javidipour and M. Qian*, *Oregon State University, Corvallis.*

Whey protein concentrate (WPC) has become a popular ingredient in food industry, both in sports nutrition as well as traditional products such as dairy, bakery, meat, beverage and infant formula due to its excellent nutritional value and unique functional properties. Whey protein concentrate typically has a shelf life of 9-12 months when stored at normal conditions. However, WPC can develop off-flavor during the storage, and those unpleasant off-flavors limit its application in some delicate formulations. To investigate the chemical nature of the off-flavor, two WPC samples (one was regular 80% WPC, one was instantized 80% WPC) were stored at room temperature for 12 months to develop the off-flavor. Three g of samples were dissolved in 7 mL of deodorized water, and the off-flavor compounds were extracted using a DVB/Carboxen/PDMS fiber (2 cm, 50/30 μm) at 45°C for 3 h. The off-flavor compounds were analyzed using gas chromatography-olfactometry and GC-mass spectrometry on a DB-Wax column. Based on the aroma intensity, the most important off-flavor compounds were identified as dimethyldisulfide (sulfur, rubbery), dimethyltrisulfide (gas, cabbage), pentanal (green), hexanal (grass), heptanal (grass, rancid), octanal (green, fatty), nonanal (fatty), t-2-octenal (fatty, rancid), t-2-decenal (tallowy), t-2-nonenal (old book), t,t,2,4-nonadienal (fatty, earthy), 1-octanol (fatty, waxy, green) and 1-hexanol (green, herbaceous). The results demonstrated that the off-flavor compounds in WPC were mostly lipid and protein oxidation products.

Key Words: Whey protein concentrate, SPME, Off-flavor compounds

T50 Off-flavor development of whey protein concentrate during storage investigated by headspace solid-phase microextraction-gas chromatography. I. Javidipour and M. Qian*, *Oregon State University, Corvallis.*

Whey protein concentrate (WPC) is a nutritious and functional protein ingredient and has gained popularity to be used in many traditional as well as novel food products. It typically has a 9-12 months of room temperature storage shelf life. Fresh manufactured WPC has a bland or slightly dairy, utensil, whey flavor. However, inadequate flavor stability during storage is generally recognized and the off-flavor becomes one of the major factors limiting the usage of WPC. To understand the flavor stability of WPC, off-flavor formation in WPC 80 and instantized WPC 80 was investigated in this study. Both samples were stored

at 35, 45 and 55 °C while another instantized WPC80 sample was filled with argon and stored at the same temperatures. Samples were taken weekly for a period of three months. A headspace solid-phase microextraction-gas chromatography technique was used to study the off-flavor formation. Multiple internal standards were used to build the calibration curves and the off-flavor compounds were quantified. The result showed that lipids oxidation products such as aldehydes, ketones and free fatty acids were the main source of off-flavor. Protein breakdown and Maillard reaction also played a role in off-flavor development of WPC. Storage temperature seemed to be very important in the formation of those off-flavor compounds. The results could be used to build a model to estimate shelflife of WPC at extreme conditions.

Key Words: Whey protein concentrate, SPME, Off-flavor

T51 Differentiation of cheese sauces made with different starches and evaluation of the effect of starch type on flavor loss using FTIR spectroscopy. M. C. M. Soledad*, C. J. Kuo, L. E. Rodriguez-Saona, and W. J. Harper, *The Ohio State University, Columbus.*

A growth in the utilization of cheese sauces in institution and foodservice markets has been observed. Starches are added in the formulation to reduce texture problems in cheese sauces but contribute to flavor loss. This study was aimed to develop a simple and fast protocol to differentiate cheese sauces made with different starch types and to evaluate probable contribution of starch to flavor loss by using Fourier-Transform infrared (FTIR) spectroscopy combined with multivariate analysis. Sauces were prepared using the Stephan processed cheese maker. Natural Swiss cheese was used as source of cheese flavor. The native starches compared included: waxy corn (NWC), waxy rice (NWR), sago (NS), and tapioca (NT). Freshly prepared samples were placed on contact with a three-reflection diamond crystal plate for attenuated total reflectance infrared (ATR-IR) measurements. Classification models (Soft Independent Modeling of Class Analogy, SIMCA and Hierarchical Cluster Analysis, HCA) generated from derivatized infrared spectra (4000-800 cm^{-1}) were created and evaluated based on class distances and clustering. Specific infrared spectral information was obtained that allowed for the generation of classification (SIMCA) models that exhibited tight and well-separated clusters and discriminated among samples containing different native starches. Most of the discrimination among cheese sauces was in the 900-1150 cm^{-1} dominated by C-O and C-C stretching modes, the 1500-1200 cm^{-1} region associated to O-C-H, C-C-H, and C-O-H bending vibrational modes and the 1800-1700 cm^{-1} region associated with carbonyl group of various R(CO)OH or R(CO)OR. The highest absorbance peak at the carbonyl region was observed from the sauce made with NS suggesting least effect on flavor loss. This technique could contribute to the development of simple and rapid protocols for monitoring the presence of native starches in cheese sauces and elucidate the effect of starch addition on flavor loss of cheese sauces.

Key Words: Cheese sauce, FTIR, Starch

T52 Validation of ED-XRF as a reliable method for determining the mineral composition of skim milk powders. S. Uson*, C. Immoos, and R. Jiménez-Flores, *California Polytechnic State University, San Luis Obispo.*

Milk powders are an efficient method of delivering such nutrients to areas of the world where fresh milk is not readily available or cost-efficient. Inductively Coupled Plasma Mass Spectroscopy (ICP-MS)

is a well-established method for measuring mineral compositions. However, it is a more difficult and time-consuming process. Non-destructive Energy Dispersive X-ray fluorescence (ED-XRF) also measures mineral compositions, but requires very little preparation of the sample and results are obtained in a matter of minutes. This is an advantage in the analysis of large numbers of samples. The objective of this study was to validate the use of ED-XRF for the determination of minerals in skim milk powders (SMP). One hundred SMP samples were obtained from various sources. Standard values of mineral content and concentration were obtained using ICP-MS. Samples, placed in acid cleaned tubes, were allowed to dry at 60°C for 48 hours. They were treated with 70% HNO₃ and digested on a hotplate. Samples were brought to 5ml total volume with 2% HNO₃, I, S, Ga, Ti, In, and Y. They were analyzed for Al, K, Ca, Fe, Ti, Co, Ni, Sr, Cu, Zn, Mn, Cr, and Ba. Although unnecessary, samples for ED-XRF were formed into pellets of 4 g of powder under 20 tons of pressure. Triplicates were made for each sample. Spectra were recorded using a pin diode detector with a collection time of 92 s, tube current 26 µA, and tube voltage of 15kV. Results of ED-XRF, for the most part, proved to be comparable with those obtained by ICP-MS. While it was found that Pb is not detectable in the samples by ED-XRF, there was very good correlation between most of the elements in both methods (Variance ≤ 1%) ; with Al, Cr, and Cu having the greatest variation among samples and the lowest correlation coefficients. Thus, ED-XRF proved to be an acceptable method for the determination of mineral content and composition of SMP.

Key Words: X-ray fluorescence, Minerals, Skim milk powder

T53 Impact of storage on sensory profiles and volatile components of skim milk powder. R. E. Miracle, A. E. Croissant*, M. A. Lloyd, S. E. Zevchek, and M. A. Drake, *North Carolina State University, Raleigh.*

Fresh low heat skim milk powder (SMP) should ideally exhibit a mild and bland flavor reminiscent of fluid skim milk. A shelf life of anywhere between 6-36 months for non-instantized unfortified SMP under optimal storage conditions has been proposed by various sources. Characterizing SMP flavor variability, flavor stability and its role in consumer acceptance is crucial. Further, identification of key compounds that are associated with flavor degradation is important in order to identify rapid instrumental methods for evaluation of SMP flavor quality. Previous studies have evaluated sensory properties concurrently with labor-intensive solvent extraction instrumental approaches. The objective of the current study was to evaluate the efficacy of a more rapid instrumental volatile analysis to assess changes in SMP across storage time. Low heat SMP commercially packaged in 3-ply 22 kg bags were received from six commercial facilities on the west coast of the United States within 3 weeks of production. SMP were stored in the dark at 21°C, 40% RH and sampled every 3 mo for sensory and instrumental analysis through 30 mo. SMP were rehydrated at 10% solids (w/w) for analysis. A trained descriptive sensory analysis panel conducted flavor profiling of the SMP. Instrumental volatiles were extracted by solid phase microextraction (SPME) followed by gas chromatography-mass spectrometry (GC-MS). Compounds were identified by comparison of retention indices and GC-MS data against reference standards. Selected compounds were quantified by standard addition. Univariate and multivariate statistical analyses were applied to analyze the collected data. The SMP were differentiated by both sensory and instrumental volatile analyses. As SMP aged, cardboard flavor and astringency increased ($P<0.05$). Concurrently, the concentration of many aldehydes increased while

the abundance of maltol decreased ($P<0.05$). Instrumental analysis differentiated the aged SMP from the fresh control, similar to sensory analysis. SPME of volatile components may provide a rapid way to assess SMP quality.

Key Words: Skim milk powder, Flavor, Storage stability

T54 Evaluation of chemical properties and consumer perception of fluid milk from conventional and pasture-based production systems. A. E. Croissant*¹, L. Dean², S. Washburn¹, and M. A. Drake¹, ¹*North Carolina State University, Raleigh,* ²*USDA-ARS, Raleigh, NC.*

Consumer interest in the organic and natural food sector is growing. Sales of organic products are projected to continue double-digit growth through 2010. Flavor remains a vital concern for the consumer. Fluid milk composition and flavor variations have been attributed to feed, seasonal variation, and breed. The objectives of this study were to compare chemical properties and consumer perception of fluid milk from cows fed pasture-based (PB) or total mixed ration (TMR) diets. Fluid milk was collected from two herds; one fed on a PB diet and one fed on a TMR diet. Milk from Holstein and Jersey cows was collected separately and milkfat was standardized by breed. Volatile compounds were extracted by solid-phase microextraction (SPME) followed by gas chromatography-mass spectrometry (GC-MS). Compounds were identified by comparison of retention indices and GC-MS data against reference standards. Fatty acid profiling was also conducted. A trained descriptive sensory analysis panel documented the flavor profiles of the milks. Triangle tests and acceptance testing were conducted with consumers in separate sessions. Instrumental and sensory analysis differentiated the PB and TMR milks ($P<0.05$). Concentrations of many volatile compounds were different between PB and TMR milks including 3-methyl indole, indole, toluene, limonene, octanoic and decanoic acids ($P<0.05$). PB milks contained higher percentages of unsaturated fatty acids, including conjugated linoleic acid (CLA) ($P<0.05$). Trained panelists documented higher intensities of sweet aromatic and grassy flavors in PB milks compared to TMR milks ($P<0.05$). Consumers were able to detect differences between pasture-based and TMR milks, and consumer acceptance scores were higher for TMR milk compared to PB milk ($P<0.05$). These results indicate distinct flavor and compositional differences between TMR and PB milks which are crucial issues to consider and optimize for the growing organic dairy market.

Key Words: Fluid milk, Flavor, Feed

T55 Heat stability of skim milk powder. M. Faka*¹, M. J. Lewis¹, A. S. Grandison¹, and H. Deeth², ¹*University of Reading, Reading, United Kingdom,* ²*University of Queensland, Brisbane, Qld, Australia.*

The heat stability of skim milk powder depends principally on the stability of casein micelles. This project studies the changes in some factors influencing casein micelle stability during the production of skim milk powder, such as ionic calcium, pH, casein micelle size and ζ-potential. An in-can sterilisation procedure was used to measure heat stability, followed by viscosity measurement. Skim milk powder was considered to be heat stable when the reconstituted milk did not coagulate after sterilisation at 115°C for 15 minutes. Two types of powder were produced from pasteurised skim milk, namely a low-heat and high-heat powder, the difference being in the preheating of skim milk at 92°C for 10 minutes prior to evaporation for high-heat powder. The high-heat powder was heat stable when reconstituted to both 9 and

25% total solids and was found to have a lower ionic calcium, higher ζ -potential and larger casein micelle size in comparison to low-heat powder. The heat stability of low-heat powder was satisfactory when reconstituted to 9% total solids but decreased when total solids increased to 25%. The effect of water quality on these properties and on heat stability was evaluated, using soft water (no calcium) and hard water (250 ppm total hardness). Although water quality affected some of the measured properties, it did not have a marked effect on the heat stability. The heat stability of a low-heat powder was considerably improved by two procedures which reduced ionic calcium by about 30%, prior to evaporation. This reduction in ionic calcium was accompanied by associated changes in some of the other measured attributes of milk. Hence, the heat stability of skim milk powder could not only be improved by the preheating of milk but also by alterations in the calcium equilibrium in milk.

Key Words: Heat stability, Skim milk powder, Ionic calcium

T56 Quantification of fructooligosaccharides in infant formula. S. Gokavi*, M. S. Alam, and M. Guo, *University of Vermont, Burlington.*

Oligosaccharides are the third most abundant solid constituents in human milk in which these are believed to play two major roles i.e., defense agents by acting as receptor analogues to inhibit the binding of enteropathogens to the host cell receptors and bifidogenic factors. Cow's milk is in lack of oligosaccharides and infant formulas made with cow's milk may be deficient in oligosaccharides. It is believed that supplementing infant formula with certain oligosaccharides could improve the nutritional value of formula and help mimic some of physiological functions of mother's milk. The objective of the present study was to quantify fructooligosaccharides in infant formula. Infant formulas, seven from China and three from the United States of America, were collected and analyzed for fructooligosaccharide content using a colorimetric method. The principle of the method is that sucrose, starch and maltosaccharides (if present in the sample) are hydrolyzed to D-glucose by sucrase, amylase and maltase, respectively. Fructooligosaccharides are hydrolyzed to fructose and glucose by fructanase enzyme and the reducing sugars are reacted with p-hydroxybenzoic acid hydrazide resulting in color which is measured at 410 nm using a spectrophotometer. Fructooligosaccharide content of most infant formulas analyzed ranged from 0.10±0.01% to 0.52±0.14% and only one formula had 1.39±0.20%.

Key Words: Infant formula, Fructooligosaccharides, Colorimetry

T57 Effect of individual cow variation and interaction with diet on the content of health-promoting fatty acids in milk fat from dairy cows. C. Tyburczy*, A. L. Lock, J. A. Kelsey, D. G. Peterson, B. A. Corl, and D. E. Bauman, *Cornell University, Ithaca, NY.*

Many fatty acids have been associated with a positive effect on biomarkers of coronary heart disease risk, and the enhancement of these fatty acids in milk fat may be desirable to improve the overall healthfulness of dairy products. Health-promoting fatty acids (HPFA) include oleic acid, linoleic acid, linolenic acid, rumenic acid (conjugated linoleic acid), vaccenic acid, eicosapentaenoic acid, and docosahexaenoic acid. The objective of the current analysis was to examine the extent to which individual cow variation, and interaction with diet, affects the milk fat content of HPFA. Data from over 250 cows were collected from previous studies that examined effects of diet and individual phenotypic variation on milk fat composition (J.Dairy

Sci. 85:2164; 86:2588; 88:489). Milk fat content of HPFA ranged from 23.3 to 38.3% with individual HPFA varying 3-fold. Milk production variables (days in milk, milk yield, milk fat content, and milk fat yield) were not correlated with total HPFA content ($R^2 < 0.05$ for all variables). Intake of the experimental diets (polyunsaturated oils or extruded soybeans) resulted in a 13 to 46% increase in HPFA content in milk fat, when compared with the respective control diet. In the series of diets examined, the greatest increase resulted from supplementation with 2% soybean oil plus 1% fish oil. Dietary supplementation was effective for maintaining an elevated HPFA content in milk fat over a period of 12 weeks. Individual differences were apparent, and the hierarchy among individuals was maintained even when cows switched between diets. These data suggest that individual variation may offer an opportunity to select for cows naturally producing a high level of HPFA in milk fat. An additional opportunity exists to formulate diets that result in a substantial increase in the HPFA content in milk fat. A potential outcome of producing modified milk is the development of niche markets, but over time it may be possible to more broadly apply these changes, thereby improving the overall healthfulness and public perception of dairy products.

Key Words: Milk fat, Functional foods, Coronary heart disease

T58 Conjugated linoleic acid from butter fat is absorbed and incorporated into tissue lipids to a greater extent than when consumed as a dietary free fatty acid supplement. A. L. Lock*¹, D. E. Bauman¹, and A. M. Salter², ¹*Cornell University, Ithaca, NY*, ²*University of Nottingham, LEICS, UK.*

Dairy products are the major source of conjugated linoleic acid (CLA) in the human diet, with the *cis*-9, *trans*-11 isomer (rumenic acid, RA) representing 75-90% of total CLA. Dairy products also contain vaccenic acid (VA, *trans*-11 C18:1) which can be converted to RA through via $\Delta 9$ -desaturase. An alternative source of RA is dietary supplements which are normally available as free fatty acid (FFA) preparations. The aim of the current study was to compare the absorption and tissue deposition of RA when consumed from butter, specifically enriched in RA and VA, with that consumed as a FFA supplement. Golden Syrian Hamsters were fed chow-based diets supplemented with 0.2% cholesterol and containing 20% added fat, for 14 d. This fat consisted of either 20% standard butter (containing 0.4 and 1.4% of total fatty acids as RA and VA, respectively) supplemented with 5 g/kg RA-FFA, or 20% RA/VA-enriched butter (containing 3.6 and 15.4% RA and VA, respectively). The total RA content of the two diets was 5.5 g/kg of diet. Prior to sacrifice, animals were injected with Triton to prevent the breakdown of chylomicrons by lipoprotein lipase. Plasma chylomicrons were isolated and chylomicron, liver and adipose tissue fatty acid composition determined. Compared to the RA-FFA supplement, chylomicrons from animals fed RA/VA-enriched butter contained 74% more RA ($P < 0.001$). RA concentrations were also higher in adipose tissue and liver (104% and 146%, respectively). In a second experiment hamsters were fed RA/VA-enriched butter in the presence or absence of sterculic acid (a known inhibitor of $\Delta 9$ -desaturase). Inhibition of $\Delta 9$ -desaturase reduced the accumulation of RA in adipose tissue and liver by 36% and 37%, respectively ($P < 0.001$). Thus tissue concentrations of RA were significantly higher in animals fed equivalent amounts of RA as milk triacylglycerol than as a FFA supplement. This appears to be due to a combination of increased absorption and de novo synthesis through the action of $\Delta 9$ -desaturase on VA.

Key Words: CLA, Milk fat, Desaturase

T59 Production of the bacteriocin thermophilin 110 in whey-based media. G. A. Somkuti*, S. E. Gilbreth, and D. H. Steinberg, *Eastern Regional Research Center, USDA-ARS, Wyndmoor, PA.*

Thermophilin 110 is a bacteriocin of the dairy bacterium *Streptococcus thermophilus* with a high level of activity against pediococci that cause spoilage in wine and beer fermentations. Whey-based media were evaluated to establish optimum conditions for producing thermophilin 110 on a larger scale. Whey permeate solids were reconstituted to 3% lactose concentration, and the effects of yeast extract and the nontoxic organic buffer salts MOPS, MES and PIPES were tested on the growth of *S. thermophilus* ST110, changes in medium pH and thermophilin 110 accumulation over a period of 24 h. The presence of 0.5% yeast extract was essential for thermophilin 110 production which paralleled growth of *S. thermophilus* ST110 at 37°C and reached the highest level after 10-12 h, followed by a gradual decline, as shown by bioassays with *Pediococcus acidilactici* as the target organism. The presence of organic buffer salts decreased the rate of decline in medium pH and generally resulted in increased dry cell mass ($\mu\text{g/ml}$) and higher levels of thermophilin 110 (units/ μg of cells) produced. The greatest effect was shown by the addition of 1% MES to the medium which reduced pH drop to 1.8 units after 10 h (compared to 2.3 pH units in the control), and resulted in a 1.5-fold increase in cell mass (495 $\mu\text{g/ml}$) and a 7-fold increase in thermophilin 110 production (77 units/ μg of dry cells) over the control. Further, the productivity of *S. thermophilus* ST110 after 10 h in the whey permeate medium was 10-fold higher than in conventional tryptone-yeast extract-lactose medium (7.8 thermophilin 110 units/ μg of dry cells). The results showed that the use of whey-permeate based media may offer an economical approach to producing larger quantities of thermophilin 110 that could find applications in controlling spoilage pediococci in wine and beer fermentations.

Key Words: Thermophilin 110, *Streptococcus thermophilus*, Whey permeate

T60 Characterization of the indigenous microflora present in commercial Queso Fresco from Mexico. J. A. Renye Jr.*¹, G. A. Somkuti¹, B. Vallejo-Cordoba², D. L. Van Hekken¹, and A. F. Gonzalez-Cordova², ¹USDA-ARS-NAA-ERRC, Wyndmoor, PA, ²CIAD, A.C., Hermosillo, Sonora, Mexico.

Queso Fresco is the most popular variety of Hispanic-style cheese consumed in the United States and Mexico. It is traditionally made from raw milk without specific starter cultures and the functional and flavor properties of the cheese are determined by the native microflora present in the raw milk. In the U.S., Queso Fresco is made from pasteurized milk with non-specific starter cultures resulting in a product with different organoleptic qualities from the traditional cheese. In this ARS-CIAD study, the indigenous microflora from six commercial Queso Fresco cheeses, obtained from Sonora, Mexico, were analyzed to identify bacterial species which may function as specific starter cultures. Four of the cheeses analyzed were made from raw milk and two from pasteurized milk. Classification of bacterial species was based on growth on selective media and 16S rDNA sequencing. The highest colony counts were obtained on M17 and MRS agar used for the selection of streptococci and lactobacilli respectively. Growth on MRS agar supplemented with vancomycin suggested that *Leuconostoc* species were present in all six samples. A high number of coliforms, enterococci and coagulase-positive staphylococci were identified in all raw milk samples. The number of enterococci remained high in cheese samples made from pasteurized milk but a 2 log₁₀ reduction

of coliforms was observed. Coagulase-positive staphylococci were reduced by 3 log₁₀ in one pasteurized milk sample but remained high in the other (log 6.26 CFU/g). 16S rDNA sequence analysis revealed that lactobacilli were not present in any sample. *Lactococcus lactis* ssp. *lactis* was identified in four samples and *Leuconostoc mesenteroides* and *Enterococcus faecium* were identified in all six samples. The results suggest that these species need further study to explore their potential as starter cultures for the production of cheese made from pasteurized milk while preserving the organoleptic qualities of traditional Queso Fresco.

Key Words: Queso Fresco, Starter culture, Raw milk

T61 Production of potassium acetate from cheese whey using immobilized cell fermentation. M. Alam*, J. Li, and M. Guo, *University of Vermont, Burlington.*

Conventional deicing salts such as sodium chloride and calcium chloride are causing serious corrosion and major environmental problems. The objective of this study was to explore the use of immobilized cell technology in the production of environment-friendly substitute deicer potassium acetate (PA) from cheese whey. A fibrous-bed bioreactor was constructed using a jacketed glass column (5-cm I.D., 1-L capacity) packed with fibrous matrix (cotton cloth) and connected to a 5-L stirred-tank fermenter through a recirculation line. The fermentation was carried out anaerobically with agitation (100 rpm) after single inoculation of lactate/acetate tolerant *Lactococcus lactis* (10%) and *Clostridium formicoaceticum* (10%) into a nutrient-supplemented whey permeate (5%) in the 5-L vessel and maintained the temperature at 37°C and pH at 7.5 by adding 5 M potassium hydroxide. The circulation started through the fibrous-bed bioreactor after 40 h of fermentation in the vessel and continued for another 40-50 h. Aliquots (10 ml) of the fermentation broth were collected periodically and analyzed by HPLC. The PA concentration in the broth was 3.2-5.0%. Application of encapsulated cultures in the production of PA was also investigated. *L. lactis* and *C. formicoaceticum* were independently immobilized in sodium alginate beads after harvesting the bacterial cells by centrifugation (1,000 X g) at 10°C for 15 min. Batch fermentation of whey permeate using a coculture of the alginate-encapsulated cells produced 2.9-4.8% of PA in the fermentation broth. In comparison, when using free-cell cocultured batch fermentation, the PA production ranged from 2.6 to 3.4% after 60-72 h, and increased to 2.9 to 4.1% with nutrient supplementation. Results of this study suggest that fibrous-bed cell immobilization technology has potential to produce high yield acetate from cheese whey. Successful development and application of the alternative deicer for road maintenance will be beneficial to the dairy industry, transportation systems, and the environment.

Key Words: Potassium acetate, Cheese whey, Immobilized cell fermentation

T62 Effect of *Lactobacillus* spp. and whey protein isolates on intracellular glutathione and antioxidative activities. J. R. Byun and Y. H. Yoon*, *Chung-Ang University, Ansung-Si, Kyunggi-Do, S. Korea.*

Bovine whey protein is rich in cysteine, which is the rate limiting amino acid for synthesis of the antioxidant glutathione(GSH). Some strains of *Lactobacillus* spp. have been reported to contain high levels of GSH in cell extracts. This study is an attempt to find out the effect of dietary whey protein isolates and probiotic lactic acid bacteria on

the intracellular glutathione concentration and antioxidative activities. Treatment of RWPE-1 cells and PC-3M-MM2 cells with hydrolyzed WPI for 48h at concentration of 500µg/ml elevated glutathione sulphhydryl (GSH) by 28.2% and 38.4%, respectively compared with control cells receiving no hydrolyzed WPI ($P < 0.05$). Supplementation with *Lactobacillus casei* HY2782 cell extracts elevated intracellular GSH in both types prostate cells and the degree of elevation was dependent on the type of cells PC-3M-MM2 cell revealed significant elevation ($P < 0.05$) and RWPE-1 cell revealed an elevation with no statistical significance. The effects of hydrolyzed WPI and *Lactobacillus casei* cell extract on the oxidant induced cell death and DNA damage was Oxidant t-butyl hydroperoxide (TBHP) treatment of PC-3M-MM2 cells with 500µM induced viability by 62.0%. Pretreatment of PC-3M-MM2 cells with buthionine sulfoximine (BSO) prior to the TBHP reduced the viability by 33.7%. The effect of *Lactobacillus casei* cell extract on the oxidant induced cell death was Oxidant t-butyl hydroperoxide (TBHP) treatment of PC-3M-MM2 cells with 500µM induced viability by 33.7%. The effect of *Lactobacillus casei* cell extract on the oxidant induced cell death was Oxidant t-butyl hydroperoxide (TBHP) treatment of PC-3M-MM2 cells with 500µM induced viability by 82.4%. The effect of *Lactobacillus casei* cell extract on the oxidant induced cell death was pretreatment of PC-3M-MM2 cell with *Lactobacillus casei* cell extract elevated cell viability by 82.4%, a similar degree of protective effect with that of hydrolyzed whey protein isolates against oxidant induced cell death has been revealed.

Key Words: Glutathione, Whey protein isolates, *Lactobacillus casei*

T63 Characterization of a two-component regulatory system implicated in the bile tolerance of *Lactobacillus acidophilus* NCFM. E. A. Pfeiler^{*1}, M. A. Azcarate-Peril^{1,2}, and T. R. Klaenhammer^{1,2}, ¹North Carolina State University, Raleigh, ²Southeast Dairy Foods Research Center, Raleigh, NC.

Lactobacillus acidophilus NCFM is used industrially as a probiotic culture in yogurt formulation and dietary adjuncts. Tolerance to bile is one characteristic necessary for microbial survival and competition within the intestinal environment. Microarray analysis has shown that several genes are induced upon exposure of NCFM to bile. Among them, the genes in a putative operon (LBA1427 to LBA1432) composed of a two-component regulatory system (2CRS) and four poorly characterized genes, were significantly ($P < 0.01$) induced by bile. Inactivation of the LBA1430 (a predicted histidine kinase, HPK) was accomplished by targeted plasmid insertion via homologous recombination and replacement with a deleted version of the gene. The growth rates of the HPK mutant and a control strain were compared in MRS supplemented with 0%, 0.3%, 0.5% and 1.0% Oxgall. The growth rate for the HPK mutant was reduced significantly in the presence of 0.3% and 0.5% Oxgall. The HPK mutant also showed decreased survival on MRS agar plates as the bile concentration increased from 0.7 to 1%. Reverse transcriptase PCR on intergenic regions confirmed that LBA 1427-1432 are co-transcribed. Mutation of the HPK gene eliminated the co-induction of these genes by Oxgall. The results indicate that *L. acidophilus* relies on this two component regulatory system to regulate the expression of genes that contribute to bile tolerance.

Key Words: *Lactobacillus acidophilus*, Bile, Two-component regulatory system

T64 Characterization of a Gal⁺ *Streptococcus thermophilus* MR-1C recombinant strain. G. Robitaille^{*1}, S. Moineau², D. St-Gelais¹, C. Vadeboncoeur², and M. Britten¹, ¹Food Research and Development Centre, Agriculture and Agri-Food Canada, Saint Hyacinthe, Quebec, Canada, ²Laval University, Quebec City, Quebec, Canada.

Streptococcus thermophilus (*St*) is a lactic acid bacterium extensively used as starter culture in combination with lactobacilli in fermented foods. Capsule-producing strains, secreting exopolysaccharides that stay attached to the cell wall, are likely to improve moisture retention, yield, and melting properties of Mozzarella cheese without affecting whey viscosity. However, like the vast majority of strains, the capsule-producing *St* MR-1C is galactose negative. This metabolic property results from the inability of *St* to synthesize galactokinase, an enzyme of the Leloir pathway. Galactose, generated by lactose hydrolysis, is unwanted as it causes excessive browning of Mozzarella cheese during baking and promotes growth of non starter lactic acid bacteria. The aim of this work was to study the fermentation properties of a galactose positive (Gal⁺) MR-1C recombinant strain. MR-1C was transformed by electroporation with the plasmid pTKRL2TK that carries a functional galactokinase gene from a phylogenetically related strain specie *Streptococcus salivarius*. Unlike MR-1C, the recombinant strain named MR-AAC grew well on M17 broth supplemented with galactose as sole source of carbon. The amount of lactose consumed by MR-1C and MR-AAC during a fermentation process carried out at 40°C in reconstituted skim milk (10%) as well as the acidification rates were similar. The lactic acid/galactose molar ratio for MR-1C and MR-AAC were 1.96 and 2.05, respectively, indicating that both strains excreted the same amount of galactose. In M17 broth containing 0.5% lactose, MR-AAC first expelled galactose faster than it could be metabolized but, unlike MR-1C, excretion rate rapidly decreased as soon as lactose content decreased. These results demonstrate that the transformation of MR-1C with pTKRL2TK conferred a Gal⁺ phenotype did not prevent galactose excretion during growth in high lactose-containing media such as milk.

Key Words: *Streptococcus thermophilus*, Galactose metabolism, Starter culture

T65 Impacts of Gal⁺ phenotype on the capsule production by *Streptococcus thermophilus* MR-1C recombinant strain. G. Robitaille^{*1}, S. Moineau², D. St-Gelais¹, C. Vadeboncoeur², and M. Britten¹, ¹Food Research and Development Centre, Agriculture and Agri-Food Canada, Saint-Hyacinthe, Quebec, Canada, ²Laval University, Quebec city, Quebec, Canada.

Streptococcus thermophilus (*St*) is a lactic acid bacterium extensively used as starter culture for the production of fermented dairy products. The strain MR-1C secretes heteroexopolysaccharides that stay attached to the cell wall (CPS) forming a capsule of about 3 µm in thickness. CPS can improve moisture retention, yield and melting properties of the Mozzarella cheese without affecting whey viscosity. Like most *St* strains, MR-1C is unable to metabolize galactose. The aim of this work was to determine (1) how the synthesis of CPS was affected in a galactose-positive *St* strain derived from MR-1C, called MR-AAC, and (2) how this new metabolic trait affected the rheological properties of fermented milk. Reconstituted skim milk (RSM-10%) and M17 broth supplemented with lactose (LM17) were inoculated with MR-1C and MR-AAC and small-static fermentations were carried out at 40°C. To quantify the CPS produced by MR-1C and MR-AAC, an in situ lectin binding assay using fluorescently-labeled peanut agglutinin was developed. The CPS content of the capsule gradually increased

during the exponential growth in both RSM-10% and in LM17. CPS continued to accumulate during the stationary growth phase up to 18 hours of fermentation indicating that CPS production by *St* MR-1C and MR-AAC was not growth dependent. Between the 5th and 18th hour of fermentation, the CPS content per cell increased by a factor of 1.5 and 3 for LM17 and milk, respectively. MR-AAC and MR-1C showed a similar CPS accumulation pattern during fermentation. Milk viscosity at pH 5.3 and rheology of the curd produced with the two strains were also similar. In conclusion, ability to metabolize galactose did not result in a greater CPS production.

Key Words: *Streptococcus thermophilus*, Galactose metabolism, Capsular exopolysaccharide

T66 Pediocin production by *Pediococcus acidilactici* in co-culture with yogurt starter bacteria. G. A. Somkuti* and D. H. Steinberg, Eastern Regional Research Center, USDA-ARS, Wyndmoor, PA.

The direct production of the antilisterial bacteriocin pediocin in milk is not feasible since *Pediococcus acidilactici* poorly ferments lactose and prefers glucose for growth. Solutions to this problem have included the transfer of a lactose operon to pediococci from lactic bacteria and prehydrolysis of lactose with a suitable β -galactosidase. In a different approach described here, the production of pediocin by *P. acidilactici* (PAF) was evaluated in co-culture with the yogurt starter cultures *Streptococcus thermophilus* (ST) and *Lactobacillus delbrueckii* subsp. *bulgaricus* (LDB), and the cheese starter culture *Lactococcus lactis* subsp. *lactis* (LLL). Maintenance medium for PAF and LDB was MRS broth, whereas ST and LLL were grown in tryptone-yeast extract-lactose broth. The cultures (50 μ l each) were inoculated into milk (2% fat content) samples (10 ml) that were incubated at 37°C for up to 8 h. PAF was tested alone and in combination with ST, LDB and LLL. Samples were taken every 60 min, centrifuged for 10 min and following two-fold serial dilution, cell-free supernatants were tested for bacteriocin activity with *Listeria innocua* as the target organism. Pediocin production was not detectable when PAF was used alone or grown in co-culture with LLL. However, pediocin was apparently produced when PAF was co-cultured with either ST or LDB or in combination with the two yogurt starter cultures, and reached a maximum level estimated at 2,400 units/ml after 6 h of incubation. Since pediococci have been suggested as adjunct dairy starter cultures, the inclusion of pediocin-producing strains in starter mixtures consisting of ST and LDB strains may provide the additional benefit of serving as bioprotective agents to control listerial contamination in fermented dairy products.

Key Words: Pediocin, Lactis starter cultures, *Pediococcus acidilactici*

T67 Selective enumeration of different strains of *Lactobacillus acidophilus* in goat's milk yogurt beverage. S. Li*, S. Gokavi, and M. Guo, University of Vermont, Burlington.

An important parameter in monitoring viable probiotic cultures in a product is the ability to enumerate probiotic bacteria individually. Differential enumeration of probiotic bacteria is difficult due to the presence of several types of similar microbes in one product. In order to select a strain of *L. acidophilus* that can survive refrigerated conditions during storage of goat's milk yogurt beverage, three strains (ATCC-11975, LA-5 and NCFM) were chosen. To assess their viability, it was important to have a working method suitable for all the three strains. Twelve bacteriological media were evaluated to assess their

suitability to selectively enumerate ATCC-11975, LA-5 and NCFM which were used in combination with yogurt cultures (*S. thermophilus* and *L. delbrueckii* ssp. *bulgaricus* isolated from YC350 obtained from Chr. Hansen). Bacteriological media evaluated included *S. thermophilus* agar, pH modified MRS agar, MRS bile agar and sugar-based (maltose and sorbitol). Incubations were carried out under aerobic and anaerobic conditions at 37°C for 24, 48 and 72 h. M-17 agar with 0.5% lactose and aerobic incubation at 37°C for 24 h were suitable for *S. thermophilus*. The enumeration of *L. delbrueckii* ssp. *bulgaricus* can be done using MRS agar (pH 5.2) and anaerobic incubation at 37°C for 24 h. MRS agar with 0.2% bile and anaerobic incubation at 37°C for 72 h was found suitable for all the three strains of *L. acidophilus* used in the study.

Key Words: *L. acidophilus*, Enumeration, Goat's milk yogurt beverage

T68 Evaluation of adherence of *Bifidobacterium* and *Lactobacillus* strains to cell membranes by blot analysis and optical tweezers. C. Iñiguez*^{2,1}, J. Sharpe¹, E. Acedo-Félix², and R. Jiménez-Flores¹, ¹California Polytechnic State University, San Luis Obispo, ²Centro de investigación en Alimentación y Desarrollo, Hermosillo, Sonora, Mexico.

Bacterial adhesion to intestinal mucosa is one of the most important criteria for selection of any potentially probiotic strain. This adhesion is mediated by specific molecules present on the bacterial cell surface. Little information is available on the effect that milk fat globule membrane (MFGM) components have on the adhesion of probiotic bacteria. We have combined two techniques, dot blot analysis and laser tweezers to characterize the binding properties of several strains of *Bifidobacterium* and *Lactobacillus*. Dot blot analysis has been proven to be helpful in the determination of the affinity of bacteria to specific components in milk or the surface of bacteria. Optical tweezers have many applications in measuring biological forces due to their ability to exert piconewton scale force and to manipulate biological material with minimal damage. The optical trap consisted of a laser near infrared region Ti:saaph at 1064 nm, that was strongly focused through a lens with a very short focal length (it was used a numerical aperture microscope objective =1.25). To perform an adhesion evaluation, a bacterium was optically trapped and brought in contact with a 10 μ m diameter polystyrene microsphere coated with intestinal mucosa or MFGM by passive adsorption technique. Various calibration procedures were implemented in order to provide absolute force measurements. These measurements were compared to the relative intensities of binding obtained by dot blot assays. In this method, the intensity of binding is proportional to the color intensity developed in a dot blot assay from biotinylated bacteria adhering to a specific concentration of intestinal mucosa or MFGM immobilized in a membrane. This data will demonstrate the efficacy of this technique of adhesion force measuring and this research will contribute to knowledge of optical tweezers and their applications to investigations of living biological systems.

Key Words: Probiotic bacteria, Laser tweezers, Adhesion

T69 Probiotic weight loss yogurt. M. Guillory and K. J. Aryana*, Louisiana State University Agricultural Center, Baton Rouge.

Probiotics microorganism exert health beneficial effects on the gastrointestinal tract by improving the balance of intestinal microflora. A novel ingredient namely "Super Citrimax" is being marketed as a weight loss ingredient (WLI). The objective was to study the effect of various amounts of this weight loss ingredient on the physico-chemical,

microbiological and sensory characteristics of fat free probiotic yogurt over its shelf life. Super Citrimax incorporated into the yogurt mixes at the rate of 0, 1.5, 3.0 and 4.5 g per 228 g of yogurt. *Lactobacillus acidophilus* was incorporated at the rate of 0.054% v/v into all the homogenized, pasteurized mixes cooled to 104°F containing yogurt culture. Fat free plain yogurt manufacture was replicated three times. The WLI*storage-time interaction effect was significant for viscosity, body and texture, L* and b*. The a* values were significantly the highest for yogurts with 4.5g followed by yogurts with 3.0 g of the WLI. The a* values were the least for the yogurts with 1.5 g of WLI and the control which were not significantly different from each other. There were no differences in flavor scores between the control and the yogurts containing 1.5 g which were significantly higher than the yogurts containing 3.0 and 4.5 g WLI. Control yogurts had significantly the most syneresis followed by the yogurts with 1.5g of the WLI. The yogurts with the 3.0 and 4.5 g of WLI had significantly the least amount of syneresis. The WLI did not affect lactobacilli counts, appearance and color scores and yogurt pH, these three attributes steadily declined over yogurt shelf life. The optimum amount of WLI to be used in probiotic yogurt manufacture would be 1.5 g per 228 g yogurt.

Key Words: Probiotic, Weight loss, Fermented

T70 Health beneficial bacterial influence on the characteristics of fat free plain set yogurt. M. R. Faciane and K. J. Aryana*, *Louisiana State University Agricultural Center, Baton Rouge.*

Health benefits of *Lactobacillus acidophilus* include providing immune support for infections or cancer, providing a healthy replacement of good bacteria in the intestinal tract following antibiotic therapy, reducing occurrence of diarrhea in humans, aiding in lowering cholesterol and improving the symptoms of lactose intolerance. The objective was to study the effect of a slightly gradual increment in incorporation of *L. acidophilus* in yogurt manufacture on the physico-chemical, microbiological and sensory characteristics of yogurt over its shelf life. Yogurts were manufactured using standard procedure *L. acidophilus* was incorporated after yogurt culture addition at the rate of 0, 0.024, 0.048 and 0.144 % w/w yogurt mix. Product manufacture was replicated three times. The treatment * time interaction effect and the treatment effect were not significant for all characteristics. The incorporation of slightly increasing amounts of *L. acidophilus* did not influence viscosity, flavor, appearance, body and texture, L*,a*,b* syneresis and pH. The time effect was significant for some characteristics. Flavor scores were significantly the highest for week 0, lower for weeks 1 and 3 and significantly the lowest for week 5. Appearance scores were significantly the highest for week 0. Yogurts had best body and texture at weeks 3 and 5. Product pH at weeks 0 and 1 were not different yet significantly higher compared to weeks 3 and 5. *L. acidophilus* can be incorporated at a rate as high as 0.144% w/w without altering yogurt characteristics.

Key Words: Fermented, Health, *Lactobacillus acidophilus*

T71 A novel yogurt manufactured with probiotic bacteria at various levels. S. Ganesh* and K. J. Aryana, *Louisiana State University Agricultural Center, Baton Rouge.*

There are various types of yogurts namely, set curd, stir curd, drinking yogurt. *Lactobacillus acidophilus* has several health benefits. The objective was to study the dose effect of *L. acidophilus* on the physical and microbiological characteristics of a novel type of yogurt. A novel yogurt was manufactured and details of its manufacture will be discussed. *L. acidophilus* was incorporated in the yogurts at the rate of 0, 1, 10 and 100 g of frozen concentrate per gallon of final product. *L. acidophilus* counts, lactobacilli counts with MRS agar, coliform counts and yeast and mold counts were enumerated. Texture of the novel yogurt was determined by Texture Profile Analysis using an Instron. Product manufacture was replicated three times. The *L. acidophilus* counts in the novel yogurt were significantly lower for 1g compared to 10 and 100g incorporation. There were no differences in *L. acidophilus* counts of the product containing 10 and 100 g *L. acidophilus*. Hardness of the product with 100 g *L. acidophilus* was significantly lower than the product with 10 g. Coliform counts were less than 10 in all treatments. Different doses of *L. acidophilus* did not affect lactobacilli counts, yeast and mold counts, springiness, cohesiveness, gumminess, chewiness and adhesiveness of the product. Data indicates that the optimum level of *L. acidophilus* incorporation in the product is 10 g / gallon.

Key Words: Yogurt, Probiotic, Health

T72 Effect of *Lactobacillus acidophilus* inoculation level on yogurt properties during storage. D. W. Olson* and K. J. Aryana, *Louisiana State University Agricultural Center, Baton Rouge.*

The effect of *Lactobacillus acidophilus* inoculation level on the Lactobacilli counts, sensory (flavor, body and texture, and appearance) scores, amount of syneresis, color (L*, a*, and b* values), and pH of the resulting yogurt was determined. Plain yogurt was manufactured with skim milk, nonfat dry milk, yogurt cultures (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp *bulgaricus*), and with or without *L. acidophilus* (0 (control), 0.0239, 0.238, or 2.33% (w/w)). After homogenization at 10.3 MPa first stage and 3.45 MPa second stage and batch pasteurization at 85°C for 30 min, yogurt mixes were incubated at 40°C in 355 mL cups to pH 4.5 and then cooled to 4°C. Yogurt samples containing 2.33% *L. acidophilus* typically took about an additional 3 h to reach pH 4.5 compared to the control yogurt. Lactobacilli counts with MRS agar, amount of syneresis, and pH were determined at 0, 1, 2, 4, 6, and 8 wk of storage, and color measurements and sensory evaluations were performed at 0, 1, 2, 4, and 6 wk. Yogurts containing 2.33% *L. acidophilus* generally had significantly lower sensory scores, more syneresis, lower Lactobacilli counts, lower L* values, and higher a* and b* values than the remaining yogurts. The flavor scores and the a* values at 0 wk were significantly higher than the corresponding values for the remaining storage times, and the pH decreased from 0 wk to either 4 or 6 wk for each type of yogurt. The body and texture and appearance scores, amount of syneresis, Lactobacilli counts, and L* and b* values were not significantly affected by aging. High inoculated levels of *L. acidophilus* (2.33%) prolonged the yogurt incubation time and resulted in an inferior quality yogurt during storage.

Key Words: *Lactobacillus acidophilus*, Sensory, Yogurt

Extension Education

T73 Utilizing the Penn State dairy herd to evaluate precision feeding and the effects on ammonia emissions. V. Ishler*, N. Brown, and G. Varga, *The Pennsylvania State University, University Park.*

A key factor in extension education is to take university research results and apply them in a practical manner to our dairy clientele. There are limitations to evaluating results using small number of animals and extrapolating the data to real world situations when conducting university trials. In the case of air quality and ammonia emissions, very different outcomes are possible based on feeding management practices and housing type. To address these concerns a large scale trial was conducted simultaneously to compliment a more intensive small scale study. The objective was to evaluate an alfalfa versus a grass silage based ration and corn particle size on animal performance and ammonia emissions in group housing. The alfalfa and grass silage made up 25% of the ration dry matter. The free stall barn at Penn State houses 120 cows divided into 2 groups of 60. For four months, the left side of the barn received the alfalfa based ration and the right side received the grass based ration. The only change was varying the particle size of the corn every four weeks. Milk production, components, energy corrected milk (ECM), milk urea nitrogen (MUN), dry matter intake, income over feed costs (IOFC) and ammonia emissions were monitored. The results of the large scale study have been incorporated into numerous educational programs to illustrate concepts related to precision feeding and that positive outcomes are possible related to profitability and the environment.

Table 1.

Month	Corn particle size	Milk kg	Fat %	Protein %	ECM kg	MUN mg/dl	IOFC \$/cow
Alfalfa based diet							
Feb	fine	42.3	4.00	3.00	44.4	12	10.74
Mar	coarse	42.6	3.97	3.16	45.0	10	11.60
Apr	fine	43.5	3.83	2.98	44.6	10	10.95
May	coarse	46.9	3.94	2.94	48.7	9	12.37
Grass based diet							
Feb	coarse	37.8	4.00	3.00	39.7	12	10.09
Mar	fine	37.8	3.85	3.09	39.2	11	10.15
Apr	coarse	38.9	3.69	2.91	39.0	11	9.66
May	fine	38.8	4.10	3.26	41.9	10	10.74

Key Words: Precision feeding, Ammonia emissions, Education

T74 Financial performance of dairies in Florida and Georgia in 2004. L. Ely*¹, R. Giesy², A. deVries², B. Broaddus², C. Vann², and A. Bell², ¹University of Georgia, Athens, ²University of Florida, Gainesville.

The Dairy Business Analysis Project (DBAP) includes an annual survey of the financial performance of dairies primarily located in Florida and Georgia. Its objective is to document the dairies' financial success using standardized, accrual accounting methods in order to calculate benchmarks and provide feedback on the dairies financial strengths and weaknesses. Twenty-six dairies submitted financial data in 2004. Twenty-two dairies were included in the summary results. Of these, 15 were located in Florida, and 7 in Georgia. The average herd size was 1,170 cows and 585 heifers with 18207 lbs. milk sold

per cow. The average culling rate was 31%. There was an average of 20 FTE workers per farm and 0.97 million lbs milk sold per FTE worker. Total revenue per cwt. was \$20.89 / cwt with \$18.98 / cwt milk income. The average total expense was \$19.39 / cwt. The largest expense items were purchased feed (\$8.13 / cwt), labor (\$3.17 / cwt), livestock (\$1.87 / cwt) and milk marketing (\$1.13 / cwt). Net farm income from operations was \$1.50 / cwt and net farm income was \$1.58 / cwt. The debt to equity ratio was -0.24, the rate of return on assets was 0.06, the rate of return on equity was 0.05, the operating profit margin ratio was 0.06. Total expenses decreased and returns increased with herd size in 2004. Herds ≥ 1000 cows had the lowest total revenue (\$20.78 / cwt) and the lowest expenses (\$18.12 / cwt) resulting in the highest net farm income (\$2.82 / cwt). The herds with the highest milk production ($\geq 19,500$ lbs / cow / year) had the lowest total revenue (\$18.86 / cwt) and the lowest expenses (\$18.28 / cwt) resulting in the highest net farm income (\$1.74 / cwt).

Key Words: Dairy, Financial, Management

T75 A team based approach: Development of a comprehensive program for identification of bottlenecks to profitability on dairy farms. L. Holden*, G. Varga, K. Griswold, T. Beck, B. Hilty, M. Douglass, R. Goodling, V. Ishler, and E. Hovingh, *Penn State University, University Park.*

Field-based and campus-based dairy extension educators collaborated to develop a program to identify bottlenecks to profitability on Pennsylvania dairies. Self-selected teams worked on key areas like udder health and milk quality, reproduction, and replacement management and milk production, while a larger team developed a comprehensive tool to identify bottlenecks. Working through both face to face and electronic communication, the team created the "Profitability Assessment for Dairy" (PADairy). The PADairy tool was developed to use a consistent method of whole farm evaluation and remove bias associated with individual areas of expertise. Each area in the tool is linked to an economic outcome so that bottlenecks and the associated loss in profitability are identified. Training for using PADairy included an on-farm evaluation with multi-disciplinary teams of extension educators. The training model allowed for experimentation with "old methods" of evaluation compared to the more team-based and comprehensive use of PADairy. Evaluations indicated that nearly 80% of the participants were likely to use the tool in the next year and nearly 75% would use the tool with a team of educators. Seventy-five percent of the participants found the team based and on-farm components to training "very effective" while the remaining 25% found the training methods "moderately effective." Following internal training and on-farm testing, PADairy was presented in educational workshops for both agribusiness consultants and dairy producers. The PADairy project provided a more coordinated and effective method for both educational program development and educator training.

Key Words: Team-based, Profitability, Dairy

T76 Changes in copper sulfate use on northeastern New York and Vermont farms between 2002 and 2005. S. A. Flis*, C. S. Ballard, M. A. LeVitre, R. M. Conant, and E. D. Thomas, *W.H. Miner Agricultural Research Institute, Chazy, NY.*

The use of copper sulfate (CuSO₄) in footbaths to maintain foot health has been a common practice on dairy farms for the last 10 years. Often

the waste material from CuSO₄ footbaths is added to manure storage facilities increasing the Cu content of manure applied to fields. The Cu concentration in the Miner Institute manure slurry was 4.8 g Cu/1000 L in 1996 and 88.6 g Cu/1000 L in 2000, before and after CuSO₄ footbaths were employed, respectively. Spreading of manure slurry with high Cu concentration may adversely impact crop growth and quality. Concern about the amount of Cu being applied to cropland initiated a survey of the use of CuSO₄ in footbaths on 17 Northeastern New York and Vermont dairy farms in 2002 and their continued practices in 2005. All farms utilized CuSO₄ footbaths in 2002, while 35% had decreased or discontinued the number of footbaths per month and the kg of CuSO₄ used per footbath in 2005. The kg of CuSO₄ imported yearly decreased on 29% of farms still using footbaths in 2005. The yearly import of Cu per hectare per year decreased on 65% of the farms in 2005 because of an increase in acres in which manure slurry was spread. Forage Cu content was measured on 15 surveyed farms. Concentration of Cu decreased in both corn silage and haylage from 2002 to 2005. In 2002, the Cu concentration in corn silage was 12.7 ±5.9 mg/kg and in 2005 was 5.1 ±0.8 mg/kg ($P < 0.001$). For haylage, the Cu concentration in 2002 was 19.0 ±8.2 vs. 10.2 ±2.4 mg/kg in 2005 ($P = 0.004$). The decrease in the kg of CuSO₄ imported per hectare per year on the majority of farms surveyed may have contributed to the downward trend in forage Cu content. Since data was not collected on crop yields, manure Cu concentration, manure application rate, or soil Cu content, it is difficult to accurately determine contributing factors for the decrease in forage Cu concentration. Research is currently being conducted to determine the effect of CuSO₄ concentration on manure microbial activity and corn and grass growth and quality.

Key Words: Copper sulfate, Manure, Dairy

T77 Record keeping on Idaho dairies. M. Chahine* and J. B. Glaze, Jr., *University of Idaho, Twin Falls.*

In order to ascertain the existing level of adherence to beef quality assurance (BQA) recommendations by Idaho dairies, and to determine the needs for BQA education, a survey of dairy farmers in Idaho was conducted. The survey was prepared and sent out to all 736 known dairies operating in the State of Idaho. A total of 273 dairies responded, resulting in an overall response rate of 37%. Recognizing that accurate record keeping is one of the requirements of BQA, the survey included a series of questions asking which animal health and production records were kept by each dairy, as well as the record format and the length of time records were maintained. Record keeping was similar between Idaho geographical areas. In northern Idaho, 100% of the respondents practiced some form of record keeping. In southwest Idaho, the percentage of responding dairies that maintained records was 96.4%, compared to south central Idaho and eastern Idaho where the percentage of dairies maintaining records was 97.3% and 93.7%, respectively. When the data were analyzed by dairy size, 93% of small dairies (less than 200 cows), 99% of medium-sized dairies (200-1000 cows), and 100% of large dairies (more than 1000 cows) indicated they maintained records. Results showed that large dairies were more likely to maintain a wider variety of records. Animal identification (number and description), calf birth records, and cow records (health, reproduction, and lactation) were the types of records most commonly maintained by the dairies. Dairies indicated they were less likely to maintain feed records, product supplier names, or BQA program records. The majority (58%) of respondents from dairies with less than 200 cows used some paper format to keep records, compared to respondents at medium- and large-sized dairies that used some type

of computer based record system (85 and 100 %, respectively). In all geographical areas and size classes, 50-60% of respondents indicated they maintained records for at least two years.

Key Words: Survey, Record keeping, Dairy

T78 Spanish language educational opportunities for Idaho dairy employees-raising healthy calves. M. Chahine*¹, R. Norell², S. Jensen³, J. Dalton⁴, R. Carranza⁵, S. Etter⁴, and R. Chebel⁴, ¹*University of Idaho, Twin Falls,* ²*University of Idaho, Idaho Falls,* ³*University of Idaho, Marsing,* ⁴*University of Idaho, Caldwell,* ⁵*Pfizer Animal Health, Meridian, ID.*

Cultural and language differences present significant communication challenges between dairy operators and their employees. According to the Department of Labor, 90% of the workforce on southern Idaho dairies is Hispanic. Language barriers directly affect the performance of calf raisers who are capable of doing a very good job if they are properly trained. Training Hispanic farm labor in dairy management is critical for minimizing the spread of disease, raising healthy herd replacements, optimizing production, and increasing farm profitability. In response to requests from the Cooperative Extension Dairy Advisory Boards and the Animal and Veterinary Science Department Advisory Board (composed of dairy producers and allied industry personnel); we developed a new course for Idaho's Hispanic dairy workers. The course was entitled 'Raising Healthy Calves'. It focused on calving area cleanliness, physiology of birth, calving assistance, basic neonatal management, colostrum feeding, calf health, calf nutrition, and calf housing. Power point presentations were developed in English and Spanish. A handbook comprised of chapters addressing each of these topics in detail, in both Spanish and English, was also developed to accompany the course. In 2005, the course was offered in Caldwell, Twin Falls, and Blackfoot. Over 120 Hispanic employees attended the calf raising program. The delivery of this Spanish language program provided an educational opportunity for a traditionally underserved group throughout the state of Idaho. Proper calf raising techniques should lead to improved quality of calf care and reduced incidence of death and disease. Future efforts will seek to identify actual adoption of proper calf raising procedures to better quantify actual economic impacts.

Key Words: Calf raising, Hispanic training, Workshop

T79 Spanish language educational opportunities for Idaho dairy employees-milker school. M. Chahine*, *University of Idaho, Twin Falls.*

The Idaho dairy industry relies heavily on a Spanish-speaking workforce. Department of Labor statistics indicate that in southern Idaho, the number of dairy workers that speak Spanish as their first language exceeds 90% of the workforce. The language barrier has created communication and training problems. The majority of dairy managers speak little or no Spanish and most Hispanic employees speak little or no English. University of Idaho Cooperative Extension faculty annually consult a dairy advisory board to identify critical issues to the Idaho dairy industry. Each year, one of the top identified needs is training and educational opportunities for Hispanic employees. In response to the identified need, a classroom/on-farm Spanish language milker's school for Idaho dairy employees was developed. The course included sessions on cow preparation and sanitation, milk letdown, milk removal, milking unit handling, mastitis, prevention of antibiotic residues in bulk tank milk, and cow handling. During the year 2004 and

2005, approximately 250 milkers attended the course. A test covering various aspects of milking management was given to a sample of 43 participants at the beginning and end of the class. The test was short (ten questions), and the presenter made sure to explain and read orally the questions and emphasized that the performance on the test would be confidential and in no way will affect the milker's job. The participants were assigned numbers on their name tag and were asked to record the number on the pre- and post- test so they were not identified by their names. The numbers were used to link the pre-test to the post-test and the grades were summarized in a computer spreadsheet. The test scores before (pre-test) and after (post-test) were compared using a paired samples t-test to determine if the milker school improved participants scores (knowledge). The test showed a 27.3% improvement in knowledge ($P < 0.0001$). Proper milking and cow handling techniques should lead to improved milking procedure, closer adherence to protocols, lower somatic cell counts and lower incidence of clinical mastitis.

Key Words: Milker school, Hispanic training, Workshop

T80 Identifying management areas that limit farm profitability using a combination of industry benchmarks and economic loss factors. K. Griswold, T. Beck*, D. Baver, M. Douglass, R. Goodling, B. Hilty, L. Holden, E. Hovingh, V. Ishler, M. O'Connor, J. Tyson, and G. Varga, *Penn State University, University Park.*

Assessing revenue generation opportunities on dairy farms helps producers identify specific areas to target for in-depth troubleshooting on the farm operation. The Profitability Assessment for Dairy (PA Dairy) Tool was developed for that specific task. Using a combination of financial information and DHIA data, the Excel spreadsheet based program generates twenty-one farm-specific values and assesses these values against a series of industry benchmarks. The tool then provides a broad view of a whole farm's profitability, and initially distinguishes whether profitability is limited by the farm's capital efficiency (i.e. use of capital) or operational efficiency (i.e. ability to generate milk revenue). Within the operational efficiency section, four management areas are further assessed for their potential impact on the dairy herd's productivity and whole-farm revenue generation. These four management areas are Milk yield and components, Reproduction, Udder health and milk quality, and Culling and replacements. Once these management areas are ranked on their potential to limit herd productivity, the tool attaches revenue loss estimates to each. These revenue loss estimates can be adjusted to reflect the industry benchmarks or the farmers own goals. The PA Dairy Tool was tested across Pennsylvania on dairy farms ranging in size from 53 to 1035 cows. Based on using industry benchmarks, the tool identified Reproduction as being the most limiting factor on herd productivity in 78% of the farms with Milk yield and components ranking as the second most limiting factor in 66% of the farms. However, when economic loss estimates were attached to these management areas, Milk yield and components was twice as likely to be the most limiting factor on whole farm revenue compared to Reproduction. These results suggest that using industry benchmarks alone may not always identify the largest potential source of revenue loss on the farm. The results of the tool provide an economically-based starting point for drill down investigations to determine specific causes of revenue loss on farms.

Key Words: Profitability, Dairy, Benchmark

T81 A multidisciplinary approach to address nutrient management in large dairy operations or a confined animal feeding operation (CAFO). C. N. Lee*, R. B. Valencia-Gila, G. Porter, R. Pattnaik, R. S. Yost, and C. I. Evensen, *University of Hawaii-Manoa, Honolulu.*

The tentative agreement between the US Environmental Protection Agency and the US Dept. of Agriculture for Animal Feeding Operations (AFOs) and Confined Animal Feeding Operations (CAFOs) imposed stringent regulations across geographic regions irrespective of climate. Hawai'i's sub-tropical/tropical climate has a year round growing season for all major agriculture districts. As an island state, she is further impacted by Clean Water Act, Coastal Zone Management Act, etc. Her isolation and cultural heritage make livestock operations important within the economic components. Hence, a multidisciplinary approach is needed for developing alternative measures to alleviate potential risks in violating the AFOs/CAFOs rules. The steps were: i) identify the potential problems, ii) develop an outreach/education program for the producers, iii) solicit the participation of colleagues with different skills and expertise, iv) implement the project and v) evaluate the outcome. Results of these efforts led to: a) participation/commitment of producers "in-kind" match; b) successful grants for education and implementation of project; c) a field trial on 4 species of tropical forages and 2 sub-surface irrigation was established on producer's site; d) data collected include plant tissue analyses, soil nutrients, percolation rate of affluent, nutrient uptake by forages and e) new expanded project to resolve wastewater management in dairies. The study showed that Bana grass (*Pennisetum purpureum*) could yield ~60 tons DM/ha/yr, with high nutrient uptake of N (>500kg/ha/yr) and P (100-300kg/ha/yr) without leaching or accumulation of such nutrients in the root zone. The elements contributing to the success of this project were: 1) commitment and follow through from all parties and 2) constant communication between parties. A multidisciplinary approach brought different skills and expertise to solve problems by further expanding the knowledge and awareness critical issues. The program yielded data that were successfully used to obtain USDA/EQIP grant for nutrient management in operations with limited land area.

Key Words: CAFOs, Multidisciplinary, Nutrient management

T82 DairyVIP: A user-friendly computer program to compare the economic consequences of management changes on dairy farms. A. de Vries*, *University of Florida, Gainesville.*

Dairy producers and allied advisors frequently need to estimate the economic consequences of proposed changes in management. Changes that affect the herd dynamics are not easy to evaluate. To support estimation, the user-friendly computer program DairyVIP (Value Iteration Program) has been developed. DairyVIP first determines optimal or user-defined breeding and replacement decisions for individual cows and then calculates numerous technical and economic statistics for herds or (sub)groups of cows. For example, the technical and economic consequences of changes in pregnancy rate, milk production, prices, or culling and replacement policy are easily evaluated. The user-interface is developed in Microsoft Excel. Five input sheets allow the user to enter data about milk production, reproduction, body weights, involuntary culling, and prices. Inputs may be seasonal. These data are then used by the dynamic programming module, which calculates the optimal or user-defined breeding and replacement decisions for each cow category. Cows are categorized by level of milk production (15 classes), lactation number (12 classes), months in milk (24 classes), pregnancy status (10 classes), and season

of the year (12 classes). A Markov chain module simulates a herd consisting of cows that follow the calculated breeding and replacement decisions over time. A user-defined starting herd may be simulated over time. DairyVIP also calculates results in steady-state. Numerous technical and economic statistics are presented on 3 sheets. The user-interface shows over 40 statistics such as profit per cow per year, average days to conception, cull rate, value of a cow etc. It also displays over 40 graphs showing statistics over time, by days in lactation, by season, etc. The optimal breeding and replacement decisions for each cow category, as well as their future value, value of pregnancy, and cost per day open can also be viewed. Two sets of inputs and their results can be compared simultaneously. The computer program may be obtained at <http://dairy.ifas.ufl.edu/tools>.

Key Words: Optimization, Economics, Management

T83 Advising model for the dairy farm development in Mexico. V. Mariscal-Aguayo^{*1}, H. Estrella-Qunitero¹, A. Martinez-Cuevas², and S. Castro-Aguilar³, ¹*Universidad Autonoma Chapingo, Chapingo, Mexico*, ²*Asesor Independiente, Zapotlanejo, Jalisco, Mexico*, ³*Agropec Star, Guadalajara, Jalisco, Mexico*.

The objective of the work was to evaluate the impact of the CHAPINGO-AGROPEC Star Integral Advising and Consultancy Strategic Model in the development of a dairy farm in the state of Jalisco, Mexico from January, 2004 to December 2005. The model consisted in: 1. Advisor actualization. 2. Use of computer technology tools, AGROPEC Star software and Internet in the process; 3. Elaboration of an integral, cooperative diagnosis and strategic analysis. 4. Elaboration, implementation and following of a Strategic Plan of Re-engineering Processes (SPRP) for the identified problems. 5. Pursuit and integral evaluation of the farm and the adviser. 6. Training programs for the producer and personnel. 7. Permanent consultancy via Internet. 8. Entailment of the productive chain with universities. The farm has 105 cows and 80 heifers of Holstein breed. The cattle were confined, AI was used and their feeding was with corn silage, alfalfa and concentrates. It has advisory services as well. The results were: a) Actualization programs in five areas given to the adviser. b) Problems identified by the diagnosis (initial value) and monitor progress with the SPRP (final value): Age at first parturition (25.47 - 24.68 m), parturition-first service interval (80.82 - 75.39 d), parturition-conception interval (134.16 - 108.65 d), conception rate (41.74 - 48.24 %), milk production average (21.40 - 22.27 L), days in production (353 - 357), dry days (63.41 - 59.83); c) Elaboration of an organizational chart and a procedures manual. d) Training programs in three areas given to the personnel. e) Evaluation of the adviser performance considering farm progress. f) Involvement of a student and professors in the work. The advisory model improved the productive performance, administrative process and personnel attitude; the latter was the most important for the solution of the main problems. The use of a digitized platform by the producer, adviser and consultant facilitates the farms development.

Key Words: Farm management, Milk production, Software

T84 Development model for farms. H. Estrella-Quintero^{*1,2} and V. Mariscal-Aguayo¹, ¹*Universidad Autónoma Chapingo, Chapingo, México*, ²*Agropec Star, Guadalajara, Jalisco, México*.

The management complexity of a farm along with the fact that Mexico has a great amount of small and medium-sized farms implies that the only alternative for improving their productivity and competency is the access to the integral, qualified and professional advising services.

Given this fact, in the 80's, approximately 25,000 advisers were employed by the Mexican government for these purposes. Even though the program disappeared, other programs were implemented later on. These, however, were not effective. This is why from 2002 to the present; AGROPEC Star and the Universidad Autónoma Chapingo have created a methodology for the development of farms based on professional advising services in 20 farms. This methodology contemplates: 1. Actualization of the integral management of farms. 2. Transference of computer and communication technology to the advisers (Internet and AGROPEC Star software). 3. Elaboration of an integral, cooperative diagnosis and strategic analyses. 4. Elaboration, implementation and following of a Strategic Plan of Re-engineering Processes (SPRP) for the identified problems. 5. Implementation of a control, following and integral evaluation mechanism in the farms. 6. Specialized permanent consultancy by Internet. 7. Training programs for the producer and personnel. 8. Specialized consultancy in field. 9. Pursuit and evaluation of the performance of the advisers. 10. Entailment of the productive chain with the universities. The use of this methodology allows: updating for advisors, the generation and use of digitalized indicators of all the farms, development of research projects applied to the identified problems, and student participation to improve their professional performance in the advising market to enhance the productivity and competitiveness of the farms.

Key Words: Farms development, Animal and agriculture production, Software

T85 The Missouri Show-Me-Select™ Replacement Heifer Program. D. J. Patterson*, R. L. Weaver, M.F. Smith, D. C. Busch, and J. L. Parcell, *University of Missouri, Columbia*.

The Missouri Show-Me-Select Replacement Heifer Program was designed to improve reproductive efficiency of beef herds in Missouri and increase individual farm income. The program objectives include: 1) a total quality management approach for health and management of heifers from weaning to late gestation; 2) increased marketing opportunities for and added value to Missouri raised heifers; and 3) the creation of reliable sources of quality commercial and purebred replacement females. The program was initiated as a pilot project in two regions of Missouri in 1997 with 33 farms and 1,873 heifers. During the past 8 years, 554 farms enrolled 66,526 heifers in the program. Regional extension livestock specialists serve as coordinators of the program locally and work closely with the 179 veterinarians involved with the program state wide. State specialists provide program support to regional extension field staff and participating veterinarians. The reproductive goals for heifers enrolled in the program are aimed at improving breeding performance during the heifers' first breeding period, minimizing the incidence and severity of dystocia, with the resulting delivery of healthy, vigorous calves, and successful rebreeding of heifers during the subsequent breeding season. The marketing component of the program facilitated the sale of 15,725 heifers in 66 sales across Missouri from 1997 through the fall sales in 2005. These sales generated interest from 5,189 prospective buyers that formally registered to buy heifers, and 1,915 individuals that purchased heifers from the various sales. Heifers from the program have now sold to farms in AR, AZ, FL, IA, IL, IN, KY, KS, MO, NE, OK, SC, and TN. Collectively, 66 sales have generated \$16,393,797 in gross sales. The program is estimated to annually contribute \$3.5 million to Missouri's economy. The Missouri Show-Me-Select Replacement Heifer Program is the first statewide on-farm development and marketing program of its kind in the U.S.

Key Words: Heifer development, Reproductive management, Beef cattle

T86 Survey response of beef exhibitors to radio frequency identification device. J. W. Lehmkuhler*¹ and T. Quam², ¹University of Wisconsin, Madison, ²Wisconsin Cattlemen's Association, Sun Prairie, WI.

The Wisconsin Cattlemen's Association (WCA) was awarded funds to investigate the use of radio frequency identification device (RFID) technology for beef steers exhibited at the State and five county fairs. The University of Wisconsin Extension Livestock team assisted WCA in implementing the project. In total 1,142 steers were identified with RFID tags. Exhibitors were required to register their premises through the state's system. A brief one page, ten question survey was conducted by county Extension. The survey questions were either yes/no or scalar from 1 to 5. A total of 112 surveys were returned which was approximately a 50% return rate. Respondents indicated that the project tended to increase their knowledge of the electronic animal identification system. Responses regarding the premise registration form as being simple to understand and ease of registering their premise were between "Undecided" and "Agree". Exhibitor responses indicated the process did not appear to slow the check-in process. The

majority of the participants felt the tags did not negatively impact the appearance of their show animal either. Based upon the survey responses only, a total of 14 steers had lost the RFID device. The total number lost is unknown as not all steers that were identified at the check-ins were exhibited. Additionally, nine steers were reported by the survey respondents to have developed an infection around the site of administration. It is uncertain as to the cause and warrants further investigation. This project reports responses from neutral to acceptable regarding the device as an acceptable form of animal identification by the respondents. The project was reported by survey respondents to be important for the livestock show industry as a National Animal Identification System is developed. The use of RFID technology appears to be a plausible method for identifying cattle going to exhibitions but is not faultless. As the industry continues to make advances to the development of a national animal identification system, Extension will need to provide increased education to exhibitors regarding the system.

Key Words: Cattle, Electronic identification, Youth

Food Safety: Foodborne Pathogens in Beef and Dairy Cattle

T87 Effect of plant extract supplementation on digestive tract microbiota and carcass contamination in young Holstein bulls receiving a high-concentrate diet. M. Devant*¹, C. Adelantado², A. Anglada¹, A. Bach^{1,3}, and M. A. Calvo², ¹IRTA-Unitat de Remugants, Barcelona, Spain, ²UAB-Departament de Sanitat i d'Anatomia Animals, Barcelona, Spain, ³ICREA, Institució Catalana de Recerca i Estudis Avançats, Barcelona, Spain.

Ninety male Holstein bulls were used in a completely randomized design experiment to study the effect of a blend of plant extracts (PE: cynarin, ginseng and fenugreek) supplementation on digestive tract microbiota, and carcass contamination. Three treatments: control (CTR), monensin (MON, 32 mg/kg DM), and PE (2.8 g/kg DM) were tested. Bulls had ad libitum access to straw and concentrate during 108 d until slaughter weight (460 ± 30 kg). After sacrifice, samples from skin and carcasses before chilling at the brisket were collected to determine *Escherichia coli* O157:H7 and *Salmonella enterica typhimurium* presence. Also rumen, jejunum, cecum, and rectum grab-samples were collected to investigate *E. coli* O157:H7 and *S. enterica typhimurium* presence, and to count *E. coli*, lactic acid bacteria (LAB), aerobic mesophile bacteria (AMB), and fungi. Treatments did not affect rumen, jejunum, and rectum microbiota counts, and pathogenic bacteria studied. In the cecum, the percentage of LAB counts below 5 log cfu/mL was greater ($P < 0.01$) in MON (68.1%) than in CTR (34.6%) and PE (28.0%) treatments, the percentage of fungi counts below 3.5 log cfu/mL tended ($P = 0.09$) to be lower in CTR (26.7%) than in MON (66.7%) and PE (60.0%) treatments, and the percentage of the AMB counts below 8 log cfu/mL was greater ($P < 0.01$) in PE (46.7%) than in CTR (16.7%) and MON (16.7%) treatments. The prevalence of *E. coli* O157:H7 in the cecum tended ($P = 0.11$) to be lower in the MON (18.2%) than in the CTR (55.6%) and PE (57.2%) treatments. Skin and carcass contamination were not affected by treatment. Supplementation of bulls fed high-concentrate diets with monensin or plant extracts affected cecum microbiota; however, no differences in carcass contamination were detected.

Key Words: Beef, Plant extract, Carcass contamination

T88 Reduction adhesion of *E. coli* O157:H7 on CACO-2 cell by phage displayed peptides. C. J. Fu*, F. J. Schmidt, and M. S. Kerley, University of Missouri, Columbia.

Eighty phage clones, selected against pathogen *E. coli* O157:H7 by phage display technology, were tested to identify peptides adhesion to monolayers of CACO-2 cells. PEG/NaCl purified phages (10^{12}) and 10^5 bacteria from an overnight culture were inoculated into microtiter plate wells. Control experiments tested bacterial binding in the presence of phage clones from the unselected library or in the absence of phage. Inoculants (triplicate) were incubated in the same culture medium as CACO-2 cell for 45 minutes. Nonbinding bacteria were washed off (PBS), and the binding bacteria were dislodged with 2% tween-20 in DMEM medium for 10 minutes. Bacteria were serially diluted and plated on LB agar. Seven phage clones (PC23, PC41, PC43, PC61, PC62, PC77, and PC79) were found to reduce adhesion two-fold ($P < 0.10$) compared to both control incubations. This result suggests that specific peptides could influence adhesion affinity of gut bacteria, and thereby interfere with the establishment of chronic infection and subsequent shedding of pathogens such as *E. coli* O157:H7.

Key Words: Adhesion, CACO-2, *E. coli* O157:H7

T89 Effects of potassium lactate, sodium metasilicate, peroxyacetic acid and acidified sodium chlorite on physical properties of ground beef. S. A. Quilo*, F. W. Pohlman, A. H. Brown, P. G. Crandall, P. N. Dias-Morse, R. T. Baublits, and C. Bokina, University of Arkansas, Fayetteville.

Beef trimmings (90/10) that were left untreated (CON), or were treated with either 3% potassium lactate (KL), 4% sodium metasilicate (NMS), 200 ppm of peroxyacetic acid (PAA) or 1000 ppm acidified sodium chlorite (ASC) prior to grinding were utilized to evaluate antimicrobial chemical compound impact on bulk ground beef instrumental and sensory characteristics. After antimicrobial application, the trimmings were ground, weighed, packaged and evaluated during simulated retail

display. Bulk ground beef from the PAA treatment was lighter (L^* ; $P < 0.05$) than CON while KL and ASC were similar ($P > 0.05$) to CON. The NMS, PAA and KL ground beef were similar in redness values (a^* ; $P > 0.05$) to CON and more red ($P < 0.05$) than ASC. The KL and PAA treatments presented similar (b^* ; $P > 0.05$) yellow color to CON. In contrast, the NMS and ASC treatments were less ($P < 0.05$) yellow than CON. The NMS treatment had higher estimations of oxymyoglobin proportions (630 nm/580 nm; $P < 0.05$) when compared to CON, whereas KL and PAA were similar ($P > 0.05$) to CON for this attribute. The NMS treatment also had a lower hue angle ($\tan^{-1}(b^*/a^*)$; $P < 0.05$) than CON, whereas all other treatments were similar to CON. Sensory attributes were measured by panelists on bulk ground beef, and indicated that KL, NMS and PAA were similar ($P > 0.05$) to CON for overall color, worst point color, and percent discoloration on day 0 of display. On day 7 of display panelists detected greater ($P < 0.05$) overall red color for the NMS and KL treatments when compared to the CON, whereas PAA and ASC treatments were similar ($P > 0.05$) to the CON for this attribute. These results suggest that application of NMS, KL, PAA or ASC antimicrobials to beef trimmings prior to grinding can generally allow for similar or improved ground beef color characteristics during retail display.

Key Words: Ground beef, Antimicrobials, Instrumental color

T90 A long-term, sub-clinical, outbreak of *Salmonella enterica* subsp. *enterica* Cerro in a Pennsylvania dairy herd. J. S. Van Kessel¹, J. S. Karns¹, D. R. Wolfgang², E. Hovingh², and Y. H. Schukken³, ¹USDA-ARS, Beltsville, MD, ²Pennsylvania State University, University Park, ³Cornell University, Ithaca, NY.

Salmonella is a prominent foodborne pathogen in the US and dairy cattle have frequently been identified as reservoirs for this organism. Here we describe a long-term outbreak of *Salmonella enterica* subsp. *enterica* Cerro that was detected in a Pennsylvania dairy herd during routine monitoring as part of a longitudinal study of several dairy herds. An initial analysis of individual fecal grab samples from the milking herd indicated a very low prevalence of *Salmonella* (1/102) and *Salmonella* was not detected in 10 environmental samples. In a subsequent sampling 6 mo later, *Salmonella* was isolated from 43.5% (47/108) of the cows and 40% of collected environmental samples (10/25). The *Salmonella* isolated in the first sampling was serovar Typhimurium var. Copenhagen, however isolates from the second herd sampling were serovars Cerro (91.5%) and Kentucky (8.5%). Sporadic environmental sampling between these initial complete milking herd samplings yielded serotypes Kentucky, Typhimurium var. Copenhagen, and Cerro and clinical salmonellosis was observed in several cows shedding Typhimurium var. Copenhagen. The herd was sampled nine additional times over the next 14 mo and fecal prevalence of *Salmonella* ranged from 8.4% to 89%. Prevalence remained high (58 to 69%) over the following 8 mo, showed evidence of decline over the next 3 mo, and then increased again to 89%. Cerro was the only serotype isolated during this period. Bulk milk was cultured weekly during this 22-mo period and *Salmonella* was isolated from 5.3% (5/94) of milk samples. For the last 14 mo of the study, milk filters were also cultured for *Salmonella* on a weekly basis and 65% (37/57) of the filters tested positive. There were no significant health or production concerns in the herd during this outbreak. Based on these observations we conclude that sub-clinical *Salmonella enterica* subsp. *enterica* Cerro infection can be persistent in a milking herd.

Key Words: *Salmonella*, Dairy, Cerro

T91 Prevalence of Shiga toxin-producing *Escherichia coli* in beef cattle grazing irrigated pastures or rangeland forages during winter and spring. L. M. Bollinger¹, H. S. Hussein¹, M. R. Hall¹, and E. R. Atwill², ¹University of Nevada, Reno, ²University of California-Davis, Tulare.

Since the first outbreak of Shiga toxin-producing *Escherichia coli* (STEC), the role of beef in human infection has been emphasized. In the US, *E. coli* O157:H7 has been the STEC commonly associated with human illnesses ranging from diarrhea to the life-threatening hemolytic uremic syndrome (HUS). Worldwide, a large number of STEC serotypes have caused similar illnesses. The objective was to assess STEC prevalence in four cow/calf operations on pasture (ranging from 38 to 1,300 cows) and five on the range (ranging from 65 to 225 cows) in California during winter and spring. Fecal samples were collected from 319 cattle on pasture and 365 on the range. Prevalence rate of STEC was not affected ($P > 0.05$) by season for cattle on pasture (averaging 3.8%) but was higher ($P < 0.05$) in winter than in spring for those on the range (13.6 vs 0.6%). Across operations and seasons, calves had a higher ($P < 0.05$) STEC prevalence rate than cows (12.4 vs 2.3%). Cattle on pasture had a lower ($P < 0.05$) STEC prevalence rate than those on the range (3.8 vs 7.7%). The STEC isolates belonged to 16 serotypes (*E. coli* O26:HUT [an untypeable H antigen], O86:H2, O111:H16, O125:H2, O125:H16, O125:H19, O125:H⁻ [a nonmotile isolate], O127:H2, O127:H19, O128:H16, O146:H21, O166:H2, OUT [an untypeable O antigen]:H2, OUT:H16, OUT:H⁻, and OUT:HUT). Of these serotypes, five (*E. coli* O26:HUT, O125:H⁻, O146:H21, OUT:H2, and OUT:H⁻) are known to cause HUS and two (*E. coli* OUT:H16 and OUT:HUT) are known to cause other human illnesses. Eight of the serotypes (*E. coli* O86:H2, O125:H2, O125:H16, O125:H19, O127:H2, O127:H19, O128:H16, and O166:H2) detected in this study have not been reported in cattle. Interestingly, *E. coli* O157:H7 isolates were not found in the cattle tested. The results of this study illustrate grazing beef cattle as a reservoir of a wide range of STEC of which several serotypes are pathogenic to humans. Thus, it is critically important to develop and implement control measures to decrease carriage and fecal shedding of these foodborne pathogens by beef cattle.

Key Words: Food safety, Beef cattle, *Escherichia coli*

T92 Prevalence of Shiga toxin-producing *Escherichia coli* in dairy cattle during winter and spring. H. S. Hussein¹, L. M. Bollinger¹, M. R. Hall¹, and E. R. Atwill², ¹University of Nevada, Reno, ²University of California-Davis, Tulare.

The role of dairy cattle in human infections with Shiga toxin-producing *Escherichia coli* (STEC) has emerged in the past two decades. A large number of outbreaks and sporadic cases of human illnesses resulted from visiting dairy farms or consumption of raw milk, dairy products, or ground beef from culled dairy cows. The illnesses included mild or bloody diarrhea, vomiting, abdominal pain, hemorrhagic colitis, and the life-threatening hemolytic uremic syndrome (HUS). The objective was to determine STEC prevalence in four dairy farms (averaging 713 Holstein cows and heifers) in California during winter and spring. Fresh fecal samples were collected from 532 cows and 73 heifers. Over the two seasons, STEC were recovered in all farms with prevalence rates ranging from 0.6 to 4.1%. Prevalence of STEC was not altered ($P > 0.05$) by season, parity, or days in milk (1 to 60, 61 to 150, or 151 d). The corresponding prevalence rates averaged 2.0, 1.5, and 1.3%, respectively. Heifers tended to have a higher ($P = 0.17$) prevalence rate of STEC than cows (5.5 vs 1.5%). The STEC isolates belonged to five

serotypes (*E. coli* O15:H⁻ [a nonmotile isolate], O127:H19, O136:HUT [an untypeable H antigen], OUT [an untypeable O antigen]:H⁻, and OUT:HUT). Of these STEC serotypes, one (*E. coli* OUT:H⁻) is known to cause HUS and two (*E. coli* O15:H⁻ and OUT:HUT) are known to cause other human illnesses. The *E. coli* O127:H19 serotype detected in this study has not been reported in cattle. Interestingly, *E. coli*

O157:H7 isolates were not found in the cattle tested. The results of this study emphasize the importance of testing dairy cattle for STEC, in general, and suggest the need for developing pre-harvest control methods to decrease carriage and fecal shedding of these foodborne pathogens.

Key Words: Food safety, Dairy cattle, *Escherichia coli*

Forages and Pastures: Silages and Dairy

T93 Dynamics of early fermentation of *Albizia lebbbeck* silage. T. Clavero* and R. Razz, *Centro de Transferencia de Tecnología en Pastos y Forrejes. Facultad de Agronomía. Universidad del Zulia, Maracaibo, Zulia, Venezuela.*

The dynamics of fermentation were studied with *Albizia lebbbeck* ensiled in the western part of Venezuela. Chopped fresh plant materials were ensiled into a laboratory silo, with a relationship 1:2 (w:v) of legumes:molasses, and stored at 25°C, and then were opened on 0.5, 1, 3, 5, 7, 14 and 30 days after ensiling, respectively. The samples were taken from three silos at each sampling time and the fermentation qualities and nitrogenous components were analyzed. The fermentation dynamics showed a fast pH reduction ($P < 0.05$) within the initial three days of ensiling, decrease to 4.11 at day 5 and then remained almost constant until the end of ensiling (30 day). LA content showed a significant ($P < 0.05$) increase after the first day of ensiling, reaching the peak (8.19 g/kg) on day 7, followed by an insignificant decrease ($P > 0.05$). AA content increased significantly ($P < 0.05$) after 3 days of ensiling and reached a highest concentration (1.63 g/kg) on day 7. PA and BA were detected in no or only small amount over the ensiling period. This was attributed to a fast reduction in pH because of the rapid production of LA which restricted growth of clostridia. TN and PN showed a slight decrease within the initial 3 days of ensiling, followed by an insignificant decrease ($P > 0.05$). SN increased gradually and reached the highest value on day 3 ($P < 0.05$) and then tended to decrease. AN was not detected over the ensiling period. Some of the changes in nitrogenous components could be attributed to the action of plant enzymes within initial days of ensiling. This study showed that the silage made from *Albizia lebbbeck* with molasses addition had good fermentation characteristics where active LA fermentation took place in the initial stage of ensilage, resulting in a decrease pH with early stabilization of the medium.

Key Words: *Albizia lebbbeck*, Silage, Fermentation quality

T94 Effect of storage time on ruminal starch degradability in corn silage. J. R. Newbold*¹, E. A. Lewis¹, J. Lavrijssen¹, H. J. Brand¹, H. Vedder², and J. Bakker², ¹Provimi Research and Technology Centre, Brussels, Belgium, ²BLGG, Oosterbeek, The Netherlands.

Fifteen corn silages, covering a wide range in dry matter (DM) and starch content, were stored in bunker silos on commercial farms in the Netherlands. Each silo, filled with one harvest of one cultivar, was sampled at two-monthly intervals from approximately two to ten months after ensiling. Samples were frozen until evaluation of ruminal degradability. Three lactating Holstein cows were used to determine degradability of DM, starch and crude protein (CP) by *in sacco* incubation for 0, 3 and 24h, followed by machine washing. At ensiling, mean DM was 332g/kg (SD=55.0, range=171-476) and mean starch was 312g/kg DM (SD=59.7, range=126-426). Data were analysed by analysis of variance with repeated measures within each

subject (silo) and cultivar as covariate. The proportion of starch degraded after 3h incubation increased with storage time (mean = 0.532, 0.535, 0.589, 0.639, 0.690 when stored for 2, 4, 6, 8 and 10 months, respectively, SE=0.014, $P < 0.001$). Similar effects, of smaller magnitude, were observed for degradability of starch after 0h and 24h. Although the proportion of CP degraded also varied with time of storage (for example, 3h degradability = 0.392, 0.361, 0.335, 0.429 and 0.470 for 2, 4, 6, 8 and 10 month storage, respectively, $P < 0.001$), degradabilities of starch and CP were not correlated ($P > 0.1$). There was an interaction between effect of storage time and DM concentration at ensiling ($P < 0.001$): the increase in 3h starch degradability between 2 and 10 months of ensiling was 0.007 for silages <300g DM/kg at ensiling and 0.251 for silages >375g DM/kg at ensiling. The rate of increase in 3h starch degradability during storage was correlated positively with DM at ensiling ($r=0.77$, $P=0.006$) but not with starch concentration at ensiling ($r=0.26$, $P=0.35$). The effect of time since ensiling on starch degradability should be considered when formulating ruminant rations containing corn silage.

Key Words: Degradability, Starch, Corn silage

T95 Corn hybrid forage quality differences as influenced by ensiling. D. J. R. Cherney*, J. H. Cherney, and W. J. Cox, *Cornell University, Ithaca, NY.*

Hybrid selection is one of the most important management practices that affect the feeding quality of corn silage. Our objective was to determine the impact of ensiling on forage quality of 54 corn hybrids. Four field replicates of each hybrid were planted at each of two locations in NY in 2003 (Groveland Station, NY and Aurora, NY). Five plants from each hybrid were harvested, chopped through a chipper shredder, mixed and sub-sampled for fresh and ensiled samples. Silage samples were vacuum bagged within one hour of chopping. There were differences among hybrids in pH ($P < 0.01$) at both sites. pH of ensiled samples was positively correlated with silage dry matter (DM; $r=0.82$) and increased 0.016 pH units for each 10 g/kg increase in DM. All samples were well ensiled, with an average pH of 3.6, and an individual sample total range of 3.43 to 3.91. Dry matter of fresh and ensiled samples were highly correlated ($r=0.98$), with ensiled samples averaging 10 g/kg lower than their fresh counterpart. Crude protein (CP) of ensiled samples was highly correlated ($r=0.95$) with CP of fresh samples. The slope of ensiled sample CP to fresh CP was not different from unity, but there was a 4.1 g/kg bias in CP in favor of the ensiled samples, due to loss of dry matter from oven drying of silage. Sugar of fresh samples averaged 99 g/kg while that of corresponding ensiled samples averaged 36 g/kg. Ranking of hybrids for sugar changed from fresh to ensiled, but was not consistent between sites. Non fibrous carbohydrate of ensiled samples was 52 g/kg lower than fresh samples. There were hybrid x ensiling/fresh interactions for neutral detergent fiber (NDF) and *in vitro* true digestibility

IVTD at one site, this interaction was not significant at either site for fiber digestibility. Correlations between fresh and ensiled were $r=0.47$, $r=0.60$ and $r=0.74$ for NDF and IVTD and fiber digestibility, respectively. Inconsistencies for hybrid x ensiling/fresh interactions indicated that more research is needed to fully assess the relative benefits of ensiling prior to quality comparisons of corn hybrids.

Key Words: Corn silage, Forage quality

T96 Polymerase chain reaction for identification and quantification of *Lactobacillus buchneri* in silage. R. J. Schmidt*, S. Kim, M. G. Emara, and L. Kung, Jr., *University of Delaware, Newark.*

Lactobacillus buchneri is a gram-positive, heterofermentative bacterium that has been used as a silage additive for the past 5 years in the USA. This organism has been implicated to enhance the aerobic stability of silages; however the dynamics of this microbe in the process are not well understood. Traditional methods for species-specific quantification of bacteria are labor intensive and time-consuming, thus the aim of this study was to develop a PCR-based assay for identification and quantification of *L. buchneri* in silage. The assay is based on the amplification of a 134-bp 16S rDNA fragment. Species-specific primers were designed by alignment of the bacterial 16S rDNA sequences from known bacteria and selection of sequences specific at their 3' ends. The specificity of the primers was evaluated in a PCR using DNA from 10 lactic acid bacteria as templates and no cross reactivity was detected. Different methods to isolate the bacterial DNA from silage samples were evaluated before quantification: (1) phenol/chloroform (1×); (2) phenol/chloroform, followed by chloroform (3× each); (3) Ultraclean™ soil DNA kit; and (4) GenElute™ Bacterial Genomic DNA kit. Based on the DNA yield and purity, and the amplification curves, method (1) showed the best results (202 ng DNA/μL and $A_{260}/A_{280}=1.60$). To test our assay, corn silage was inoculated with *L. buchneri* 40788 (Lallemand Animal Nutrition, Milwaukee, WI) in the range of 10^3 to 10^8 colony-forming units (cfu)/g and then the isolated DNA from these treated samples was used as a standard for determining the log cfu of *L. buchneri* per gram of silage by real-time qPCR. The results demonstrated that real-time qPCR was highly correlated ($r^2 = 0.98$) with the different cfu of *L. buchneri* in the spiked silage samples. The PCR-based method proved to be faster and more sensitive for identifying and quantifying *L. buchneri* than classical methods. In addition, the assay will be an important tool for understanding the late effects of this bacterium during the ensiling process.

Key Words: *Lactobacillus buchneri*, qPCR, 16S rDNA

T97 The effect of staygreen ranking, maturity and moisture concentration of corn hybrids on the performance of dairy cows. K. G. Arriola*, A. T. Adesogan, C. R. Staples, D. B. Dean, S. C. Kim, N. A. Krueger, J. L. Foster, S. Chikagwa-Malunga, and M. C. Huysden, *University of Florida, Gainesville.*

This study aimed to determine the effects of hybrid staygreen ranking, maturity at harvest and added moisture to simulate rainfall at harvest on the performance of dairy cows. Two corn hybrids with high (Croplan Genetics 691, HSG) and low (Croplan Genetics 737, LSG) staygreen ranking were grown on separate halves of a 10-ha field, harvested at 26

(Cut 1) or 35% DM (Cut 2) and ensiled in 32-ton plastic bags for 84 and 77 d respectively. A further treatment involved addition of water (15 l/t) to the HSG, Cut 1 hybrid as it was being packed to simulate rainfall during ensiling. Each of the resulting silages was fed as part of a TMR consisting of 35, 55 and 10% (DM basis) of corn silage, concentrate and alfalfa hay, respectively. The TMR was fed ad libitum twice daily to 30 Holstein cows (92 average DIM). The experiment was a completely randomized design and consisted of two 28-d periods, with 14 d for adaptation and 14 d for sample collection. Body weight change (0.6 ± 0.1 kg/d), ruminal contraction rate (2.28 ± 0.14 contractions/min), milk production (36.02 ± 1.5 kg/d), milk fat (3.5 ± 0.1 kg/d) and milk protein (2.3 ± 0.05 kg/d) were not affected ($P>0.05$) by treatment. Intakes of DM (30 vs. 28 kg/d), CP (4.4 vs. 4.03 g/kgDM), NDF (9.3 vs. 8.3 g/kgDM) and ADF (6.2 vs. 5.5 g/kgDM) were greater in cows fed Cut 1 versus Cut 2 hybrids. Rectal temperatures were higher ($P<0.05$) in cows fed HSG (38.1°C) than those fed LSG (37.9°C). Staygreen x maturity interactions were not detected. Therefore, harvesting corn silage at 26% instead of 35% DM increased feed intake but did not affect milk yield or milk composition. Staygreen ranking of these corn hybrids or moisture concentration at ensiling had no differential effect on the performance of lactating dairy cows.

Key Words: Corn silage, Staygreen, Dairy cows

T98 High temperatures have detrimental effects on the stability of silage inoculants that have been rehydrated in water. C. N. Mulrooney*, W. Hu, and L. Kung, Jr., *University of Delaware, Newark.*

Microbial inoculants used to improve the fermentation of silages are often mixed in water and stored in containers that may be exposed to heat from high ambient temperatures and mechanical equipment. The objective of this research was to determine if exposure to high temperatures affects the viability of various inoculants. Inoculants (A-F) were enumerated on Mann Rogosa Sharpe agar to standardize a final count of colony forming units (CFU) in water such that about 473 ml added to a tonne of wet forage would achieve the recommended application rates of lactic acid bacteria (LAB) for each inoculant. Testing was done in four sequences (SEQ). For each SEQ, inoculants were rehydrated in deionized water for 45 min at 30°C followed by incubation for 6 h at 30°C (SEQ 1), 35°C (SEQ 2), 40°C (SEQ 3) or 45°C (SEQ 4) in duplicate 125 ml flasks rotating at 125 rpm. Rotation was stopped and the incubator temperature was lowered to 30°C for the next 18 h. Numbers of LAB were enumerated at 0, 3, 6, and 24 h. Each sequence was repeated twice. Data were analyzed using the MIXED procedure of SAS with repeated measures (time). Data after the first 3 h of incubation for each SEQ is shown below (LAB, log cfu/ml). Incubation at a moderate temperature (SEQ 1) did not affect the viability of the microbial inoculants. However, as temperature of incubation increased, the stability of some inoculants declined varying by inoculant, especially in SEQ 4. Only inoculant A was unaffected by any high temperature after 3 h of incubation. Precautions should be taken to ensure that rehydrated microbial inoculants do not reach elevated temperatures during use and storage.

Table 1.

Inoculant	SEQ 1	SEQ 1	SEQ 2	SEQ 2	SEQ 3	SEQ 3	SEQ 4	SEQ 4
	0 h	3 h	0 h	3 h	0 h	3 h	0 h	3 h
A	8.22	8.20	8.20	8.12	8.07	8.08	8.01	7.68
B	8.63	8.61	8.44	8.41	8.68 ^a	8.15 ^b	8.71 ^a	8.04 ^b
C	8.23	8.20	8.10	7.96	8.29 ^a	7.28 ^b	8.30 ^a	7.17 ^b
D	8.45 ^a	7.97 ^b	8.42 ^a	7.95 ^b	8.09 ^a	7.46 ^b	8.00 ^a	6.07 ^b
E	8.06	8.03	7.96	8.00	7.99	8.00	8.07 ^a	7.52 ^b
F	8.44	8.26	8.46 ^a	8.20 ^b	8.16 ^a	7.67 ^b	8.26 ^a	4.82 ^b

^{ab}Means in rows within a sequence with different superscript differ $P < 0.05$.

Key Words: Silage, Inoculant, Lactic acid bacteria

T99 Effect of corn silage maturity and mechanical processing on nutrient digestibility by lactating dairy cows of different lactation stages. G. Ferreira¹ and D. R. Mertens^{*2}, ¹University of Wisconsin, Madison, ²USDA-ARS, US Dairy Forage Research Center, Madison, WI.

Starch digestibility (StarchD) can decrease when corn silage is harvested at advanced stages of maturity. Processing corn silage through rollers during chopping typically increases StarchD. We hypothesized that corn silage processing increases StarchD in lactating dairy cows to a greater extent when corn silage is harvested at a late (L) than at an early (E) maturity stage. Corn silages were harvested at 34 or 42% DM (E and L, respectively) and with (P) or without (U) kernel processors. Twenty-four cows in mid lactation and 24 cows in late lactation (73±23 and 455±113 DIM, respectively) were used in a replicated 4×4 Latin square design with 28-d periods to determine nutrient digestibility. Diets contained ~70% corn silage (DM basis). Total tract nutrient digestibilities were measured using LaCl₃ as an external marker. Maturity ($P < 0.06$) and processing ($P < 0.01$) affected dry matter digestibility (69.6, 73.6, 68.7, 72.5% for EU, EP, LU and LP, respectively; SEM=1.0), but the interaction was not significant ($P > 0.20$). Fiber digestibility (NDFD) was greater for cows in late lactation than for cows in mid lactation (48.7 vs. 44.6%, $P < 0.01$). Maturity ($P < 0.01$) and processing ($P < 0.02$) affected NDFD (49.6, 51.3, 41.0, 44.7% for EU, EP, LU and LP, respectively; SEM=2.4), but the interaction was not significant ($P > 0.20$). Lactation stage did not affect StarchD ($P > 0.20$). In agreement with our hypothesis, we observed a significant maturity by processing interaction ($P < 0.04$) for StarchD (92.7, 98.0, 91.4, 98.5% for EU, EP, LU and LP, respectively; SEM=0.7), although the difference in StarchD between EU and LU was less than expected. The corn silage fragmentation index (JDS 88:4414-4425) for EU and LU corn silages was 41 and 58%, respectively, suggesting that a greater fragmentation of the kernels occurred during harvesting of the LU corn silage. This increased fragmentation may have attenuated the negative effect of maturity on StarchD. We concluded that the increase of StarchD due to processing is greatest when corn silages are harvested at advanced stages of maturity.

Key Words: Corn silage maturity, Corn silage processing, Corn silage fragmentation index

T100 Conjugated linoleic acid and omega-3 fatty acids in milk of grazing dairy cows fed fish oil and linseed oil. W. Brown^{*1}, A. AbuGhazaleh¹, and S. Ibrahim², ¹Southern Illinois University, Carbondale, ²North Carolina A&T State University, Greensboro.

The objective of this experiment was to determine the effect fish oil (FO) and linseed oil (LSO) on milk conjugated linoleic acid (CLA) and omega-3 fatty acids when fed to grazing dairy cows. Sixteen Holstein cows (180 ± 20 DIM) were fed a TMR (50:50) diet for 1 wk then divided into 2 groups (n=8 per treatment) and offered oil supplements for 6 wk. Cows in group one were fed a basal diet (8.2 kg/d; DM basis) consisting of corn, soybean meal, molasses, vitamin/mineral premix plus 800 g animal fat (CONT). Cows in the second group were fed the basal diet plus 200 g of FO and 600 g of LSO (FOLSO). Cows were milked twice a day and milk samples were collected weekly. Cows grazed together on Sudan grass pasture for ad libitum and fed treatment diets after the morning and afternoon milking. Analysis of variance was conducted using the MIXED procedure of SAS for a completely randomized design with repeated measures. Treatments had no effect ($P > 0.05$) on milk production (24.4 and 22.8 kg/d for treatments 1 and 2, respectively), milk protein percentages (2.80 and 2.90%), and milk protein yield (0.67 and 0.67 kg/day). Milk fat percentages (3.8 and 3.0%) and yield (0.91 and 0.69) were higher ($P < 0.05$) for cows fed the control diet. The concentrations of cis-9 trans-11 CLA (0.63 and 2.48g/100g of fatty acids) and vaccenic acid (2.1 and 7.3 g/100g of fatty acids) in milk fat were higher ($P < 0.01$) in cows fed FOLSO diet compared with control diet. The concentration of cis-9 trans-11 CLA in milk fat reached maximum (0.58 and 2.9 g/100g fatty acid for diets 1 and 2, respectively) on wk 1 with concentrations for both diets remaining relatively constant thereafter. Concentrations of C18:3 (0.41 and 1.10 g/100g of fatty acids), C20:5 (0.03 and 0.07g/100g of fatty acids), and C22:6 (0.005 and 0.05 g/100g of fatty acids) in milk fat were higher ($P < 0.05$) in cows fed the FOLSO diet. In conclusion supplementing grazing cow diets with FOLSO enhances milk cis-9 trans-11 CLA and omega-3 fatty acids content and could be used as a practical approach to increase CLA and omega-3 fatty acids as functional ingredients in milk.

Key Words: Grazing, CLA, Oil supplements

T101 Economic and environmental impacts of corn silage maturity management. C. S. Ballard^{*}, M. P. Carter, K. W. Cotanch, H. M. Dann, H. M. Wolford, J. W. Darrah, E. D. Thomas, and R. J. Grant, *W. H. Miner Agricultural Research Institute, Chazy, NY.*

The objectives of this study were to evaluate yield and forage quality changes with increasing maturity for one corn hybrid and to determine the effect of maturity on silage effluent production. One field of NK3030 (RM93d) was harvested following a completely randomized design with four replicates at each of three levels of maturity with target dry matters (DM) of: 25% (Mature 1), 30% (Mature 2), and 35% (Mature 3). Concrete silos (91-cm diameter, 109-cm length), equipped with an effluent collection system, were filled with 497 ± 20 kg of fresh corn forage. A temperature data logger was buried midway through the silo to record silage temperature throughout fermentation. Effluent was collected one week after silo filling and analyzed for 5-day biochemical oxygen demand (BOD5) and nutrient content. After 70-100 days of ensiling, silos were opened and emptied. The top 15 cm of silage was weighed and discarded. The remaining silage was removed and analyzed for chemical composition, DM digestibility (DMd) determined by 48 h in vitro dry matter disappearance, and economic value as determined by estimating milk yield using Milk2000

(University of Wisconsin v 7.54). Data were analyzed as a one-way analysis of variance with Tukey Test used for mean separation of treatment differences. The harvested forage was less mature than anticipated with DM of 23%, 25% and 31% for the three levels of maturity. Forage ensiled at Mature 2 resulted in 8.8 L of effluent and 3000 kg less milk compared to corn forage ensiled at Mature 3.

Table 1. Effect of corn maturity at harvest on yield, nutrients, effluent, and estimated milk yield of corn silage

	Mature 1		Mature 2		Mature 3		P
	Mean	sd	Mean	sd	Mean	sd	
DM Yield (T/Ha)	15.33 ^b	0.99	15.53 ^b	0.20	16.90 ^a	0.58	0.02
CP (g/kg DM)	82 ^a	4	86 ^a	3	76 ^b	6	<0.01
NDF (g/kgDM)	498 ^a	10	445 ^b	9	425 ^c	15	<0.01
DMD (g/kg DM)	786 ^b	8	808 ^a	14	812 ^a	13	<0.01
Effluent (L)	2.68 ^b	2.4	8.83 ^a	0.5	0 ^c	0	<0.01
Effluent BOD5 (g/L)	28.5	13.6	36.3	0.9	-	-	0.30
Milk Yield (kg/Ha)	25,120 ^c	888	26,505 ^b	994	29,563 ^a	1123	<0.01

a,b,c Means within a row with different superscript differ ($P < 0.05$).

Key Words: Corn silage, Maturity, Effluent

T102 An evaluation of various nitrogenous additives or a microbial inoculant on the fermentation and aerobic stability of corn silage.
R. J. Schmidt^{*1}, P. G. Summer², and L. Kung, Jr.¹, ¹University of Delaware, Newark, ²Ajinomoto USA, Inc., Eddyville, IA.

Various N-based compounds or a microbial inoculant were added to freshly chopped whole-plant corn to determine their effects on silage fermentation and aerobic stability. Treatments were: 1) nothing, control (C), 2) 0.75% (wet forage weight) urea (about 7% added CP/t DM), 3) 2.5% Silaferm (A1) (an amino acid fermentation liquor byproduct, Ajinomoto, USA, Inc, Eddyville, IA, about 3.5% added CP/t DM), 4) 5% Silaferm (A2) (about 7% added CP/t DM), 5) 2.35% Silaferm and urea combination (AU) (about 7% added CP, 60% of CP from urea and 40% from Silaferm), or 6) *L. buchneri* and *P. pentosaceus* (LBC) (400,000 and 100,000 cfu/g of wet forage, respectively, Lallemand Animal Nutrition, Milwaukee, WI). Forages were packed into quadruplet 20-l mini silos for each treatment and ensiled for 120 d. Relative to C and LBC silages, addition of the various N-based treatments had minimal effects on the acid end products of silage but they increased ($P < 0.05$) the concentrations of ammonia-N and CP and decreased ($P < 0.05$) the concentration of ethanol in silage. Silage A1 had higher ($P < 0.05$) in vitro DM digestibility compared with control (52.25 vs. 46.73%), while A2, AU, U and LBC were all intermediate in DMD; 50.25, 50.89, 48.88 and 48.89%, respectively. Silage A2 had a higher level ($P < 0.05$) of true protein, measured as tungstic acid insoluble N (6.96 % of DM) compared with all other treatments (average of 5.85%). Silage AU had a higher ($P < 0.05$) concentration of tungstic acid insoluble N (6.30%) compared with C and LBC silages (5.58 and 5.51%, respectively). Silage LBC had more ($P < 0.05$) acetic (1.63 vs. 1.07%) acid and 1,2 propanediol (0.94 vs. 0.0%) than did silage C. Treatment with LBC (66.5 h) and AU (44.0 h) improved ($P < 0.05$) the aerobic stability of silage compared to C (28.5 h). Dry matter recovery was not different among treatments. Treatment with amino acid fermentation byproducts and urea has potential for improving the nutritive value and aerobic stability of corn silage.

Key Words: Silage, Inoculant, Amino acids

T103 Corn silage genotype effects on intake, digestion, and milk production by dairy cows. J. P. Goesser*, R. D. Shaver, and J. G. Coors, University of Wisconsin, Madison.

The Wisconsin Quality Synthetic (WQS C3) is a corn breeding population under selection at the University of Wisconsin for improved NDF digestion and silage yield. A recessive allele, *floury2*, increases floury endosperm in corn grain, and its starch has been found to be more ruminally degradable than dent corn. Population WQS C3, and two near-isogenic hybrids, W64AXOH43 (ISO) and W64AXOH43 *fl2* (*fl2*), were harvested from isolated 0.5 ha plots as whole-plant corn silage at approximately 35% DM. Treatment silages were fed in TMR to six cows assigned randomly to a replicated 3x3 Latin Square design with 21-d periods. However, only two periods were completed due to unforeseen silage shortages. Data were analyzed using a mixed models procedure. The ISO, *fl2*, and WQS C3 corn silages averaged 35.9, 35.7, and 35.7 % NDF, respectively. Diets were formulated to meet or exceed NRC (2001) protein, mineral, and vitamin requirements and averaged 30.8% NDF. Diets were comprised of 54% corn silage, 36% concentrate, and 10% alfalfa hay (DM basis). Lactation performance and digestion data are presented in Table 1. Intake and milk production did not differ among treatments. Ruminant 48-h in situ DM and NDF disappearance were greater for WQS C3, but total tract NDF digestibilities were not in agreement with our in situ results or prior in vitro measurements. Reduced total tract NDF digestibility for ISO relative to *fl2* was unexpected based on previous in vitro measurements and our in situ measurements, and cannot be explained. Starch in situ disappearance and total tract digestibility will be determined.

Table 1

Item		W64A	<i>fl2</i>	WQS	SE	P
Dietary DM	%	50.3	47.7	50.9	1.0	NS
DMI	kg/d	22.6	23.2	24.4	1.0	NS
Milk Yield	kg/d	36.0	37.3	37.3	2.7	NS
24-h ruminal DM disappearance	%	64.0	62.0	66.5	1.2	0.07
24-h ruminal NDF disappearance	%	31.3	30.1	38.0	2.5	0.12
48-h ruminal DM disappearance	%	75.4 ^b	74.5 ^b	79.5 ^a	0.9	0.03
48-h ruminal NDF disappearance	%	52.9 ^b	54.6 ^b	62.2 ^a	1.9	0.04
Total tract DM digestibility	%	56.4	63.1	63.1	2.2	NS
Total tract NDF digestibility	%	32.1 ^b	46.1 ^a	48.6 ^a	2.8	0.03

Key Words: Corn silage, NDF digestibility, DM digestibility

T104 The nutritive value of normal- or high-cut normal corn silage versus normal-cut BMR corn silage for lactating dairy cows.
B. M. Moulder*, L. Kung, Jr., R. S. Teller, C. N. Mulrooney, and R. J. Schmidt, University of Delaware, Newark.

A normal corn silage hybrid (Mycogen FQ7511) was cut at a normal height (leaving 10-15 cm of stalk) or a high height (leaving 46-51 cm of stalk) and a BMR hybrid (F2F797) was harvested at a normal-cut height (leaving 10-15 cm of stalk). High cutting of FQ7511 increased the concentrations of DM (+4%), CP (+5%), NEL (+3%) and starch (+7%) but decreased the concentrations of ADF (-9%), NDF (-8%) and ADL (-13%) compared to normal-cut FQ7511. The 30 h NDF-D of normal-cut FQ7511, high-cut FQ7511 and normal-cut BMR corn silage was 51.7, 51.4, and 63.5%, respectively. Corn silages were fed to cows and comprised 45% of the TMR ration DM. Diets were isonitrogenous and isocaloric. Thirty Holstein cows (average 81 ± 48 DIM) were blocked by production and DIM and randomly assigned

to ten simultaneous 3 × 3 Latin squares. Each period consisted of a 3-wk period and the data from last 10 d of each period was used for statistical analysis. Mean separation was performed using the Least Significant Difference procedure when the treatment effect was significant. Milk production, milk protein production and milk lactose % were greater ($P < 0.05$) for cows fed normal-cut BMR (48.8 kg/d, 1.40 kg/d, 4.88%) than for those fed normal-cut FQ7511 (46.8 kg/d, 1.34 kg/d, 4.82%) or high cut 7511 (47.7 kg/d, 1.36 kg/d, 4.83%). Cows fed high-cut FQ7511 had milk with less fat (3.48%) than cows fed high-cut silage (3.60%). Cows fed BMR corn silage tended to produce more ($P < 0.12$) 3.5% FCM than cows fed the other silages. Dry matter intake was not affected by treatment. Feed efficiency (kg of 3.5% FCM milk/kg of DMI) was greater (1.83, $P < 0.05$) for cows fed normal-cut BMR than those fed normal-cut 7511 (1.77) or high cut 7511 (1.75) corn silages. Cows fed normal-cut BMR had milk with a lower ($P < 0.05$) MUN (14.8 mg/dl) than did other treatments (average of 16.2 ml/dl). Harvesting a normal corn hybrid at a high-cut height improved its nutritive value but the improvement in feeding value to lactating cows was not equivalent to that found when cows were fed BMR corn silage harvested at a normal-cut height.

Key Words: BMR, Corn silage, Cutting height

T105 Fermentation characteristics of sugarcane silage mixing with *Gliricidia sepium* and cassava tops. T. Clavero*¹, R. Razz¹, and J. Urdaneta², ¹Centro de Transferencia de Tecnología en Pastos y Forrajes. Facultad de Agronomía. Universidad del Zulia, Maracaibo, Zulia, Venezuela, ²INIA, San Felipe, Yaracuy, Venezuela.

In order to increase the concentration of CP and improve fermentation quality of sugarcane silage, we tested ensiling with *Gliricidia sepium* and/ or cassava tops. Sugarcane was cultivated in a tropical dry forest in north central Venezuela. *Gliricidia sepium* tops (GS) were harvested at 2 month's regrowth. Cassava tops (leaves and stems) were collected right after root harvesting. The treatments for silage making were: 100% sugarcane (SC), 98% SC + 2% GS, 96% SC + 4% GS, 92% SC + 8% GS and 92% SC + 4% GS + 4% of cassava tops. Fresh plant materials were chopped to 1 cm length, mixed according to treatment, ensiled in laboratory silos and stored at 25°C for 60 d. After opening the silos, DM, pH, total nitrogen content (TN), volatile basic nitrogen (VBN), NDF and ADF were determined. The data were analyzed according to a completely randomized design with three replications. Across all mixed silages, NDF concentrations were reduced by 5.4%. Dry matter and ADF concentrations were not affected by treatment. All mixed silages had decreased ($P < 0.01$) pH when compared with SC silage. Addition of GS or cassava increased ($P < 0.05$) TN in silages, with a tendency ($P < 0.10$) of increased TN with increased GS in the silage mixture. Also, TN concentrations did not differ between 8% GS and 4% GS + 4% cassava treatments. Sugarcane silage had extremely high VBN (21.3%) whereas mean VBN for mixed silages was 12.8%. Tannin concentrations in the mixed silages may have limited proteolytic activities thus reducing the loss of silage nitrogen. In the present experiment, mixing GS and/or cassava tops with sugarcane during silage making improved silage quality parameters.

Key Words: Mixing, Sugarcane, Silage quality

T106 Use of effective microorganisms (EM) as additive for grass silage. E. González*^{1,2}, R. Casals², and E. Albanell², ¹Estación Experimental Pastos y Forrajes IH, Central España, Matanzas, Cuba, ²Grup de Recerca en Remugants; Facultat Veterinaria, Universitat Autònoma de Barcelona, Bellaterra, Barcelona, Spain.

Mixtures of selected species of microorganisms including predominant populations of lactic acid bacteria, photosynthetic bacteria, yeasts, actinomycetes and molds, have been effectively used recently and have gained attention worldwide for sustainable agriculture (improving soil quality, soil health, and the growth, yield, and quality of crops), and to a lesser extent, in animal production systems. Two effective microorganisms (EM) solutions, control fermented solution (EM-U) or fermented solution with added sugarcane molasses, (EM-A) were evaluated as additives for ensiling sorghum (*Sorghum bicolor*) harvested during the end of summer season in Catalonia, Spain. The inoculant (EM) was mixed (% of fresh wt) with the chopped grass (≈2 cm particle size) to form four treatments: 1) Control (No EM); 2) EM-A2 (EM-A inoculant applied at 2%); and 3) EM-A5 (EM-A at 5%); and 4) EM-U2 (EM-U at 2%). For each treatment, duplicate plastic bags were filled with 20 kg of fresh chopped sorghum, adequately compacted and stored at ambient temperature in the dark. After 2.5 months incubation, the two bags per treatment were emptied and sampled in order to determine effluent pH, DM, and volatile fatty acids (VFA) and ammonia nitrogen (NH₃-N) concentrations. Statistical analysis of data was performed with PROC GLM of SAS. Effective microorganisms improved ($P < 0.05$) fermentation characteristics of silages, decreasing pH and NH₃-N, and increasing VFA concentrations. There were significant differences ($P < 0.05$) between the doses for the evaluated parameters; lowest pH (4.05) was obtained with EM-A2, while no differences were detected for NH₃-N and VFA between the two extended treatments (EM-A2 and EM-A5). Control and EM-U2 treatments did not differ in DM (18.36 vs. 18.12%) or VFA (107.04 vs. 127.60 mmol/l) concentrations; however, pH and NH₃-N were decreased with EM-U2, which was considered the optimal treatment in this study.

Table 1. Effects of 'EM' on the conservation of *Sorghum bicolor*. Data are the average of treatments by duplicates

Item	Control	EM-A2	EM-A5	EM-U2	S.E.M	P value
DM content, %	18.36 ^a	16.82 ^b	16.55 ^b	18.12 ^a	0.31	0.003
pH	4.27 ^a	4.05 ^c	4.14 ^b	4.11 ^b	0.02	0.001
N-NH ₃ , mg/l	91.90 ^a	88.14 ^{ab}	84.51 ^{ab}	83.93 ^b	2.64	0.003
VFA, mmol/l	107.04 ^a	237.72 ^b	232.37 ^b	127.60 ^a	18.02	0.005

a,b,c: Within rows, for each parameter, means with different letters differ at $P < 0.05$

Key Words: Effective microorganisms, Silage, Conservation

T107 Fermentation characteristics of hairy indigo (*Indigofera hirsuta*) and guinea grass (*Panicum maximum*) ensiled alone or in combination. O. Araujo-Febres* and R. Razz, Facultad de Agronomía. La Universidad del Zulia, Maracaibo, Venezuela.

Characteristics of the forage legume hairy indigo (*Indigofera hirsuta*) ensiled as a sole crop or mixed with guinea grass (*Panicum maximum*) were evaluated. Tropical legumes are characterized as forages with high protein and lignin concentrations, and with relatively high concentrations of cell wall components. Thus, tropical legumes are difficult to ensile because of their low concentrations of water-soluble

carbohydrates which are required for lactic acid fermentation. In addition, tropical legumes contain high concentrations of buffering substances which counteract the desired quick pH drop for optimal conservation. This experiment was designed as a completely randomized design with four replications of three silages made either from guinea grass, hairy indigo or a 50:50 mixture of both forages on a w/w basis. Silages were stored in 20-L plastic containers, without additives, for 56 days. Cell wall components and N concentrations were assayed. Volatile fatty acid analysis was performed using gas chromatography. Results are shown in Table 1. Ensiling a 50:50 mixture of hairy indigo and guinea grass resulted in intermediate values for lactic acid, CP, NDF and lignin concentrations compared to the legume or grass alone. The pH and the concentrations of ADF of the mixture were similar to the grass but lower than for the legume. Acetic acid concentrations did not increase with addition of the grass to the legume. Butyric acid was not detected. These data indicate that guinea grass added to hairy indigo in equal proportions increased NDF and decreased CP concentrations, enhanced silage fermentation and quality, and decreased the pH to values needed for adequate forage preservation.

Table 1. Fermentation characteristics of hairy indigo and guinea grass, or ensiled in combination

Treatment	DM	pH	Lactate	Acetate	Butyrate	CP	NDF	ADF	Lignin
					% DM				
Legume	24.90a	6.03a	6.9c	1.1b	0.00	17.75a	45.77c	46.20a	12.63a
50:50	23.61a	4.79b	8.1b	1.6b	0.00	15.42b	54.52b	41.39b	7.75b
Grass	17.79b	4.60b	9.9a	2.1a	0.00	11.52c	67.74a	38.79b	4.59c

a, b, c means within column with different superscripts differ ($P \leq 0.05$).

Key Words: Indigofera hirsuta, Panicum maximum, Silage

T108 An evaluation of extended lactation as a strategy to alleviate reproductive loss in a seasonal pasture-based system. S. T. Butler*, L. Shalloo, and J. J. Murphy, *Teagasc Moorepark DPRC, Co. Cork, Ireland.*

This study was carried out to examine whether extending the calving interval to 24 months would be a viable alternative to culling and replacing cows that had failed to become pregnant during the breeding season. 46 non-pregnant lactating cows were assembled in late Nov 2004, paired on the basis of parity, days in milk, and previous milk production, and assigned to receive either 3 or 6 kg ('low' or 'high') concentrate and ad libitum grass and maize silage (50:50 mix) over the winter period (13 weeks). Cows were turned out to pasture in late March, and received 1 kg concentrate/day until dry-off (milk yield <5 kg/day). Cumulative milk production was calculated from calving to the end of Nov 2004 (normal period), and from the start of Dec 2004 until dry off in 2005 (extended period). Data were analysed using the MIXED procedure of SAS, with indoor feeding treatment and block in the model statement. High winter feeding resulted in greater ($P < 0.01$) milk production over the winter indoor period (20.0 ± 0.3 vs. 17.8 ± 0.3 kg/day), and had a carryover effect of increased milk production through the end of lactation (5177 vs. 4686 kg during the extended period, $P < 0.05$). At the end of the study period, cows (regardless of previous feeding) were ranked on the basis of cumulative milk solids, and separated into 3 groups (R1, R2, and R3). R1 produced 7287 (549) and 5738 (476) kg, R2 produced 6267 (466) and 4836 (393) kg, and R3 produced 5273 (391) and 4266 (350) kg milk in the normal and extended periods, respectively (milk solids in parentheses). Average lactation length was 593 days (range 475-677), was not affected by winter feeding, but was longer ($P < 0.05$) in R1 and R2 than R3 ($615 \pm 10, 609 \pm 13$, and 558 ± 13 , respectively). 85% of the cows became pregnant during the breeding season of year 2, with a first service conception rate of 52%, and was not affected by either feeding treatment or rank. The results indicate that extended lactation may be a viable alternative to culling non-pregnant cows, and seems more suited to high producing cows.

Key Words: Extended lactation

Graduate Student Paper Competition: National ADSA Production Division Poster Competition

T109 Predictors of stillbirth for cows moved to calving pens when calving is imminent. J. Carrier*, S. Godden, J. Fetrow, S. Stewart, and P. Rapnicki, *University of Minnesota, St. Paul.*

The objective of this study was to identify predictors for stillbirth (SB) in cows moved from freestalls to a calving pen when calving is imminent (therefore interrupting the parturition process). The herd was a 2500-cow dairy where pre-fresh heifers and cows were kept in two separate freestall pens and moved to individual pens for calving. Cows fresh from 11/2003 to 2/2004 were included in the cohort, excluding twin births. Stillbirth was defined as death of a calf at calving or within 24 hours of calving. The advance of parturition immediately prior to moving was scored as (a) presence of only mucus or blood at the vulva, (b) presence of a "water bag" (allantochorion or amnion) or (c) presence of feet or head. The other predictors were parity (1 vs. 2+), total serum calcium concentration of the dam after calving (totCa), calf weight (CW, expressed as % of the dam's weight) and body condition score (BCS). Calving ease score (CE) was reported on a 5-point scale, later contracted to 3 levels of assistance (1: none, 2: light and 3+:

required). A total of 495 parturitions could be videotaped (277 heifers, 218 cows). There were 15% SB in the cohort. The risk of SB was modeled using multivariate logistic regression. Odds ratios (OR) adjusted for the other predictors are shown with 95% C.I. Stillbirth was not associated with BCS. Compared to unassisted calvings (CE1), the odds of SB were 2.9x higher for CE2 (1.4 to 6.0) and 46x higher for CE3+ (17 to 120). Stillbirth odds were reduced by 36% per 1% unit increase of CW relative to the dam (OR = 0.64, 0.47 to 0.89). Similarly, the odds of SB tended to be reduced by 22% per 1-mg/dL increase in totCa (OR=0.78, 0.57 to 1.06). The odds of SB were 5.2x higher for heifers vs. cows (2.2 to 12). Cows moved to a calving pen earlier (mucus only) were 2.5x more at risk of SB than those moved later with a "water bag" (1.0 to 6.0), but presence of feet was not different from the "water bag" stage. The fact that advance of parturition, parity and totCa remained in the model even after adjustment for CE could be due to a potential association with duration of calving, to be analyzed in another part of the study.

Key Words: Stillbirth, Parturition, Epidemiology

T110 Effect of grains differing in expected ruminal fermentability on productivity of lactating dairy cows. C. Silveira^{*1}, M. Oba¹, J. Helm², and K. A. Beauchemin³, ¹University of Alberta, Edmonton, AB, Canada, ²Alberta Agriculture Food and Rural Development, Lacombe, AB, Canada, ³Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.

The objective was to evaluate effects of grains differing in expected fermentability in the rumen on dry matter intake (DMI) and productivity of lactating dairy cows. Twenty two multiparous and 9 primiparous lactating Holsteins cows (94 ± 29 d in milk; mean ± SD) were used in a 3 × 3 Latin square design with 21 d per period. Experimental diets contained either steam-rolled barley Dillon (BD), steam-rolled barley Xena (BX), or corn mix (CM; 87.5 % dry ground corn, 11.4% beet pulp, and 1.1% urea at DM basis; to match the starch and protein concentrations of BX) at 38% of dietary DM. Starch concentration was 50.0, 58.7, and 60.4% and in vitro 6-h starch digestibility was 73.5, 78.0, and 71.0%, respectively for BD, BX, and CM. All diets were formulated for 18.1% CP and 24.7% forage NDF. The DMI (23.6 vs. 21.6 kg/d; $P < 0.0001$), yields of milk (40.4 vs. 37.4 kg/d; $P < 0.002$), milk protein (1.20 vs. 1.12 kg/d; $P < 0.001$) and milk lactose (1.85 vs. 1.74 kg/d; $P < 0.006$) were higher for cows fed CM than for cows fed barley. Cows fed BX had higher yields of milk (38.5 vs. 36.2 kg/d; $P < 0.04$), milk protein (1.18 vs. 1.07 kg/d; $P < 0.001$) and milk lactose (1.80 vs. 1.69 kg/d; $P < 0.009$) than cows fed BD. However, milk fat concentration tended to be higher (3.47 vs. 3.23%, $P < 0.08$) for cows fed BD than BX. The DMI was not different between cows fed BX and BD (21.9 vs. 21.4 kg/d; $P < 0.35$). Differences in body weight were observed between cows fed BX and BD (-0.53 vs. 0.16 kg/d; $P < 0.001$). Greater milk production for cows fed CM compared with barley treatments might be attributed to expected slower starch digestion and greater DMI for CM. However, despite expected less ruminal fermentation, cows fed BD decreased milk production compared with BX, indicating that reducing starch digestion of barley grain may not improve productivity of lactating dairy cows.

Key Words: Barley, Starch digestibility, Dairy cows

T111 Plasma tumor necrosis factor- α concentrations during the transition period of cows fed at either ad libitum or restricted diet intakes during the dry period. L. A. Winkelman^{*1}, T. H. Elsasser², and C. K. Reynolds¹, ¹The Ohio State University, Columbus, ²USDA, ARS, Beltsville, MD.

Tumor necrosis factor- α (TNF- α) is a pro-inflammatory cytokine that upregulates suppressors of cytokine signaling (SOCS) mRNA and induces nitric oxide (NO) production. Both SOCS and NO inhibit intracellular growth hormone (GH) signaling and uncouple the somatotrophic axis. Liver TNF- α mRNA increases after calving in dairy cows, when GH signaling is disrupted. Plasma TNF- α concentrations in transition dairy cows have not been reported. The objective of this study was to measure plasma TNF- α , GH, and insulin-like growth factor-I (IGF-I) concentrations over the course of transition in dairy cows. Multiparous Holstein cows ($n = 18$), dried off 45 d before expected calving, were fed diets at either ad libitum (AL) or restricted (R) DMI until calving. The R diet was formulated to meet nutrient requirements at a DMI of 9.4 kg/d, while AL cows consumed 13.7 kg DM/d. Cows were fed the same diet ad libitum for 4 wk after calving. Coccygeal or jugular vein blood samples were collected weekly, with additional samples taken on days -18, -13, -9, -5, -2, +1, +4, and +7 relative to calving. Plasma TNF- α concentrations (pM) were unaffected by diet, but tended to be less ($P = 0.11$) after calving (5.02 vs. 4.77). Plasma GH concentrations (nM) were increased ($P < 0.01$) by R and

were greater ($P < 0.01$) after calving for all cows (prepartum: 0.06 vs. 0.05; postpartum: 0.15 vs. 0.11, for R vs. AL). Plasma IGF-I concentrations (nM) were unaffected by diet before calving, but decreased ($P < 0.01$) after calving for all cows (prepartum: 13.28 vs. 12.87; postpartum: 9.84 vs. 8.21, for R vs. AL, respectively). During wk 1 postpartum, IGF-I concentrations were less ($P < 0.01$) for AL vs. R (7.49 vs. 10.13). If TNF- α is involved in the uncoupling of GH signaling after calving, its role is not readily explained by peripheral plasma changes. Regulation of TNF- α within the liver itself may be more important to understand its role in GH signaling.

Key Words: TNF- α , Transition, Dairy cow

T112 The effect of feeding increasing levels of dried distillers grains plus solubles to dairy cows in early lactation. B. N. Janicek^{*} and P. J. Kononoff, University of Nebraska, Lincoln.

The objective of this experiment was to evaluate the effects of feeding increasing levels of dried distillers grains plus solubles (DDGS) on lactational performance of Holstein dairy cows. The hypothesis of this experiment was that increasing the levels of DDGS will decrease milk fat yield but not affect milk production or protein yield. Twenty multiparous Holstein cows averaging 76 ± 24 DIM and 638 ± 68 kg BW were randomly assigned to one of five 4 X 4 Latin squares. During each of the 28-d periods, cows were offered one of four dietary treatments. Based on the percent of diet dry matter, dietary treatments differed by the proportion of DDGS replacing both forage and corn grain. Dietary treatments were as follows 1) control, no DDGS, 2) 10% DDGS, 3) 20% DDGS, 4) 30% DDGS. Diets were formulated to be similar in crude protein (19%) and energy (1.74 Mcal/kg), but starch decreased with increasing levels of DDGS (24.5, 23.8, 23.3, and 23.0%). Dry matter intake increased ($P < 0.05$) linearly with increasing levels of DDGS (20.8, 21.8, 22.4, and 23.4 kg/d). Similarly, milk production tended ($P \leq 0.10$) to increase linearly (27.3, 28.5, 29.2, and 30.6 kg/d). Percentage of milk fat and protein did not differ across treatments, averaging 3.65 ± 0.16% and 3.17 ± 0.08% across experimental treatments. In comparison, fat yield tended ($P \leq 0.10$) to increase with increasing levels of DDGS (0.99, 1.03, 1.09, and 1.11 kg/d). Protein yield was not affected by dietary treatments, averaging 0.89 ± 0.05 kg/d. Milk urea nitrogen tended ($P \leq 0.10$) to decrease as the inclusion rate of DDGS increased (15.64, 15.21, 14.65, and 14.65 mg/dL). Milk fat yield did not decrease with increasing levels of DDGS while milk production tended to increase and protein yield remained unchanged. These results suggest that dairy diets may be formulated to contain DDGS at as high as 30% of the diet DM and may result in increased DMI and milk yield.

Key Words: Dairy cow, Distillers grain plus solubles, Lactation

T113 Gut peptide concentrations and dry matter intake in lactating dairy cows fed rumen-inert fats differing in degree of saturation. A. E. Relling^{*} and C. K. Reynolds, The Ohio State University, Wooster.

Adding fat to lactating dairy cow diets often decreases DMI, but the extent of the decrease varies, in part due to the iodine value of the fat fed. Our objective was to determine the effect of feeding rumen-inert fats differing in degree of saturation on DMI and plasma concentrations of insulin, glucagon-like peptide 1 (GLP-1), glucose-dependent insulinotropic polypeptide (GIP), and cholecystokinin (CCK) in lactating dairy cows. Four mid-lactation, primiparous, Holstein cows were fed a control ration containing (DM basis) 17 % alfalfa haylage, 38 % corn silage and 45 % concentrate in a 4 X 4 Latin square design

with 2-wk periods. Treatments were the addition of 3 rumen-inert fats at 3.5 % of ration DM comprised of mostly saturated (SFA), monounsaturated (MUFA) or polyunsaturated (PUFA) fatty acids. Hormone concentrations (pmol/L, Table 1) were measured in jugular vein plasma samples taken at 30 min intervals (15/d) on day 12 and 14. Feeding fat decreased DMI (d 11 - 14) and insulin concentration and increased GLP1 concentration, and the effect was greater for MUFA and PUFA vs. SFA. Feeding fat also increased CCK concentration, and the effect was greatest for MUFA. Degree of saturation determines the extent to which dietary fat decreases DMI in dairy cows, and the response is associated with changes in plasma concentrations of gut peptides.

Table 1. Dry matter intake and plasma hormone concentrations in lactating dairy cows fed rumen-inert fats.

Item	1	2	3	4	SEM	$P < .1$		
	Control	SFA	MUFA	PUFA		1 vs. 2-4	2 vs. 3,4	3 vs. 4
DMI, kg/d	23.8	23.1	22.1	22.0	1.1	0.042	0.115	0.725
GLP-1	27.8	29.6	32.9	31.9	1.7	0.004	0.036	0.527
GIP	499	590	570	534	63	0.004	0.129	0.181
CCK	10.0	12.6	15.9	13.8	1.6	0.001	0.017	0.040
Insulin	188	187	160	158	27	0.070	0.033	0.883

¹ Probability corresponding to effect of feeding fat (1 vs. 2-4), saturated vs. unsaturated fats (2 vs. 3, 4), or degree of unsaturation (3 vs. 4).

Key Words: Gut peptides, Rumen-inert fats, Saturation

T114 Chemical characterization, carbohydrate and protein subfractions, total digestible nutrients and estimated energy values of canola byproducts in ruminants. R. G. N. Heendeniya* and P. Yu, *University of Saskatchewan, Saskatoon, SK, Canada.*

The objective of this study was to determine chemical characterizations, evaluate nutritive values, in terms of protein and carbohydrate subfractions, total digestible nutrients and estimate energy content of a special canola byproduct from recent processing technology, in comparison with soybean and canola meal. The canola byproduct contained lower ($P < 0.05$) ash, CP and true protein and higher ($P < 0.05$) OM, CHO, NDF, ADF, lignin, ADIN and NDIN, compared with soybean and canola meal. 2) The canola byproduct contained 13.9, 12.8, 32.4, 16.0 and 24.9%CP for PA, PB1, PB2, PB3 and PC fractions, respectively. The protein subfractions are significantly different ($P < 0.05$) from soybean which contained 4.1, 9.2, 77.8, 7.5 and 1.4%CP for PA, PB1, PB2, PB3 and PC, respectively. 3) Compared with soybean meal, the canola byproduct contained higher ($P < 0.05$) tdNDF (4.7 vs 2.2%DM), lower ($P < 0.05$) tdNFC (19.8 vs. 35.9%DM) and tdCP (27.8 vs 48.1%DM) and similar tdFA (0.5 vs 0.3%DM). 4) The canola byproducts contained lower ($P < 0.05$) TDN1x (46.5 vs. 79.8%DM). 5) The energy contents estimated using a chemical approach from NRC-2001 were also different ($P < 0.05$) between the canola product and soybean meal (DE3X: 2.16 vs. 3.72; ME3X: 1.73 vs 3.31 NEL3X: 1.03 vs.2.14; DE4X: 2.08 vs. 3.57; ME4X:1.64 vs. 3.16; NEL4X: 0.97 vs 2.03 Mcal/kg DM for dairy cattle and ME: 1.91 vs 3.30; NEm: 1.07 vs 2.27; NEg:0.52 vs 1.58 Mcal/kg DM for beef cattle). In conclusion, the canola byproduct had completely different chemical characterization, protein and carbohydrate fractions, total digestible nutrients and estimated energy values from soybean and normal canola meal.

Key Words: Canola byproducts, Nutritive value, Chemical characterization

T115 The impact of corn grazing on feed intake, milk production and grazing patterns of dairy cattle. B. J. McClenton*, G. B. Triplett, M. E. Boyd, A. Chapa, and T. R. Smith, *Mississippi State University, Starkville.*

To further investigate the use of corn grazing as a management tool for dairy producers, an 8-week trial was conducted to evaluate corn grazing effects on milk production, intake, activity and overall animal wellbeing of lactating dairy cows. Three groups of 18 cows were randomly allotted to treatments based on DIM, production and parity. Control (C) cows were housed in a traditional free-style barn and fed a balanced TMR ad libitum. Two Grazing (G) groups were allowed 24-hr access to 1.8-ha plots of ECOB Round Up-Ready Hybrid corn planted on April 19, 2005 at 79,000 seeds/ha and limit-fed TMR. Portable electric fences were used to progressively allow cows access to the grazing plots. Cow activity was monitored weekly by randomly selecting two cows per group and attaching handheld Global Positioning System units to the cow's collar. Cows began grazing on June 28, 2005 while the corn was still immature (R-2) and they consumed the entire plant. At week 3, G cows consumed an average of 12.6 kg/hd/d of the standing corn. As the plant matured and the nutrients redistributed, cows began eating less of the stalks and more of the leaves and ears. Once corn reached the dent stage, cows only ate ears. Intake of TMR by C cows averaged 24.5 kg of DM/hd•d⁻¹ and was 23.9 ± 0.44% less in the grazing groups. Daily milk production averaged 25.3 kg/d for C cows and was similar for G cows over the entire trial. Grazing cows spent an average of 179 min/d grazing. Cows began grazing in the evening around 1830 when temperatures had cooled to 30°C and in the mornings cows grazed again from around 0630 till 0800 when temperatures approached 24°C. The time spent lounging was similar between groups, but G cows walked 4.4 ± 0.39 km/d, 3 times further than C cows. Corn grazing reduced the need for purchased commodities on the dairy while maintaining milk production and cow health. While distance traveled and grazing time are important considerations, corn grazing systems provide a viable management option for dairy producers. Research was supported by the Mississippi Agricultural and Forestry Experiment Station.

Key Words: Corn grazing, Dairy nutrition, Dairy management

T116 In situ rumen degradation kinetics of canola byproduct from recent processing technology: Comparison with soybean and canola meals. R. G. N. Heendeniya* and P. Yu, *University of Saskatchewan, Saskatoon, SK, Canada.*

The objective of this study was to determine in situ rumen degradation kinetics for dry matter (DM), crude protein (CP), neutral (NDF) and acid detergent fiber (ADF) of canola byproduct (CB) from recent enzymatic processing technology, compared with soybean (SM) and canola meal (CM). The parameters determined included soluble fraction (S), potentially degradable fraction (D), undegradable fraction (U), degradation rate of fraction D (Kd), lag time (T0), effective degradability (ED) and ruminally undegradable fraction (RU). The results show that the CB had significantly different degradation patterns from SM and CM ($P < 0.05$). For DM, S was 7, 23, and 21% of DM, D was 45, 73, and 64% of DM; Kd was 9.85, 7.94, 8.99%/h, T0 was 0.2, 0.25, and 0.01 h; ED of DM was 35, 64, and 59% of DM for CB, SM, and CM, respectively. For CP, S was 6, 1, and 12% of CP, D was 55, 99, and 81% of CP; Kd was 15.04, 7.21, 10.95%/h, T0 was 0, 0.39, and 0 h; ED of CP was 45, 54, and 64% of CP; RUCP was 168, 211, 147 g/kg DM for CB, SM, and CM, respectively. For NDF, D was 33, 98, and 49% of NDF; U was 67, 2, and 51% of NDF; Kd was 9.03,

5.94, 7.71%/h, T0 was 1.12, 0.86, and 1.52 h; ED of NDF was 20, 49, and 28% of NDF; ED of NDF was 109, 45, 65 g/kg DM for CB, SM, and CM, respectively. For ADF, D was 24, 100, and 42% of ADF; U was 76, 0, and 58% of ADF; Kd was 9.89, 5.31, and 9.08%/h, T0 was 1.78, 2.13, and 2.94 h; ED of ADF was 15, 47, and 25% of ADF; ED of ADF was 67, 29, and 48 g/kg DM for CB, SM, and CM, respectively. In conclusion, the CB rumen degradation characteristics differed from SM and CM, indicating the nutrient utilization and availability in the digestive tract are different.

Key Words: In situ degradation kinetics, Feed processing, Canola byproduct

T117 Ovulation rates and improved uterine health in cows fed Megalac[®]-R compared to Megalac[®]. B. E. Jones^{*1}, D. Fish¹, A. Martin², and R. L. Ax¹, ¹University of Arizona, Tucson, ²Dairy Veterinary Services, Chandler, AZ.

A trial was designed to compare reproductive outcomes in a commercial dairy herd (approximately 2000 Holsteins) fed Megalac[®] (control) or Megalac[®]-R (Church and Dwight, Princeton, NJ). All cows were randomly assigned to be fed either product beginning at parturition and continuing until 150d postpartum (0.16 kg/d). Beginning 21d prepartum every cow received 0.11 kg/d of Megalac[®]. Cows were milked 4X for two months postpartum, and 2X until dryoff. Daily milk production (3.5% FCM) averaged 36.9 kg and 37.1 kg for Megalac[®] and Megalac[®]-R, respectively. To monitor ovarian status, real-time ultrasonography was utilized to examine a subset of cows at 2 wk and 4 wk postpartum. All ovarian structures on both ovaries were recorded. Results indicate within cow, numbers of follicles and their distributions in terms of follicular sizes were similar between treatments. However, 28/57 cows fed Megalac[®]-R had ovulated (49%) compared to 17/63 cows fed Megalac[®] (27%) by 30d fresh. The difference in ovulation frequency was statistically significant by Chi-square analysis. Prostaglandins were prescribed by the herd veterinarian as a uterine therapy. Within the first 60d postpartum, 38.9% of cows fed Megalac[®] and 29.0% of cows fed Megalac[®]-R required prostaglandin treatment, with this difference being statistically significant. The incidence of cystic ovaries was less than 3.0% in both treatment groups within the 60d comparison period. In summary, Megalac[®]-R contributed to improved uterine health and ovulation rates early postpartum compared to Megalac[®].

Key Words: Ovulation, Uterus, Ultrasound

T118 Expression and regulation of glucose transporter gene expression in a bovine mammary epithelial cell line, Mac-T. K. A. Finucane^{*}, A. F. Keating, and F. Q. Zhao, University of Vermont, Burlington.

After parturition, as the demand for lactose increases, the demand for the glucose precursor also increases dramatically. Mammary epithelial cells lack the glucose-6-phosphatase needed for glucose synthesis, and thus are dependent upon glucose transporters to take up glucose from the blood. For effective milk synthesis there must be sufficient transport of glucose across the plasma membrane of the mammary epithelial cell and to the Golgi vesicle for lactose synthesis. Studies have shown that a facilitative glucose transport process mediates mammary epithelial cell glucose uptake and the lactating bovine mammary gland expresses the facilitative glucose transporters GLUT1, GLUT8 and GLUT12. The mRNA expression of these transporters

increase from at least 5-fold to several hundred-fold in the transition from the late pregnant to early lactating stage, indicating that expression of these transporters may be regulated by the lactogenic hormones: insulin, glucocorticoid and prolactin. To address this hypothesis, we have studied the expression and regulation of GLUT1, GLUT8 and GLUT12 *in vitro* using a bovine mammary epithelial cell line, Mac-T. RT-PCR studies confirmed expression of all three transporters in the Mac-T cell. Immunofluorescence staining showed that in the Mac-T cells, GLUT1 and GLUT8 proteins were distributed in both the cytoplasm and plasma membrane. Preliminary studies indicated that the expression of GLUT8 protein appears to be insulin responsive; GLUT8 expression increases with increasing amounts of insulin. Results of this study are the first to demonstrate that Mac-T cells express these glucose transporter proteins.

Key Words: Glucose transporter, MAC-T, Bovine

T119 Development and evaluation of a mechanistic model to predict liquid passage from the reticulo-rumen of dairy cattle. S. Seo^{*1}, L. Tedeschi², and D. Fox¹, ¹Cornell University, Ithaca, NY, ²Texas A&M University, College Station.

A mechanistic and dynamic model was developed to quantitatively predict the dynamics of liquid flows in the reticulo-rumen (RR) of cattle. The model was composed of two inflows (water consumption and salivary secretion), one outflow (liquid flow through the reticulo-omasal orifice), and one in and out flow (liquid flux through the rumen wall). We assumed liquid flow through the reticulo-omasal orifice (ROO) is coordinated with the primary reticular contraction, which is characterized by its frequency, duration and amplitude during eating, ruminating and resting. A database was built to predict each component of the model. A random coefficients model was used with the MIXED procedure of SAS with studies as a random variable to identify significant variables. The parameters were estimated using the same procedure only if a random study effect was significant; otherwise the GLM procedure was used. Total water consumption was estimated as 4.893 × DMI, and 20% of drinking water was assumed to by-pass the RR. Salivary secretion was estimated to be 210 g/min during chewing. During ruminating, however, the rate was assumed to be adjusted for the proportion of liquid in the rumen. Resting salivation was exponentially related with DMI. Liquid efflux through the rumen wall was assumed to be the mean value of the database (4.6 kg/h). Liquid outflow through the ROO was estimated for each chewing behavior. The input variables for the model are DMI, BW, dietary DM, concentrate content in the diet, time spent eating and time spent ruminating. When compared with 28 observations in 7 experiments, the model accounted for 40, 70 and 90% of the variation with root mean square prediction errors of 9.25 kg, 1.84 kg/h and 1.3%/h for liquid content in the rumen, liquid outflow rate and fractional rate of liquid passage (Kpl), respectively. Sensitivity analysis showed that DMI, followed by BW and time spent eating, are the most important input variables for predicting the dynamics of liquid flow from the rumen. We conclude this mechanistic and dynamic model can be used to accurately predict Kpl in dairy cattle.

Key Words: Liquid passage rate, Ruminant liquid dynamics, Modeling

T120 Immune response in dairy cows fed fish oil and condensed corn distillers solubles. M. Bharathan*, D. J. Schingoethe, R. S. Kaushik, K. F. Kalscheur, A. R. Hippen, and G. Moorkanat, *South Dakota State University, Brookings.*

Dietary fatty acids are known to modulate immune response in animals and humans. To assess the influence of dietary fatty acids on immune response, 12 lactating Holstein dairy cows were randomly assigned to one of four dietary treatments which included control (D1), control with 0.5% fish oil (D2), 10% condensed corn distillers solubles (CCDS) supplying 2% fat (D3), and 10% CCDS with 0.5% fish oil (D4). Cows were fed individually as TMR once daily for ad libitum consumption for 28 d. Blood samples were collected on d 0, 7, 14, 21 and 28 to isolate peripheral blood mononuclear cells (PBMC). The proliferation responses of PBMC on d 0, 14, 21 and 28 when stimulated in vitro with mitogens, concanavalin (ConA), phytohemagglutinin (PHA) and lipopolysaccharide (LPS) were measured using Brdu proliferation kit. There were no differences ($P>0.05$) among treatments over time for proliferation assays compared to D1. Percentages of cells and mean fluorescence intensity resulting from immunolabelling for bovine leukocyte markers CD3, CD4, CD8, CD14, CD21, MHC classII, and $\gamma\delta$ T cells were determined on 20,000 PBMC using a FacsCalibur on d 0, 7, 14, 21 and 28. There was a trend ($P<0.09$) for decreased number of CD3+ cells; however CD4+ and CD8+ cells decreased ($P<0.03$) with cows fed D4 compared to D1. Cows fed D2 and D3 had lower ($P<0.05$) CD4+ cell numbers compared to D1 but there was no difference for CD8+ cells. The percentage of CD21+ cells were similar across diets (28.8, 31.7, 30.4 and 36.9%; $P>0.10$). CD14+ cells increased ($P<0.02$) and MHC classII+ cells showed an increasing trend (51.5, 59.4, 60.7 and 75 %; $P<0.08$) with D4 compared to D1. There was an increase in the number of $\gamma\delta$ T cells ($P<0.01$) in D3 but no differences were observed with D2 and D4 compared to D1. Since there was a decrease in CD3+, CD4+, and CD8+ cells, this may lower the T-cell mediated immunity in D4 fed cows. Increased CD14+ cells and the trend of increasing MHC classII+ cells suggest that D4 may enhance the antigen presentation and innate immunity in lactating dairy cows.

Key Words: Immune response, Fish oil, Condensed corn distillers solubles

T121 Preliminary validation of an on-farm culture system. A. Lago*¹, S. Godden¹, R. Bey¹, K. Leslie², R. Dingwell², P. Ruegg³, and L. Timms⁴, ¹University of Minnesota, St. Paul, ²University of Guelph, Guelph, ON, Canada, ³University of Wisconsin, Madison, ⁴Iowa State University, Ames.

There is increasing adoption of on farm culture systems for selective treatment of clinical mastitis cases. They may also be useful for the diagnosis and selective treatment of subclinical intramammary infections in fresh cows. We present preliminary validation of an on-farm culture system (Minnesota Easy Culture System II). Farm personnel collected milk samples from clinical mastitis quarters, and from fresh cow quarters that tested positive using the Californian Mastitis Test (CMT) within three days after calving. The fresh samples were then plated on farm using a sterile cotton swab onto each half of a bi-plate. Plates were incubated overnight and then interpreted as 'no growth', when bacteria did not grow, or 'Gram-positive' or 'Gram-negative' depending if growth was on the Factor or the MacConkey

media half of the bi-plate respectively. After plating, milk samples were frozen and later cultured in the laboratory using standard identification procedures. On farm culture results and corresponding in laboratory results are available from 80 quarter cases of clinical mastitis, and from 87 fresh cow CMT positive quarters. Using the on-farm culture method for clinical mastitis cases, producers were able to detect 83% of the Gram-positive cases (sensitivity), and classified correctly about 90% of the Gram-negative cases or cases where bacteria was not present (specificity). Consequently, 83% of the treated cases, 'Gram-positive' quarters underwent intramammary treatment, were truly Gram-positive (predictive value of a positive test; PV+), and 90% of the not treated cases, 'Gram-negative' or 'no growth', were truly uninfected or Gram-negative (predictive value of a negative test; PV-). For fresh cow CMT positive quarters, the sensitivity of the on-farm culture to detect gram-positive quarters was 88%, and the specificity was 70%. Accordingly, 80% of the treated cases were truly gram-positive (PV+), and 81% of the not treated cases were truly uninfected or Gram-negative (PV-).

Key Words: On farm culture, Bi-plate, Mastitis

T122 Effects of rumen protected choline and dry propylene glycol on production performance and blood metabolites of periparturient Holstein dairy cows. Y.-H. Chung*¹, I. D. Girard², P. Cavassini³, and G. A. Varga¹, ¹The Pennsylvania State University, University Park, ²Probiotech International Inc., Québec, Canada, ³Ascor Chimici s.r.l., Via Piana, Italy.

Effects of supplementing rumen protected choline (RPC; 50% choline as choline chloride) and dry propylene glycol (PG; 65% purity) to periparturient Holstein dairy cows were studied utilizing a 2x2 factorial treatment arrangement. Sixty-three multiparous cows (average lactation number = 2.3 ± 0.2) were blocked according to criteria before entering the trial. Beginning at 20 d ($\pm 0.3d$) before the expected calving date, cows were top dressed with 0 or 50g RPC/cow/d. After parturition, half of the cows from each RPC group were additionally supplemented with 250g dry PG/cow/d mixed into the TMR until d 21 postpartum. Tail vein blood was sampled at -21, -14, -8, -5, -3, -1, +2, +7, +14 and +21 d (± 0.2 d) relative to calving. Pre- and postpartum data were analyzed separately as repeated measure using MIXED procedure of SAS. Dry matter intake, as % of body weight, tended to increase with dry PG supplementation ($P = .12$). Variability in prepartum blood NEFA was reduced for cows supplemented with RPC ($P = .11$) as they neared parturition. Changes in postpartum blood BHBA ($P = .02$) and urine ketones ($P = .02$) were significantly affected by the interaction of RPC and dry PG overtime. Dry PG appeared to reduce blood BHBA (9.4 vs. 7.4 mg/dL for 0 and 250g dry PG without RPC, respectively) but this reduced effect seemed to be blocked by RPC (9.2 vs. 9.2 mg/dL for 0 and 250g dry PG with RPC, respectively). Urine ketone values were highly correlated with blood BHBA. Milk production did not differ across treatments. Milk fat % tended to increase with RPC supplementation ($P = .14$). Collectively, RPC and dry PG each had influences on blood metabolites via different mechanisms and through interactions with each other. Individual or additive effects of RPC or dry PG did not elicit any production responses likely due to a relatively positive energy balance based on pre and postpartum BHBA and NEFA values.

Nonruminant Nutrition: Dietary Influences in Finishing Pigs

T123 Validation of the NCCC-42 vitamin-trace mineral premix in grower pigs. T. D. Crenshaw^{*1}, M. D. Lindemann², H. H. Stein³, and NCCC-42 Swine Nutrition Committee¹, ¹University of Wisconsin, Madison, ²University of Kentucky, Lexington, ³South Dakota State University, Brookings.

A multi-state (WI, KY, and SD) experiment with 20 to 50-kg pigs was conducted by the NCCC-42 Swine Nutrition Committee to evaluate a vitamin trace mineral premix (VMP). A VMP was formulated to provide minimal quantities of vitamins and trace minerals needed to complement nutrients supplied by ingredients typical in US swine diets. Because of limited data on bioavailability of several B vitamins (biotin, choline, folate, pyridoxine, and thiamin) in feed ingredients, another premix (+B) was used to supply these vitamins at minimal concentrations. Diets were formulated with either corn and soybean meal (C-SBM) or C-SBM plus amino acids (C-AA). Added amino acids (Lys, Trp, Thr, Met, Val, and Ile) reduced SBM such that additional B vitamins, particularly folacin (F) might be needed. VMP was added to all diets at either 1X or 1X+B where X equals quantities of vitamins to meet minimum requirements if nutrients from other ingredients are considered. One treatment involved added F to C-AA diets (1X+F). A sixth treatment (St) involved addition of standard premixes used at each respective station. Trace minerals were constant in all diets except St. Pigs were allowed continuous access to assigned meal diets and water throughout a 35-d trial. Differences among stations were detected ($P < 0.05$) in ADG, but not ADFI or G:F. An interaction between diets and station was detected ($P < 0.05$) for ADG. No differences were detected in ADG of pigs fed C-SBM diets with 1X or 1X+B, however pigs fed C-AA diets gained less ($P < 0.05$) than pigs fed C-SBM diets regardless of 1X, 1X+B or 1X+F additions. No advantages in ADG were detected in pigs fed C-AA diets with +B or +F. In conclusion, 1X VMP allowed adequate growth over a 5-wk grower trial. Additions of higher concentrations of B vitamins did not improve growth.

Table 1

Trait ¹	C-SBM 1X	C-SBM 1X+B	C-AA 1X	C-AA 1X+B	C-AA 1X+F	St	SEM
ADG, kg/d	0.832 ^a	0.824 ^a	0.806 ^b	0.790 ^{c*}	0.787 ^{c*}	0.831 ^a	0.01
ADFI, kg/d	1.69 ^a	1.75 ^a	1.68 ^a	1.71 ^a	1.67 ^a	1.72 ^a	0.05

¹Means based on 11 pens/treatment. Means within a row with different superscripts differ ($P < 0.05$) or * ($P < 0.10$).

Key Words: Swine, Premix, Vitamins

T124 Effect of Se and vitamin E supplementation on growth performance, nutrient digestibility and blood characteristics in finishing pigs. J. C. Park^{*1}, H. J. Kim², B. J. Min², J. H. Cho², Y. J. Chen², J. S. Yoo², Q. Wang², Y. H. Kim¹, H. J. Jung¹, I. C. Kim¹, S. J. Lee¹, and I. H. Kim², ¹Swine Research Division, National Livestock Research Institute, RDA, Cheonan, Chungnam, Korea, ²Dankook University, Cheonan, Chungnam, Korea.

This study was conducted to investigate the effect of Se and vitamin E supplementation on growth performance, nutrient digestibility and blood characteristics in finishing pigs. A total of eighty (Landrace×Yorkshire×Duroc) pigs (74.74kg initial BW) were randomly allocated into five treatments with four replications and fed for 6 wk.

Dietary treatments included 1) CON (basal diet), 2) ISE2 (CON+0.2 ppm inorganic Se+100 ppm vitamin E), 3) ISE4 (CON+0.4 ppm inorganic Se+100 ppm vitamin E), 4) OSE2 (CON+0.2 ppm organic Se+100 ppm vitamin E) and 5) OSE4 (CON+0.4 ppm organic Se+100 ppm vitamin E). Through the entire experimental period, ADG and G:F were not different ($P > 0.05$). ADFI (2.739, 2.677 vs. 2.490 kg) was improved in treatments of CON and ISE2 compared with treatment of ISE4 ($P < 0.05$). Nutrient digestibility was not different ($P > 0.05$). The white (WBC) and red (RBC) blood cell content in blood tended to increase treatment of ISE2, but were no different ($P > 0.05$) among the treatments. Differences of HDL cholesterol, LDL cholesterol, triglyceride and total cholesterol concentration in the pigs fed the OSE2 treatment was lower than those of the pigs fed the other treatments ($P < 0.05$). In conclusion, Se and vitamin E were effective for increasing ADFI and influencing WBC, RBC and the cholesterol concentration.

Key Words: Se, Vitamin E, Cholesterol

T125 Effect of copper and zinc supplementation on growth performance, nutrient digestibility and carcass characteristics in finishing pigs. Y. H. Kim¹, H. J. Kim^{*2}, B. J. Min², J. H. Cho², Y. J. Chen², J. S. Yoo², Q. Wang², J. C. Park¹, H. J. Jung¹, I. C. Kim¹, S. J. Lee¹, and I. H. Kim², ¹Swine Research Division, National Livestock Research Institute, RDA, Cheonan, Chungnam, Korea, ²Dankook University, Cheonan, Chungnam, Korea.

This study was conducted to investigate the effect of copper and zinc supplementation on growth performance, nutrient digestibility and carcass characteristics in finishing pigs. A total of 72 (Landrace×Yorkshire×Duroc) pigs (58.10kg initial BW) were randomly allocated into six treatments with three replications and fed for 10 wk. Dietary treatments included 1) COE (basal diet+10ppm copper+80ppm zinc), 2) COH (basal diet+10ppm copper+120ppm zinc), 3) CTE (basal diet+30ppm copper+80ppm zinc), 4) CTH (basal diet+30ppm copper+120ppm zinc), 5) CSE (basal diet+60ppm copper+80ppm zinc) and 6) CSH(basal diet+60ppm copper+120ppm zinc). Through the entire experimental period, ADG (0.752 vs. 0.680, 0.684 kg) was improved for pigs fed CTE compared with pigs fed CTH and CSE ($P < 0.05$). ADFI (2.348 vs. 2.193, 2.122, 2.133 kg) was improved for the pigs fed COH compared with pigs fed COE, CTH and CSH ($P < 0.05$). The G:F (0.343 vs. 0.301, 0.305) was improved in treatment of CSH compared with treatments of COH and CSE ($P < 0.05$). DM digestibility (72.38, 72.96, 73.25 vs. 69.78 %) was improved in treatments of COE, COH and CTH compared with treatment of CSH ($P < 0.05$). N digestibility (74.07, 73.30, 72.76 vs. 70.14 %) was improved in treatments of CTH, CSE and CSH compared with treatment of COH ($P < 0.05$). Carcass grade (1.00 vs. 1.75) was improved in treatment of CTH compared with treatment of CSE ($P < 0.05$). In conclusion, dietary supplementation of copper and zinc at the level of 60ppm and 120ppm is effective on feed efficiency, while at the level of 30ppm and 120ppm, it has beneficial effects on nutrient digestibility and carcass grade.

Key Words: Copper, Zinc, Growth performance

T126 Effects of dietary probiotic on growth performance, nutrient digestibility, blood characteristics and fecal noxious gas content in growing pigs. Y. J. Chen^{*1}, K. S. Son¹, B. J. Min¹, J. H. Cho¹, O. S. Kwon¹, B. C. Park², and I. H. Kim¹, ¹Dankook University, Cheonan, Chungnam, Korea, ²NutraBio Inc, Seoul, Korea.

The aim of this study was to assess the effects of dietary complex probiotic (*Lactobacillus acidophilus*, 1.0×10^7 CFU/g; *Saccharomyces cerevisiae*, 4.3×10^6 CFU/g; *Bacillus subtilis* 2.0×10^6 CFU/g) on growth performance, nutrient digestibility, blood characteristics and fecal noxious gas content in growing pigs. A total of 90 [(Duroc×Yorkshire)×Landrace] pigs (initial BW of 39.75 ± 1.97 kg) were allocated into three treatments by a randomized complete block design. There were five pens per treatment with six pigs per pen. Dietary treatments were: 1) CON (control diet); 2) CP1 (CON + complex probiotic 0.1%) and 3) CP2 (CON + complex probiotic 0.2%). During the entire experimental period of 6 wk, results showed that addition of complex probiotic at the level of 0.2% to diet increased ADG (623 vs. 576g) significantly. Digestibility of DM and N tended to increase, however, no significant differences were observed ($P > 0.05$). Blood characteristics (IgG, albumin, total protein, RBC, WBC and lymphocyte) of pigs were not affected ($P > 0.05$) in two complex probiotic supplementation treatments. Fecal $\text{NH}_3\text{-N}$ was decreased (11.8%) significantly by the addition of complex probiotic ($P < 0.05$), but no effects were observed on fecal acetic acid, propionic acid and butyric acid concentrations ($P > 0.05$). In conclusion, results in this experiment indicated that dietary complex probiotic supplementation had a positive effect on growing pigs performance and could decrease fecal $\text{NH}_3\text{-N}$ concentration.

Key Words: Probiotic, Digestibility, Growing pigs

T127 Effects of reducing dietary crude protein on growth performance, noxious gas emission from manure and blood urea nitrogen and IGF-1 concentrations of serum in nursery pigs. J. H. Cho^{*1}, B. J. Min¹, Y. J. Chen¹, H. J. Kim¹, J. S. Yoo¹, Q. Wang¹, T. C. Ko², Y. Hyun², and I. H. Kim¹, ¹Dankook University, Cheonan, Chungnam, Korea, ²Dodram B&F Inc, Eumseong, Chungbuk, Korea.

Two experiments were conducted to investigate the effects of reducing dietary crude protein on growth performance, noxious gas emission from manure and blood urea nitrogen and IGF-1 concentrations of serum in nursery pigs. In Exp 1, the dietary treatments were 1) CON (CP 19.5%) and 2) T1 (CP 16%). Eight crossbred (Landrace×Yorkshire×Duroc) pigs (14.58 ± 0.10 kg) housed in metabolic cages were fed each of two diets for 8-d periods. The experimental designs were 2×4 Latin squares with pigs and periods as blocking criteria. Feces and urine were collected on d 7 and 8 of each period. NH_3 , H_2S , mercaptans and VFA emissions were not significantly different between treatments in mixed fecal and urine. Pigs fed T1 diet had lower ($P < 0.05$) NH_3 , H_2S and VFA emissions in fecal. In Exp 2, the dietary treatments were 1) CON (CP 19.5%) and 2) T1 (CP 16%). Twenty eight crossbred (Landrace×Yorkshire×Duroc) pigs (13.58 ± 0.10 kg) were used in a 42 days growth trial. The pigs were assigned to the treatments according to body weight and each treatment had 7 replicates of 2 pigs per pen in a randomized complete block design. Through the entire experimental period, ADG and ADFI in pigs fed CON diet were higher than in pigs fed T1 diet ($P < 0.05$). Blood urea nitrogen and IGF-1 concentrations in serum increased in the pigs fed CON diet compare to pigs fed T1 diet. From d 0 to 14, digestibility of nitrogen in pigs fed CON diet was greater than in pigs fed T1 diet ($P < 0.05$). From d 14 to 42, pigs fed CON diet showed higher ($P < 0.05$) digestibility of dry matter than pigs fed T1 diet. In conclusion, these results indicate that reduction in

dietary CP concentration decreased NH_3 , H_2S and VFA emissions in fecal and growth performance.

Key Words: Crude protein, Noxious gas emission, Growth performance

T128 Effects of dietary bacillus-based probiotic on growth performance, nutrient digestibility, blood characteristics and fecal noxious gas content in finishing pigs. Y. J. Chen^{*1}, B. J. Min¹, J. H. Cho¹, O. S. Kwon¹, K. S. Son¹, H. J. Kim¹, B. C. Park², and I. H. Kim¹, ¹Dankook University, Cheonan, Chungnam, Korea, ²NutraBio Inc, Seoul, Korea.

This study was conducted to evaluate the effects of supplementation *bacillus*-based probiotic (*Bacillus subtilis*, 1.0×10^7 CFU/g; *Bacillus coagulans*, 2.0×10^6 CFU/g and *Lactobacillus acidophilus*, 5.0×10^6 CFU/g) on finishing pigs growth performance, nutrient digestibility, blood characteristics and fecal noxious gas content and to determine the optimal addition level of this probiotic preparation. A total of forty eight pigs with an initial body weight of 90.60 ± 2.94 kg were allotted to three dietary treatments (four pigs per pen with four pens per treatment) according to a randomized complete block design. Dietary treatment included: 1) CON (control, basal diet); 2) BP1 (basal diet + *bacillus*-based probiotic 0.1%) and 3) BP2 (basal diet + *bacillus*-based probiotic 0.2%). The experiment lasted 6 weeks. Through the entire experimental period, ADG was improved by 11% ($P < 0.05$) in pigs fed diets supplemented with 0.2% *bacillus*-based probiotic compared to pigs fed basal diet. ADFI and G:F were not affected among all the treatments ($P > 0.05$). Supplementation of *bacillus*-based probiotic did not affect either DM and N digestibilities or blood characteristics ($P > 0.05$) of pigs. Fecal ammonia nitrogen ($\text{NH}_3\text{-N}$) measured at the end of experiment were reduced ($P < 0.05$) when pigs fed diets with 0.2% *bacillus*-based probiotic. Fecal butyric acid concentration also decreased significantly ($P < 0.05$) whereas acetic acid and propionic acid concentrations were not affected ($P > 0.05$) when pigs fed diets added *bacillus*-based probiotic. In conclusion, dietary supplementation of *bacillus*-based probiotic can increase growth performance and decrease fecal noxious gas content concentration.

Key Words: Probiotics, Digestibility, Fecal noxious gas

T129 Energetic efficiency of fat deposition from highly fermentable NSP in fattening pigs. V. Halas and L. Babinszky^{*}, *University of Kaposvár, Hungary.*

The use of non-starch polysaccharide (NSP)-rich components in pig feeds has increased in recent years, leading us to study the energetic efficiency of fat deposition from fermentable NSP (fNSP) compared to digestible starch and oil (dSt and dO) at two feeding levels (2.4 and 3.4 times maintenance). A 3×2 factorial design was used with 3 dietary energy sources (DES): maize starch, sugar beet pulp and soy oil, all added to a basal diet fed at 2 energy levels (EL). In each EL isocaloric daily intakes ($200 \text{ kJ DE/kg}^{0.75}$) from each energy source (11, 11, and $5 \text{ g/kg}^{0.75}$ for fNSP, dSt, dO, respectively) were provided above the basal diet. Protein intake was limiting for protein gain at each EL (8 vs $11 \text{ g/kg}^{0.75}/\text{d}$) to avoid the use of protein for fat gain. A total of 58 individually housed pigs ($48\text{--}106 \text{ kg}$) were used. Chemical body composition was determined at 48 kg (10 pigs) and 106 kg (48 pigs), and fecal digestibility of nutrients at 80 kg BW . Effects of DES and EL on ADG, G:F and protein and fat gain (PD, FD; g/d) were tested by ANOVA. Utilization of different energy sources for fat gain was computed by multivariate regression analysis: $\text{PD} = [\Sigma(\text{DE}_i \cdot \text{tp}_i) -$

a]/0.0236 and $FD = [\sum(DE_i * tf_i * (1 - tp_i)) - PD * 0.0236 * 0.48 - NEm] / 0.0393$, where DE_i -DE intake (MJ/d) from i (i =protein, NSP, starch, oil), tp_i and tf_i -efficiency of transformation for protein and fat gain of i , a -intercept, 0.48-net energy cost for protein gain (kJ/kJ) taken from literature, NEm-maintenance net energy requirement as 750 kJ/kg^{0.60}/d. Results show that the measured parameters were not affected by DES but differed at two ELs (ADG 453 vs 786g/d, G:F 0.24 vs 0.30 kg/kg, PD 60 vs 91g/d, FD 112 vs 260g/d; $P < 0.05$). Energetic efficiency (NE/DE) of NSP, starch and soy oil was 62, 73 and 62 %, respectively, and the values were independent of energy supply. These efficiency values for starch and soy oil have been also reported in the literature. Our results support that highly fermentable NSP can be used in pig diets, and its relatively high energetic efficiency should be considered at diet formulation.

Key Words: Fattening pig, NSP, Energetic efficiency

T130 Effect of feeding rye silage on growth performance, blood and carcass characteristics in finishing pigs. J. H. Cho^{*1}, Y. K. Han², B. J. Min¹, Y. J. Chen¹, H. J. Kim¹, J. S. Yoo¹, J. W. Kim¹, and I. H. Kim¹, ¹Dankook University, Cheonan, Chungnam, Korea, ²Sungkyunkwan University, Faculty of Life Science & Technology, Suwon, Gyeonggi, Korea.

This study was conducted to evaluate the effects of feeding rye silage on growth performance, blood and carcass characteristics in finishing pigs. The total of eighteen (Landrace×Yorkshire×Duroc) pigs (74.22±0.71kg) were used in 49-days assay. Dietary treatments included 1) CON(basal diet), 2) S1(basal diet + 1.66% rye silage), 3) S2(basal diet + 3.32% rye silage). Through the entire experimental period, ADFI in CON(2,446g) and S2(2,385g) treatments was higher than S1(2,295g) treatment ($P < 0.05$). Pigs fed rye silage were significantly decreased on serum cortisol concentration difference(-1.79, -1.21 vs 0.30) compare to pigs fed basal diet ($P < 0.05$). The Hunter's L^* value(44.16) of loin of pigs fed S2 diet was higher than that(38.83) of loin of pigs fed CON diet ($P < 0.05$). The b^* value(3.40, 3.47) of loin of pigs fed S1 and S2 diets were higher than CON(2.65) treatment ($P < 0.05$). Backfat thickness in CON treatment(22.45 vs 17.35, 16.78mm) was significantly increased compare to S1 and S2 treatments ($P < 0.05$). In leans fatty acid contents, the content of palmitic(21.91 vs 19.92, 20.65) and stearic(13.28 vs 11.45, 11.16) acids were significantly higher in CON than others ($P < 0.05$), also, eicosenoic(1.27 vs 0.91, 0.69) and linolenic(0.30 vs 0.23, 0.24) acids were the highest in S2 treatment among treatments ($P < 0.05$). Total SFA(34.41 vs 33.66, 33.87) was the highest in CON ($P < 0.05$). S1 and S2 treatments were higher USFA/SFA ratio(1.80, 1.81 vs 1.56) than CON treatment. In fats those, linolenic acid was higher in S2(0.38) treatment than those of S1(0.28) and CON(0.29) treatments ($P < 0.05$).

Digestibility of DM(81.39, 81.59 vs 77.61%) in pigs fed S1 and S2 diets were greater than that of pigs fed CON diet ($P < 0.05$) and S1 treatment was higher than CON on digestibility of N(84.38 vs 76.25%) ($P < 0.05$). VFA emission from fecal, measured after 1d, was significantly increased in pigs fed S1 and S2 diets ($P < 0.05$). In conclusion, our results showed that feeding rye silage might be beneficial in cortisol concentration difference, hunter's L^* value and b^* , fatty acid contents and nutrient digestibility.

Key Words: Rye silage, Growth performance, Carcass characteristics

T131 Effect of sex and feeding level on productive performance and carcass quality of Iberian × Duroc pigs. M. P. Serrano¹, D. G. Valencia¹, J. C. Sánchez¹, R. Lázaro¹, A. Fuentetaja², and G. G. Mateos^{*1}, ¹Universidad Politécnica de Madrid, Spain, ²Copese, Segovia, Spain.

Iberian pigs are the ancestral dark-haired pigs of Spain. Currently, they are reared under free range or intensive production systems and sacrificed at 150 to 180 kg BW, and both sexes are castrated. We used 160 Iberian pigs under an intensive system to study the influence of sex (EF, entire females; CF, castrated females; and CM, castrated males) and feeding level (AL, *ad libitum*; RT, 23% restriction of *ad libitum* feed intake from 42 to 112 kg) on productive performance and carcass quality at 152 kg BW. There were six treatments (3 × 2) and four replicates (seven pigs) per treatment. From 42 to 152 kg BW, EF tended to eat less (2762 vs. 2902 and 2840 g/d; $P \leq 0.10$) than CF or CM but sex did not affect ADG or G:F. From 42 to 112 kg BW, AL fed pigs grew faster than RT pigs (720 vs. 551 g/d; $P \leq 0.001$). However, from 112 to 152 kg BW, after the end of the feed restriction period, RT pigs recovered, and ate more feed (3714 vs. 3390 g/d; $P \leq 0.05$) and grew faster (822 vs. 655 g/d; $P \leq 0.001$) than AL fed pigs. As a result, G:F was better for RT than for AL pigs ($P \leq 0.01$). At the end of the trial, RT fed pigs grew less ($P \leq 0.001$) than AL fed pigs but G:F was not affected. Carcass yield ($P \leq 0.10$) and carcass fat (51.7 vs. 58.2 and 58.9 mm at P_2 and 40.9 vs. 49.4 and 49.1 mm at m. *Gluteus medius*; $P \leq 0.01$) were lower and primal cuts yield was higher (43.8 vs. 41.9 and 41.4%; $P \leq 0.001$) for EF than for CF or CM. Carcass yield (80.1 vs. 81.0%; $P \leq 0.001$) and carcass fat (52.8 vs. 59.8 mm at P_2 and 43.2 vs. 49.7 mm at m. *Gluteus medius*; $P \leq 0.001$) were lower but primal cuts yield were higher (42.9 vs. 41.8%; $P \leq 0.05$) for RT than for AL fed pigs. The use of EF rather than CF is recommended when Iberian pigs reared under intensive production systems are destined to the dry cured industry. Also, a 23% feed restriction from 42 to 112 kg BW might improve primal cuts yield of pigs at slaughter without jeopardizing gain to feed ratio.

Key Words: Iberian pigs, Productivity, Carcass quality

Physiology and Endocrinology: Reproductive Physiology

T132 Production and cryopreservation of embryos from Sarabi cattle. M. H. Fazeli^{*1,2} and S. M. Mirtorabi², ¹Azad University, Shahre Kord Campus, Shahre Kord, Iran, ²Animal Breeding Center, Karaj, Iran.

Endogenous breeds of cattle despite of their genetic values in terms of adaptability to the suboptimal or adverse environmental, management, and disease conditions are becoming extinct. They are either being crossed with exotic breeds or totally replaced in most cases by the European breeds. Preservation of the breeds has been an important implication of the embryo transfer technology. A program concerning

preservation of several native cattle breeds was launched by the Animal Breeding Center, Karaj, Iran. The program consists of collection and freezing of both semen and embryos. The results of production and freezing of embryos from Sarabi, a breed of cattle native to the north-east of Iran is reported here. A total of 127 Sarabi cows were super-ovulated by either eCG or FSH following synchronization by two injections of PGF 11 days apart. Embryo collection by non-surgical technique was attempted on 97 cows (76%) which were considered to have responded favorably to the super-ovulatory treatments. The remaining cows were not flushed due to failure of response (ovarian

cysts or difficulties in passing the Foley catheter as very large and prolapsed cervical rings was a common finding in this breed). Of 940 eggs, 694 were classified as fertilized (73.8%) and 452 as suitable for freezing (65.1%). The mean numbers of eggs per super-ovulated cows and collected cows were 7.4 and 9.7, respectively. The corresponding mean numbers for the fertilized eggs were 5.5 and 7.15, respectively. The mean number of frozen embryos per collected cow was 4.6. Thirty two percent of the donor cows produced more than 10 eggs (range: 0-52). It was concluded that despite the large size of the cervix with the prolapsed rings in Sarabi cows, embryo production can be carried out as successfully as in European breeds.

Key Words: Embryo production, Sarabi breed, Cattle

T133 Fertility of bull semen imported or domestically produced in Iran. M. H. Fazeli*^{1,2}, F. Raeissi¹, A. Haghighat Nia³, H. Nabizadeh², and F. Zamani², ¹*Azad University, Shahre Kord Campus, school of Veterinary Medicine, Share Kord, Iran,* ²*AI Center, Nahadehaye Dami Jahad, Karaj, Iran,* ³*Damshid Softwares, Tehran, Iran.*

There were complaints regarding the low fertility of frozen semen produced in Iran. Many variables affect fertility of frozen semen including female fertility, management, environment, and all factors associated with production, handling and the innate fertility of the bulls. Many times the poor fertility of the semen is blamed for the unacceptable pregnancy rate. It was decided to make a valid comparison of fertility between the imported and the domestically produced bull semen. The origins of imported semen were mostly North America and the Netherlands. No attempt was made to compare fertility of bulls from different countries and they were treated as one single group. A total of 65009 AI records collected during 3 years from 33 dairy herds scattered around the country were analyzed. The eligibility criteria for the bulls were to have AI records from at least 5 different herds and a minimum of 100 heifers or 200 cows. Pregnancy rates determined by rectal palpation were used as fertility criterion. Results showed a significant decline in the pregnancy rates by AI during the 3 years period (46.1% vs 41.63% vs 40.6%, $P < .05$). The pregnancy rates for all bulls during spring, summer, fall, and winter were 44.9%, 36.2%, 43.8% and 46.1%, respectively. The pregnancy rate was significantly lower during the summer seasons. The imported semen were mostly used on heifers (66.2%) whereas only 24.5% of the locally produced semen were used on heifers and they were used mostly on the cows as in most cases the cost of imported semen was 30-40 times higher. The pregnancy rates for the imported and Iranian semen on heifers were 63.9% and 64.8% ($P > .1$) and on cows were 42.7% and 40.2% ($P > .1$), respectively. It was concluded that fertility of semen produced in Iran was not different from that of those imported. Most complaints of poor fertility is because of reduced success rate occurring during the summer seasons which is due to heat stress and failure of proper management to alleviate the condition.

Key Words: Bull semen, Fertility, Iran

T134 Profiles of circulating estradiol after different estrogens in dairy cows. A. H. Souza, A. P. Cunha*, D. Z. Caraviello, and M. C. Wiltbank, *University of Wisconsin, Madison.*

Supplementation with estrogens may allow correction of some reproductive problems due to high steroid metabolism rate in high producing cows. Thus, the objective of this study was to characterize the circulating concentrations of estradiol-17 β (E2) after treatment with different types or doses of estrogens in the absence (Experiment

1) or presence (Experiment 2) of a dominant follicle in lactating dairy cows. In Experiment 1, cows ($n = 12$) had all follicles > 5 mm removed by ultrasound-guided follicular aspiration. Treatments were: no treatment, E2 (0.5 mg), or estradiol benzoate (EB, 0.5 mg). Cows were then re-randomized to receive: no treatment, E2 (1.0 mg), EB (1.0 mg), or estradiol cypionate (ECP, 1.0 mg). Analyses were performed with the procedure MIXED of SAS. In Experiment 1, cows treated with E2 had greater peak of E2 (0.5 mg = 8.3 pg/mL; 1.0 mg = 12.8 pg/mL) than ECP-treated (1.0 mg = 3.4 pg/mL) cows with EB-treated cows having intermediate values (0.5 mg = 4.9 pg/mL; 1.0 mg = 9.6 pg/mL). Similarly, E2-treated cows had the shortest intervals from treatment to peak (4h) and from peak until return to nadir (23h) with ECP-treated cows having longest (peak = 30h; nadir = 50h) and EB-treated cows having intermediate values (peak = 16h; nadir = 30h). In Experiment 2, circulating E2 was evaluated near AI in cows ($n = 24$) receiving Ovsynch with or without E2 supplementation 48h after PGF2 α . Treatments were: no treatment, E2 (0.5 mg), or E2 (1.0 mg). Cows treated with 1.0 mg E2 had shorter time to peak and greater maximum circulating E2 (5.0 h; 18.5 pg/mL) than controls (9.5 h; 5.5 pg/mL) with cows treated with 0.5 mg E2 being intermediate (5.5 h; 10.6 pg/mL). Thus, the presence of a dominant follicle and treatment with differing types of estrogen produce substantial differences in the circulating E2 profile. In dairy cows, 1.0 mg dose of E2 increased circulating E2 during Ovsynch without disrupting the normal decline in circulating E2 after the LH surge.

Key Words: Estradiol, Dairy cattle, Ovsynch

T135 Observed and predicted numbers of single, twin, and triplet births in a cattle population selected for increased twinning. G. L. Bennett*, M. F. Allan, R. A. Cushman, and S. E. Echternkamp, *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

A previously developed mathematical model to predict the distribution of single, twin and higher order calvings was tested in a cattle population selected for increased twinning to evaluate the model at high levels of multiple births. The original model was based on a distribution of ovulation rate (estimated from ewes because genetically high ovulating cows did not exist), an independent loss of preimplantation embryos, and a dependent, placental anastomosis caused loss of fetal litters. Unlike sheep, placental anastomosis occurs in most multifetus pregnancies in cattle. When it was developed, the model showed good agreement with actual distributions of singles, twins, and triplets for groups of females ranging from 13 to 35% multiple births in a cattle population selected for high twinning rate. This population currently averages about 50% multiple births. In 16 year-season groups from spring 1998 through fall 2005, there were 940 single, 823 twin, 67 triplet and two quadruplet calvings with calves born per cow ranging from 1.33 to 1.66 per year-season. In each year-season, the distribution of singles, twins, and triplets or more was predicted from the model based on observed average calves per cow. In total, 948.8 single, 804.0 twin, 78.8 triplet, and 0.5 quadruplet calvings were predicted by the model. Predicted and observed singles, twins, and triplets or more for the 16 year-season groups showed good agreement ($\chi^2 = 18.17$; $df = 16$; $P = 0.31$). Results validate the use of this model based on concepts of independent and dependent losses of embryos and fetuses for predicting distributions of singles, twins, and triplets in populations of cattle with high genetic levels of twinning.

Key Words: Calving, Model, Twin

T136 Effects of estradiol and testosterone on the peripheral and anterior pituitary IGF system in barrows. J. A. Clapper* and E. M. Stansbury, *South Dakota State University, Brookings.*

Estradiol (E) has been demonstrated to alter components of the peripheral and anterior pituitary (AP) IGF system in pigs, however, testosterone (T) may also play a role. To further delineate the effects of E and T on the IGF system in pigs the following experiment was conducted. Fifteen crossbred barrows of similar age and weight (100 ± 3 d, 53.4 ± 1.4 kg) were stratified by litter to one of three treatment groups. Treatments were barrows receiving no E or T (C; n = 5), those receiving E (E; n = 4), and those receiving T (T; n = 6). Two E implants (Compudose) were placed subcutaneously in one ear of E pigs while T pigs received two silastic tubing implants (5 cm \times 0.465 cm) filled with crystalline T placed subcutaneously in the base of each ear. Blood samples were obtained on d 1 before implantation, then on d 14, 28, 42, 56, and 63. Pigs were killed on d 64 when AP were collected. Mean serum concentrations of E were not different ($P > .05$) among groups on d 1 but by d 14 through 63, mean serum concentrations of E were greater ($P < .05$) in E pigs than in T or C pigs. Mean serum concentrations of T were increased ($P < .05$) in T pigs from d 14 through 63 compared to d 1. Mean serum concentrations of IGF-I were greater ($P < .05$) in E pigs (244 ± 22 ng/mL) than in C (178 ± 12 ng/mL) or T pigs (184 ± 11 ng/mL). Western ligand blot analysis identified 46- and 41- kDa forms of IGF-binding protein (IGFBP)-3 and a 34 kDa IGFBP-2 in serum and a 33 kDa form of IGFBP-2 and a 29 kDa form of IGFBP-5 in the AP. Mean relative amounts of 46- and 41-kDa IGFBP-3 in serum were decreased ($P < .05$) in T pigs compared to E and C pigs. No difference ($P > .05$) was detected in mean relative amounts of serum IGFBP-2 among treatments. Mean relative amounts of AP IGFBP-2 and -5 were each greater ($P < .05$) in E pigs than C or T pigs. These preliminary data provide evidence that while E may increase circulating IGF-I and AP IGFBP-2 and -5, T may alter relative amounts of IGFBP-3 to effectively increase the bioavailability of IGF-I in the pig.

Key Words: IGF-I, Estradiol, Testosterone

T137 Accuracy of pregnancy diagnosis in Holstein cows using transrectal ultrasonography based on a serum pregnancy associated glycoprotein (PAG) ELISA. E. Silva*¹, R. A. Sterry¹, D. Kolb², N. Mathialagan³, M. F. McGrath³, J. M. Ballam³, and P. M. Fricke¹, ¹University of Wisconsin, Madison, ²Lodi Veterinary Clinic, Lodi, WI, ³Monsanto Agricultural Company, St. Louis, MO.

Pregnancy examinations were performed by one herd veterinarian throughout the study using transrectal ultrasonography (US) in lactating Holstein cows (n=877) 27 d after first postpartum timed AI. Outcomes were categorized as: pregnant (PG) = CL, normal uterine fluid, embryo visualized; questionable pregnant 1 (QP1) = CL, normal uterine fluid, embryo not visualized; questionable pregnant 2 (QP2) = CL, abnormal uterine fluid, embryo not visualized; pregnancy loss (PL) = nonviable embryo; nonpregnant (NP) = no CL and/or uterine fluid. Outcomes using US were compared to those categorized PG or NP using a PAG ELISA of plasma samples collected at US. Outcomes for cows in which US and PAG agreed were considered correct, whereas cows in which outcomes disagreed were rechecked using US 32 d after TAI. Outcomes for 112 cows disagreed between US and PAG, and 102 of these cows were rechecked. Statistical agreement (Kappa) between PAG and US was 0.74 ($P < 0.001$). Distribution of cows among the US

categories was 21.7, 19.7, 4.4, 1.0, and 53.1 % for PG, QP1, QP2, PL and NP categories, respectively. Within each US category, the proportion of cows in which pregnancy outcomes disagreed was 3.7 (7/190), 13.9 (24/173), 64.1 (25/39), 44.4 (4/9), and 11.2 (52/466) % for PG, QP1, QP2, PL and NP categories, respectively. Based on the US recheck, 51.0 and 49.0 % of incorrect outcomes on d 27 were from PAG and US, respectively. Incorrect outcomes for US were 2.1 (4/190), 8.9 (15/168), 52.8 (19/36), 22.2 (2/9) and 2.2 (10/464) % for PG, QP1, QP2, PL, and NP categories, respectively. Overall, PAG incorrectly diagnosed 2.1 (10/467) % of PG cows as NP and 10.5 (42/400) % of NP cows as PG. Thus, although agreement between PAG and US at 27 d after TAI was acceptable, US outcomes of QP1, QP2 and PL (25.2% of all US outcomes) were less accurate than PG or NP outcomes.

Key Words: Pregnancy associated glycoprotein, Transrectal ultrasound

T138 Angiogenesis of the endometrium and fetal membranes during early pregnancy in sheep: Morphological evaluation. L. P. Reynolds*¹, A. T. Grazul-Bilska¹, L. Della Salda², G. Ptak², and P. Loi², ¹North Dakota State University, Fargo, ²Universita di Teramo, Teramo, Abruzzo, Italia.

Placental vascular development (angiogenesis) is critical for normal placental function and thus for embryonic/fetal growth and development. With assisted reproductive techniques, including cloning, the embryos exhibit poor placental angiogenesis, which may contribute to their high rate of loss after transfer. Although we previously reported a 2-fold increase in endometrial vascularity from d12 to 40 of pregnancy in ewes (Reynolds and Redmer, *Biol Reprod* 47:698-708, 1992), only relatively broad (6- to 10-d) intervals were evaluated. To provide a more complete description of normal placental vascular development, tissues were collected from ewes on d20, 22, 24, 26, 28, and 30 after mating (n = 5 to 6/d), and also from mid-luteal, nonpregnant (d9 to 11 after estrus; n = 5) control ewes. To maintain the morphology, specimen-pins were inserted completely through the uterus and fetal membranes at the level of the external intercornual bifurcation. Cross-sections (0.5-cm thick) were then made with a Stadie-Riggs microtome knife, immersion-fixed in 10% neutral buffered formalin or Carnoy's solution, and embedded in paraffin. To visualize the vascular beds, histological sections were stained with periodic acid-Schiff's reagent. The crown-rump length (C-R) of the embryos increased exponentially from d20 to 30 of pregnancy ($y = 4.694e^{0.2319x}$, where $y = C-R$ in mm and $x = \text{day}$; $R^2 = 0.973$; $P < 0.001$). By d22, the endometrial luminal epithelium was already flattened (low cuboidal to squamous) compared with that of nonpregnant controls, which was tall, pseudo-stratified columnar. On d22, a sub-epithelial endometrial capillary plexus also was beginning to develop, and the fetal membrane (allantochorion) was just beginning to vascularize. Development of the endometrial capillary beds and sub-epithelial capillary plexus continued through d30. By d24, the capillaries of the allantochorion were well developed, and this continued through d30. This more complete description of early placental angiogenesis in sheep will provide the foundation for determining whether placental vascular development is altered in compromised pregnancies.

Key Words: Early pregnancy, Placenta, Angiogenesis

T139 Effect of neonatal environment on adult reproductive function of boars. J. K. Griffin*, M. C. Seal, and W. L. Flowers, *North Carolina State University, Raleigh.*

The objective of the study was to examine the influence of litter size during lactation on adult reproductive function of boars. Boars born in litters of 10 pigs or more during October (Fall) or March (Spring) were allocated to nurse in litters of 6 (small) or greater than 9 pigs (large) by crossfostering one day after birth (n=9 boars/treatment/season). After a 3-week lactation, boars were weaned and managed under similar conditions for 2 years. Treatment by season by time interactions were present (P<0.05) for body weight and testicular size. For boars born in the Spring, body weight and testicular size were greater (P<0.05) for boars raised in small than large litters between 3 weeks and 2 years of age. In contrast, no advantage of nursing in a small litter was observed in body weight or testicle size until 15 weeks of age (P<0.05) for boars born in the Fall. Regardless of season, more (P<0.05) boars raised in small (73%) than large (39%) litters were successfully trained to collect by 170 days of age. In the Spring replicate, boars reared in small litters had increased (P<0.01) sperm cells/ejaculate during the entire collection period (180 days to 2 years of age). In the Fall replicate, sperm cells/ejaculate were higher (P<0.05) in boars weaned in small litters only between 300 and 360 days of age compared with their counterparts in large litters. No other consistent differences were observed for other semen quality parameters (P=0.15). Heterospermic inseminations and DNA paternity testing techniques were used to assess fertility of boars beginning at 210 days of age. Insemination doses were made by mixing 3 billion motile spermatozoa each from a boar raised in a small and a large litter. Boars raised in small litters sired 65% of the 915 piglets tested (P<0.05). In conclusion, reduction of the number of piglets in the litter in which boars are raised during lactation had a positive effect on their sperm production and fertility as adults. However, the chronological development of these differences appears to be influenced by season of birth.

Key Words: Boars, Spermatogenesis, Swine

T140 Gonadal response to HCG and GnRH analog in male sheep exposed to excess prenatal testosterone. S. E. Recabarren*¹, P. P. Rojas-Garcia¹, M. P. Recabarren¹, V. Alfaro¹, R. Smith², and T. Sir-Petermann³, ¹University of Concepcion, Chillan, Chile, ²University of Chile, Santiago, ³University of Chile, Santiago.

Although there is accumulating evidence that prenatal T may compromise adult female reproductive function, the early exposure of excess T on the adult reproductive function has been less studied in males. The aim of this study was to assess the gonadal responsiveness to a pharmacological challenge of HCG (500 U) and GnRH agonist leuprolide (10 µg/kg BW) in adult male sheep exposed to T excess (T-males, n=5) during days 30-120 of fetal development and in control males (C-males, n=5). LH and T were measured in blood samples collected before, and at 30-min intervals for the first 3-h, and at 3-6-h intervals until 72 h after GnRH agonist administration while only T was measured after HCG administration. T increased similarly in C-males and T-males after HCG with a peak of 10.12±0.75 ng/ml and 9.16±0.78 ng/ml at 2-2.5 h respectively, reaching a nadir after 6h and again increasing until the end of the experiment. LH and T increased and decreased in parallel in C-males and T-males after leuprolide. T increased to a peak of 12.83±1.8 in C-males and of 13.05±2.06 ng/ml in T-males at 2-3 h respectively and then decreased with no further increase. Areas under the curve of LH and T response after leuprolide were similar between C-males and T-males. Results suggest that prenatal T exposure may not alter the pituitary-gonad endocrine

function in adult males. The long-term effect on fertility remains to be determined. Fondecyt grant 1050915

Key Words: Testosterone, Male sheep, Prenatal steroid exposure

T141 Impact of exogenous ghrelin administration on circulating concentrations of luteinizing hormone in steers. J. A. Daniel*, G. A. Perry, and A. E. Wertz-Lutz, *South Dakota State University, Brookings.*

Four steers (450 ± 13.1 kg) were used in a crossover design to determine the effects of intravenous infusion of bovine ghrelin (bGHR) on plasma concentrations of luteinizing hormone (LH). Steers were fed individually once daily (0800 h) and allowed to consume ad libitum until 2000 when feed was removed. Daily feed allotment was sufficient to result in ≥10% feed refusal. On the day of the experiment, serial blood samples were collected from steers fitted with an indwelling jugular catheter at 15-min intervals from 0600 through 1800 h. Plasma was assayed for LH by RIA. Saline (SAL) or bGHR was infused via jugular catheter at 1200 and 1400 h, which were times when steers usually did not eat feed. Exogenous bGHR was infused to achieve a plasma concentration of 1000 pg/mL. Previous research has indicated a peak bGHR concentration of 1000 pg/mL for fasting steers. Steers were allowed 5 d to adjust between treatment periods. Then, treatments were switched between steer groups, and the sampling period was repeated. Mean concentrations and area under the concentration curve were determined for LH following administration bGHR or SAL treatment at 1200 and 1400 h. Effect of treatment, period, steer and the treatment*period interaction on mean concentrations and area under the concentration curve for LH was determined by ANOVA. Mean plasma concentrations of LH and area under the concentration curve did not differ between bGHR or SAL treated steers following the 1200 h infusion (2.4 ± 0.1 vs. 3.0 ± 0.4 ng/ml and 247.5 ± 13.7 vs. 309.9 ± 36.2 ng/ml, respectively; P > 0.29) or the 1400 h infusion (2.4 ± 0.2 vs. 2.9 ± 0.2 ng/ml and 516.0 ± 58.6 vs. 651.2 ± 42.8 ng/ml, respectively; P > 0.27). Plasma concentrations of growth hormone (GH) and bGHR were also determined and previously reported that exogenous administration of bGHR increased plasma concentrations of GH in these steers. These data indicate bolus administration of bGHR sufficient to alter plasma concentrations of GH does not alter plasma concentrations of LH in steers.

Key Words: Ghrelin, Luteinizing hormone, Cattle

T142 Assessment of a practical method for identifying anovular dairy cows synchronized for first postpartum timed artificial insemination. E. Silva*, R. A. Sterry, and P. M. Fricke, *University of Wisconsin, Madison.*

Lactating Holstein cows (n=842) received a Presynch/Ovsynch protocol to initiate first postpartum (pp) timed AI (TAI) as follows: PGF_{2α} (PGF; 39±3 and 53±3 d pp); GnRH (G; 65±3 d pp); PGF (72±3 d pp); G (74±3 d pp) + TAI 16 h later. Two methods for assessing cyclicity status before TAI were compared. For the first method (RIA), blood samples were collected at the 2nd PGF of Presynch and at the 1st G of Ovsynch, and cows with serum P4 ≥1.0 ng/ml in one or both samples were classified as cycling, whereas cows with serum P4 <1.0 ng/ml in both samples were classified as anovular. For the second method (US), transrectal ultrasonography was used to determine the presence or absence of a corpus luteum (CL) at the 1st G of Ovsynch, and cows without CL were classified as anovular, whereas cows with a CL were classified as cycling. Statistical agreement (kappa) between

the presence or absence of a CL using US and serum P4 (P4 1.0 ng/ml=CL, P4 <1.0 ng/ml=no CL) at US was 0.74 (P<0.001). Sensitivity and specificity of US to assess the presence of a CL was 94.0 and 78.8 %, respectively (53 cows with a CL had serum P4 <1.0 ng/ml). Statistical agreement (kappa) between RIA and US to identify cycling cows was 0.66 (P<0.001). Sensitivity, specificity, positive predictive value, and negative predictive value of US to identify anovular status was 85.7, 87.7, 64.7, and 95.9 %, respectively. Disagreement between RIA and US to determine cyclicity status occurred because 75 cows had serum P4 \geq 1.0 ng/ml at the 2nd PGF of Presynch and <1.0 ng/ml at the 1st G of Ovsynch (cycling by RIA), and 47 of these cows had no CL at the 1st G of Ovsynch. For cows without a CL (n=232), 79.3, 5.6, and 15.0 % had P4 concentrations of <0.5, 0.5 to <1.0, and \geq 1.0 ng/ml, respectively. We conclude that assessing the presence or absence of a CL at the first G of Presynch/Ovsynch using US is a practical method for identifying cyclicity status of cows before first TAI but may slightly overestimate the proportion of anovular cows.

Key Words: Presynch/Ovsynch, Anovular cows, Ultrasonography

T143 Relationship between metabolic hormones and ovulation of dominant follicle at the first follicular wave postpartum in dairy cows. C. Kawashima*¹, E. Kaneko¹, C. Amaya Montoya¹, M. Matsui¹, T. Shimizu¹, N. Matsunaga¹, K. Kida¹, Y.-I. Miyake², D. Schams², and A. Miyamoto¹, ¹Obihiro University of Agriculture and Veterinary Medicine, Obihiro, Hokkaido, Japan, ²TU-Munich Weihenstephan, Freising-Weihenstephan, Germany.

Recent studies suggest that IGF-1 from liver is a crucial regulatory factor in the final maturation of the dominant follicle (DF) of the first follicular wave postpartum (pp), but the detailed endocrine environment has not yet been elucidated. The aim of our study was to determine in detail the changing profiles of metabolic and reproductive hormones in relation to ovulation of the DF of the first follicular wave pp in dairy cows. Blood samples were obtained from 22 multiparous Holstein cows from 4 wk prepartum to 3 wk pp. Plasma concentrations of related hormones were measured, and the development of the DF was observed with color Doppler ultrasound. Fifty-nine percent of cows showed ovulation by 15.2 d (mean) pp. Ovulated cows showed higher plasma glucose just after calving (P<0.05), and started to decrease their body condition score from 1 wk pp; that is 1 wk later than anovulated cows. Anovulated cows showed higher insulin levels than those in ovulated cows during the prepartum period (P<0.01), and higher GH levels during peripartum period (P<0.01). In contrast, ovulated cows showed higher IGF-1 levels than anovulated cows during peripartum period (P<0.001). Each DF similarly developed at the first follicular wave pp and a clear blood flow was observed by 14 d pp despite ovulation or anovulation. When we observed in detail endocrine profiles in 9 out of 22 cows, 5 out of 9 cows (56%) showed plasma E2 increase with follicular growth followed by E2 peak, LH surge and ovulation. IGF-1 levels were maintained high level, and drastically declined to basal level 3 d before E2 peak. These profiles were not observed in anovulated cows and plasma IGF-1 remained at a low level. In conclusion, our data suggest that plasma IGF-1, enhanced by metabolic status through the prepartum period, directly stimulates maturation of the dominant follicle that can ovulate at the first follicular wave pp in dairy cows.

Key Words: Cow, Metabolic hormones, First follicular wave postpartum

T144 Reproductive performance of lactating dairy cows of different leptin genotype. R. C. Chebel*¹ and J. E. P. Santos², ¹University of Idaho, Caldwell, ²University of California Davis, Tulare.

Objectives were to evaluate the relationships between leptin genotype and reproduction of dairy cows in the first 305 d in milk (DIM). Sequencing the Exon-2 region of the leptin gene in 814 lactating Holstein cows was performed to determine the presence of single nucleotide polymorphism. Resulting genotypes were CC=282 (34.6%), CT=392 (48.2%), and TT=140 (17.2%). Cows received two injections of PGF2a at 35 and 49 DIM, and were inseminated at detection of estrus after the second PGF2a. Cows not inseminated by 62 DIM were enrolled in the Ovsynch protocol and inseminated at fixed time 10 d later. Cows were re-inseminated upon detection of estrus, and those cows not re-inseminated and diagnosed as nonpregnant were resynchronized with the Ovsynch protocol. Pregnancy was diagnosed at 30 \pm 3 and 60 \pm 3 d after first postpartum AI and at 42 \pm 7 and 160 \pm 7 d after subsequent inseminations. Body condition score was recorded on d 3, 35, and 62 postpartum. Blood samples collected at 35 and 49 DIM were analyzed for progesterone and cows were classified as anovulatory if progesterone < 1.0 ng/mL in the two samples. Data were analyzed using the LOGISTIC, MIXED, and LIFETEST procedures of SAS. Leptin genotype influenced (P=0.01) the mean BCS of cows (CC = 3.02 \pm 0.02, CT = 2.97 \pm 0.01, TT = 3.05 \pm 0.02) in the first 62 DIM. Proportion of cyclic cows on study d 49 was affected (P=0.03) by genotype (CC = 65.1, CT = 59.8, TT = 51.9%). Leptin genotype was not (P>0.15) associated with conception rates after the first postpartum AI at 30 or 60 d after insemination, or pregnancy loss from 30 to 60 d of gestation. Conception rate (P=0.19) and pregnancy loss (P=0.75) after second postpartum AI were also not influenced by leptin genotype. Although proportion of cows pregnant at 305 DIM was not influenced by leptin genotype, survival analysis indicated that primiparous cows of TT genotype became pregnant at a slower (P=0.03) rate as indicated by the median days open (CC = 122, CT = 121, TT = 172). Leptin genotype had minor effects on reproduction of dairy cows and it was associated with resumption of postpartum ovulation in the first 49 DIM and days open of primiparous cows.

Key Words: Leptin, Reproduction, Dairy cow

T145 Influence of maternal and fetal breed on placental and fetal weight in sheep. P. P. Borowicz*, A. T. Grazul-Bilska, K. A. Vonnahme, J. S. Caton, D. A. Redmer, and L. P. Reynolds, North Dakota State University, Fargo.

Growth and development of the fetus depend on its ability to acquire nutrients, which in turn depends on the development of the placenta. Factors that influence placental development thereby have a dramatic impact on neonatal survival and growth. The aim of this experiment was to determine the influence of fetal and maternal breeds on fetal placental (cotyledonary; COT), maternal placental (caruncular; CAR), and total placental weights in sheep. We hypothesized that: 1) the wt of placentas of highly prolific Romanov (R) sheep (litter-bearing, small birth weight) are different from those of Columbia (C) sheep (traditional, large birth weight), and 2) not only the maternal but also the fetal genome determines the wt of the placenta and therefore the exchange rate of nutrients, respiratory gases, and wastes. To test this hypothesis we established straight-bred (controls) and reciprocal pregnancies by transferring embryos from R or C ewes to R or C recipients (n = 1 embryo per dam; n = 5 total dams per group; groups: R \times R, R \times C, C \times R, and C \times C, where the first letter is the embryo

breed and the second is the ewe breed). Gravid uteri and fetuses were collected on day 130 of gestation, and COT, CAR, total placental (CAR + COT) and fetal wts were determined. Fetal wt was less for R × R and R × C (3.5 kg), intermediate for C × R (4.5 kg), and greatest in C × C (6.2 kg; $P < 0.02$). Total placental wt was greater ($P < 0.04$) for C than for R fetuses (372 vs. 298 g) regardless of dam breed, and was greater ($P < 0.04$) for C than R dams (391 vs. 278 g) regardless of fetal breed. Similarly, fetal COT wt was greater ($P < 0.03$) for C than R fetuses (285 vs. 208 g) regardless of dam breed, and greater ($P < 0.02$) for C than R dams (289 vs. 203 g) regardless of fetal breed. In contrast, total CAR wt was greater ($P < 0.02$) for C than R (102 vs. 74 g) but was similar among fetal breed. No fetus breed × dam breed interactions were seen for total COT, total CAR, or total placental wt. These data indicate a profound effect of maternal breed on fetal weight, and fetal and/or dam breed on fetal and placental weight. NIH HL64141 to DAR and LPR.

Key Words: Fetal weight, Placenta, Reciprocal study

T146 Effect of estradiol cypionate before induction of ovulation on subsequent luteal lifespan in anoestrous Nelore cows. O. G. SáFilho and J. L. M. Vasconcelos*, *FMVZ-UNESP, Botucatu, SP, Brazil.*

The aim of this trial was to evaluate the effect of estradiol cypionate before induction of ovulation on prevention of premature luteolysis. Anoestrous Nelore cows ($n=35$; 37.17 ± 3.10 DPP) were evaluated by 2 ultrasound exams 8 d apart (days -10 and -2). On day -2, cows had their calves removed for 48h and received randomly either 0.5 mL i.m. injection of cottonseed oil (placebo) or 1 mg i.m. injection of estradiol cypionate (ECP®, Pfizer Animal Health, Brazil). On day 0, all cows received a GnRH injection (Fertagyl®, Intervet, Brazil). Two ovarian ultrasound exams were performed (day 0 and day 2) for ovulation evaluation. Only cows that ovulated within 48 h after GnRH injection were used for the study (Placebo, $n=12$; ECP, $n=8$). Blood samples were collected on days 0, 5, 9 and 15 for corpus luteum lifespan evaluation by progesterone (P4) analysis. Cows were considered having short cycle if P4 decreased more than 50% between days 5 and 7. Percentage of cows exhibiting short cycle was analyzed by logistic regression and serum P4 concentrations were analyzed by PROC MIXED. Incidence of short cycle and mean serum progesterone on days 0, 5, 9 and 15 did not differ between Control and ECP groups (83.3 vs. 75.0%, $P > 0.1$; 0.4 ± 0.4 vs. 0.4 ± 0.5 ; 3.0 ± 0.4 vs. 2.4 ± 0.5 ; 0.9 ± 0.4 vs. 1.3 ± 0.5 ; 0.8 ± 0.4 vs. 0.9 ± 0.5 ng/ml, respectively; $P > 0.1$). For both treatment groups, serum P4 increased from day 0 to day 5 ($P < 0.01$), but decreased from day 5 to day 9 ($P < 0.01$). Serum P4 concentrations on days 9 and 15 were similar ($P > 0.1$). In conclusion, treatment with 1mg of estradiol cypionate did not prevent occurrence of short cycle in anoestrous Nelore cows after induction of ovulation with calf removal and GnRH injection.

Key Words: Anoestrous, Short cycle, Estradiol cypionate

T147 Effect of progesterone or 17 β -estradiol on luteal lifespan in anoestrous Nelore cows. O. G. SáFilho*, C. C. Dias, and J. L. M. Vasconcelos, *FMVZ-UNESP, Botucatu, SP, Brazil.*

This trial was to evaluate the effect of progesterone (P4) and/or 17 β -estradiol (E2) on incidence of short cycles (SC) after induction of ovulation with calf removal (CR) and GnRH injection in anoestrous Nelore cows. Cows ($n=142$; 43 ± 12 DPP) were evaluated by 2 ultrasound (US) exams 8 d apart (day -16 and day -8) for cyclicity. Anoestrous cows ($n=114$) were randomly assigned to receive a 6 d treatment with

an intravaginal P4 device (CIDR® Pfizer Animal Health, Brazil) prior CR and/or 1 mg i.m. injection of 17 β -estradiol 48h after beginning of CR (4 treatments; 2x2 factorial design). On day -2 all cows suffered CR for 54h and received a GnRH injection at the end of CR (day 0). Only cows that ovulated within 48 h after GnRH injection (evaluated by US on days 0 and 2) were used (Control, $n=23$; E2, $n=25$; P4, $n=19$; P4+E2, $n=18$). Blood samples were collected on days 0, 5, 7, 9, 12, 15 and 19 for corpus luteum lifespan evaluation, by serum P4 analysis. Cows were considered having SC if P4 decreased more than 50% between days 5 and 7. Percentage of cows exhibiting SC was analyzed by logistic regression and P4 were analyzed by PROC MIXED of SAS. P4 were higher on day 5 than on day 0 ($P < .01$) on all treatments. Serum P4 increased ($P < .05$) between days 5 and 7 on P4 (from 2.3 ± 0.5 to 3.7 ± 0.5 ng/mL) and P4+E2 (from 2.4 ± 0.5 to 3.3 ± 0.5 ng/mL) groups and decreased ($P < .01$) on Control (from 2.9 ± 0.4 to 1.9 ± 0.4 ng/mL) and E2 (from 1.9 ± 0.4 to 0.8 ± 0.4 ng/mL) groups. Cows treated with P4 (P4 and P4+E2) had higher serum P4 than cows not treated (Control and E2) on days 7, 9, 12 and 15 ($P < .01$). Incidence of SC was lower in cows treated with P4 than in cows not treated (23.5 vs. 79.2%; $P < .01$), while treatment only with 17 β -estradiol did not differ ($P > .10$) from control group (76 vs 82.6%). Cows not treated with P4 that showed heat had the same incidence of SC than cows not detected in estrus (75 vs. 80%; $P > .1$). In conclusion, 6 d treatment with P4 prior ovulation on anoestrous cows warranted a normal luteal lifespan, while administration of 1mg of 17 β -estradiol did not prevent occurrence of SC.

Key Words: Short cycle, Progesterone, Estradiol

T148 Factors affecting conception of AI or ET in lactating cows. D. G. B. Demetrio*¹, R. M. Santos¹, C. G. B. Demetrio², C. A. Rodrigues³, and J. L. M. Vasconcelos¹, *¹FMVZ-UNESP, Botucatu, SP, Brazil, ²ESALQ-USP, Piracicaba, SP, Brazil, ³SAMVET, São Carlos, SP, Brazil.*

The objective of this study was to evaluate the factors which affect pregnancy rates (PR) of AI or ET in lactating Holstein cows. Cycling cows ($n=1025$) producing 33.3 ± 7.2 kg milk/d received PGF2 α injections and were assigned to AI or ET group. Cows detected in estrus between 48 and 96 h after the injection ($n=387$) received AI ($n=227$) 12 h after estrus detection or received 1 fresh embryo (grade 1 or 2) from non lactating donor cows ($n=160$) 6 to 8 d later. Pregnancy diagnosis was done by US 25 and 39 d after estrus and embryonic loss (EL) was considered when cows pregnant on day 25 were not on 39. The variables ovulation rate, PR and EL were analyzed by logistic model and the covariates DIM, milk yield (21 d average), body temperature (BT; 7 d after estrus) and P4 serum concentration (day 7) were measured. Ovulation rate was 84.8 % (328/387) and was only negatively affected ($p=.05$) by DIM. PR at day 25 for ovulated cows were 37.9 % (74/195) and 59.4 % (79/133) for AI and ET ($p < .01$) groups, respectively. BT ($p=.02$) affected negatively PR for both treatments. To evaluate P4, only cows with synchrony 0 (estrus 72 h after PGF2 α injection) were used ($n=191$) from both groups and PR at day 25 were 37.5% (39/104) and 63.2 % (55/87) for AI and ET ($p < .01$) groups, respectively. Interestingly, there was a positive effect of P4 ($p=.03$) and a negative effect of BT ($p=.09$) and milk production ($p=.04$) on probability of PR on AI group while on ET group only BT ($p=.08$) affected PR negatively. The EL was 11.1% (8/74) and 21.5% (17/79) for AI and ET ($p=.06$), respectively, and high BT ($p=.10$) increased the probability of EL. The PR at day 39 was always higher ($p=.02$) for ET even after embryonic loss. The results confirm the importance of the rise of the postovulatory P4 on the initial embryonic development since affected PR only in AI group. Transfer of fresh

embryos produced from non lactating cows should be used to bypass negative effects on initial embryo development, increasing pregnancy rates in lactating cows.

Key Words: Embryo transfer, Artificial insemination

T149 Induction of ovulation in sheep using a novel recombinant gonadotropin with dual (LH and FSH) activity. E. P. Lemke*¹, B. M. Adams¹, I. Boime², and T. E. Adams¹, ¹University of California, Davis, ²Washington University, St. Louis, MO.

The biopotency of a dually active chimeric gonadotropin was evaluated using prepuberal ewe lambs. This novel gonadotropin is a monomeric glycoprotein produced by CHO cells transfected with a construct that incorporates the coding regions of the α , hLH β , and hFSH β subunits into a single gene (FSH β -CTP-LH β -CTP- α , where CTP represents the sequence encoding the C-terminal portion of hCG). Lambs (bwt = 45 \pm 2 kg) received (iv) 0, 5, 10 or 20 IU/kg of the dually-active chimera (n = 6 lambs/group) at the beginning of experimentation (day 0). Follicle development and subsequent activity of corpora lutea were assessed by monitoring serum concentrations of estradiol (E2) and progesterone (P4), respectively. Ovulation rate was determined by laparoscopy on day 9. Basal serum concentrations of E2 and P4 were maintained in control animals receiving vehicle alone. Conversely, serum levels of E2 were increased (P < 0.05) above basal concentrations within 24 h of chimera administration and peak levels were noted 3-5 days thereafter. The magnitude and duration of E2 secretion varied among treatment groups in a dose-dependent manner (P < 0.05). Serum P4 was increased (P < 0.05) above basal levels by day 4 in all groups receiving the dually active gonadotropin. Ovulation rate in groups receiving 0, 5, 10 or 20 IU/kg was 0.2 \pm 0.1, 2.2 \pm 0.7, 1.6 \pm 0.5, 1.2 \pm 0.4 ova/lamb, respectively. Persistent follicular activity was also noted at laparoscopy, most prominently in animals receiving the highest dose of the chimeric protein. Collectively these observations indicate that this recombinant gonadotropin is active in sheep. The chimera stimulates growth and maturation of ovarian follicles and concurrent E2 synthesis. This suggests that both the LH and FSH activities of the gonadotropin are functionally expressed. We postulate that the prolonged physiological response induced by the chimera is due to the unique pattern of glycosylation characteristic of this novel gonadotropin. Supported by the USDA (NRI Grant 5-35203-16274).

Key Words: Ovulation, Sheep, Chimeric gonadotropin

T150 Association of timing of chorioallantoic membrane development with age in dairy cattle. J. D. Rhinehart*, R. A. Dailey, D. H. Poole, and E. K. Inskeep, West Virginia University, Morgantown.

About 12% of lactating dairy cows experience late embryonic or early fetal death (d 25 to 60 of gestation). These losses are economically important because lengthened interestrus intervals lead to longer calving intervals. Abnormal growth of the allantois and timing of its fusion with the chorion have preceded high rates of late embryonic / early fetal loss of manipulated embryos (Thompson and Peterson, *Human Reprod.* 2000, 15:59). Association of survival or loss with allantoic development is not known for embryos developed entirely *in vivo*. This study characterized timing of detection of the allantois and diameter of the allantoic lumen, in dairy cows and heifers, to determine

whether these variables might be used to investigate late embryonic / early fetal loss. Reproductive tracts of dairy heifers (n = 28) and lactating dairy cows (n = 21) were examined daily, via transrectal ultrasonography (Aloka 900), beginning on d 21 post-insemination (PI). Variables included: first day of detection of the allantois, diameter of the allantoic lumen and length of the embryo at first detection of the allantois. Range and mean of first day of detection of the allantois (d 21 to 26, 23 \pm 0.18 PI) agreed with previous reports (Curran et al., 1986, *J. Am. Vet. Med. Assoc.* 189:1295). The allantois was detected earlier (P < 0.05) in heifers (22.4 \pm 0.22 d) than in cows (23.6 \pm 0.25 d) as found by Kheradmand Kolour et al. (2005, *J. Vet. Med.* 52:74). Diameter of the allantoic lumen at first detection (4.6 \pm 0.31 mm) did not differ with day of detection and was not affected by age of dam. In contrast, length of embryo (range 2.6 to 7.9 mm) varied with day of first detection of the allantois (P < 0.05), but not with age of dam. Differences in day of first ultrasonographic detection of placental membranes, between heifers and cows, might reflect differing developmental rates and, based on present data, there might be an asynchrony in development of the embryo and the placental membranes. Therefore, the first day of detection of the allantois might be useful for predicting pregnancy loss during placentation.

Key Words: Allantois, Ultrasonography, Dairy cows

T151 Postpartum follicular development in Brahman cows under two grazing densities. R. Soto¹, C. S. Galina¹, I. Rubio*², E. Castillo², I. Hernández¹, and F. Alarcón¹, ¹Universidad Nacional Autónoma de México, Ciudad Universitaria, ²Universidad Nacional Autónoma de México, Martínez, de la Torre, Veracruz.

The aim of this study was to determine the changes occurring in the follicular population after calving in cows raised under two different grazing densities, and the relationship to body condition (BCS) and follicular dynamics. A total of 104 adult, lactating Brahman cows were maintained on Star Santo Domingo grass (*Cynodon nlenfuensis*) pasture, grazed at either a high or low density (4.0 and 2.5 Animal Units/Ha, respectively). Beginning three weeks after calving, ovarian ultrasonography was performed every other day to determine the size and number of follicles. Follicles were subdivided into the following classes <4, 4 to 5, 6 to 8, 9 to 11 and >11 mm. Cows were monitored until 180 days postpartum and cows showing estrus were mated. Analysis of variance was performed using the calving to estrus interval as a covariate. At 45 days postpartum the proportion of follicles in each class was 63, 20, 12, 4 and 1% for <4, 4 to 5, 6 to 8, 9 to 11 and >11 mm, respectively. Corresponding values for 90 days were 54, 25, 17, 4 and 1%. At 150 days values were 45, 27, 24, 4 and 1% and at 180 days 40, 29, 26, 4 and 1%. No statistical differences were found (P < 0.05) for follicular populations between the grazing densities and BCS. A correlation was found (P < 0.05) between the changes in BCS and the number of follicles in all categories being the highest for follicles < 4 mm (r = - 0.85). Grazing densities did not affect follicular growth during the first 105 days postpartum. Also, a high negative correlation was found between BCS and the number of follicles of all sizes. In conclusion, there was relationship between number of follicles in different size classes and BCS in postpartum Brahman cows under grazing conditions.

Key Words: Postpartum, Follicles, Postpartum

Production, Management and the Environment II

T152 Eating behavior and the decline in feed intake of Holstein cows during the transition period. P. D. French*, M. A. DeGroot, and J. L. Chamberlain, *Oregon State University, Corvallis.*

The objective of this study was to determine if eating behavior differs by magnitude of feed intake depression during the transition period. Data were pooled from three experiments involving 73 multiparous Holstein cows that were group housed and fed individually via Calan gates for the three weeks before and after parturition. Within each experiment, cows were ranked by decline in prepartum dry matter intake (DMI) and approximately one-half of the cows were assigned low intake depression (LID) and the remaining cows were assigned to high intake depression (HID). Decline in DMI was calculated as the change in DMI from 3 wk prepartum (average daily DMI from 21 to 15 d prepartum) to 1 wk prepartum (average daily DMI from 7 to 1 d prepartum). Prepartum and postpartum data were analyzed separately. Average decline in prepartum DMI was 5.3 and 31.6% for LID and HID, respectively. Daily DMI was similar for LID and HID until the wk prior to calving when DMI declined more for HID (intake depression \times day; $P < 0.01$). Feed intake was associated ($R^2 = 0.45$) with time spent at the feedbunk, which decreased more for HID (50%) compared to LID (25%) over the prepartum period (intake depression \times day; $P < 0.01$). Number of visits to the feedbunk did not differ, but LID cows spent more time at the feedbunk per visit (11.4 vs 13.5 min/visit for HID and LID, respectively; $P < 0.01$). Prepartum eating rate was greater for HID (109 vs 94 g DM/min for HID and LID, respectively; $P < 0.01$). During the postpartum period, DMI (16.2 vs 18.2 kg DM/d for HID and LID, respectively; $P < 0.01$), eating time (149 vs 174 min/d for HID and LID, respectively; $P < 0.01$) and feedbunk visits (12.5 vs 13.4 visits/d for HID and LID, respectively; $P < 0.01$) were greater for LID. Results show that the depression in DMI that occurs around the time of parturition coincides with a decrease in eating time per feedbunk visit and therefore daily eating time. This data provides a critical link for the further study of depressed periparturient feed intake.

Key Words: Feed intake, Eating behavior, Periparturient

T153 The simulated economic return of using Ovsynch in dairy herds. P. D. French*, *Oregon State University, Corvallis.*

Systematic breeding programs, such as Ovsynch have been developed to improve reproductive performance. Although Ovsynch has been shown to improve pregnancy rates in some studies, the economic viability of this systematic breeding program is often ignored. Therefore, the purpose of this study was to determine the financial impact of Ovsynch at different levels of reproductive performance and milk yield. A computer simulation generated weekly production, reproduction, and cull events for individual cows in a typical herd. Data for 10 herds of 125 cows in milk were generated over 5 years for one of 16 scenarios in a $2 \times 2 \times 3$ factorial arrangement of treatments. Main effects were days open (145 or 160; DO), first service synchronization (Ovsynch or none), and peak milk yield (36, 42 or 49 kg). Pregnancy rates for herds not using Ovsynch were 18.5 and 15.2% for 145 and 160 DO, respectively. Annual income was calculated as the difference between revenue (milk, calf, and cull) and expenses (feed, replacements, interest, and other). Using Ovsynch at first service increased income (+\$72.12/cow/yr) for herds at 160 DO, but did not affect income of herds with 145 DO (synch \times DO interaction; $P < 0.01$). This increase in income by using Ovsynch at first service in

herds with 160 DO was due mainly to an increase in revenue. Response to Ovsynch was similar across level of milk production. The return of using Ovsynch at first service in herds with 160 DO was 6.5:1. Sensitivity analysis was conducted to determine if profit margin would affect the feasibility of Ovsynch. Profit margin did not affect the economic return of Ovsynch. Based on average economic conditions in the US, dairy herds with DO of 160 would benefit from using Ovsynch at first service, whereas herds with DO of 145 will not benefit economically.

Key Words: Days open, Ovsynch, Reproductive losses

T154 Effect of yeast (*saccharomyces cerevisiae*) on prepartum and postpartum dry matter intake and performance of Holstein dairy cows. F. Kafizadeh* and Y. Ghorbani, *Razi University, Kermanshah, Kermanshah, Iran.*

To study the effect of *Saccharomyces Cerevisiae* (SC) on prepartum and postpartum dry matter intake (DMI) and their performance during the early lactation period, sixteen dairy cows (from a herd of 850 lactating cows) in their second parity were used in a completely randomized design ($n=8$) with two treatments (with and without yeast). Cows were allocated to each treatment randomly based on their milk yield and were fed individually during the experimental period. The experiment started from 3 weeks prepartum and continued until 30 days postpartum. Addition of SC had no effect ($P>0.05$) on DMI prepartum while it significantly ($P<0.05$) increased postpartum DMI. Daily milk yield was significantly ($P<0.05$) higher in cows fed yeast (30.64 vs. 28.39 Kg/d). Addition of SC did not have a significant ($P>0.05$) effect on milk fat or milk lactose while it resulted in an increase ($P<0.05$) in daily milk fat yield (1.23 vs. 1.04kg/d). Protein percentage (3.59 vs. 3.16) and protein yield were also higher ($P<0.05$) in SC fed group. Feed to milk ratio was not significantly ($p>0.05$) affected by feeding yeast.

Key Words: *Saccharomyces Cerevisiae*, Dairy cow, Postpartum

T155 Effect of extending the voluntary waiting period on lactation performance of Holstein cows. J. A. Rodrigues*¹, R. C. Chebel¹, and J. E. P. Santos², ¹*University of Idaho, Caldwell,* ²*University of California, Tulare.*

The objective of the present study was to evaluate the effect of extending the voluntary waiting period (VWP) on lactation performance of Holstein cows. Lactating cows were assigned to one of three reproductive protocols during study lactation 1 (VWP treatment applied), being that in two of them the VWP was 49 ± 7 DIM (SV) and in the other it was 73 ± 7 (LV). Only cows conceiving to the first postpartum AI were used in the present study. Therefore, in the present study there were 58 cows in the SV group and 69 cows in the LV group. Cows were milked three times daily and milk yields were recorded for individual cows once monthly, and milk samples were analyzed for somatic cell count (SCC), fat and true protein concentrations. Occurrence of postparturient diseases and mastitis during the first 60 d of lactation 2 were recorded. Data was analyzed using the GLM and CHISQ procedures of SAS. Cows from the SV group had shorter ($P < 0.001$) interval from calving to conception (SV = 55.9 ± 0.5 vs. LV = 73.9 ± 0.5 d), lactation length (SV = 282.9 ± 1.2 vs. LV = 301.4 ± 1.1 d), and calving interval (SV = 11.1 ± 0.03 vs. LV = 11.8 ± 0.03 mo) during lactation 1. Length of the VWP did not affect average daily

milk production ($P = 0.29$), average fat ($P = 0.82$) and protein ($P = 0.35$) concentrations, and average somatic cell count ($P = 0.84$) during lactation 1. Total milk production during lactation 1 was not affected ($P = 0.25$) by the length of the VWP period. Average milk yield ($P = 0.92$), average fat ($P = 0.83$) and protein ($P = 0.66$) concentrations, and average somatic cell count ($P = 0.33$) during the first 3 months of lactation 2 were not affected by the length of the VWP on lactation 1. There was no difference ($P = 0.97$) in the incidence of mastitis during the first 60 d of lactation 2 between SV and LV cows, but smaller proportion of cows from the LV group tended ($P = 0.09$) to experience retained fetal membranes during lactation 2 (SV = 8.62% vs. LV = 1.45%). The present study, although with limited number of experimental units, indicates that extending the VWP in approximately 24 d does not affect production of lactating dairy cows.

Key Words: Voluntary waiting period, Lactation performance

T156 Estimating the potential contribution of groups of cows within herds to the total herd milk volume. R. Goodling, K. Griswold*, and T. Beck, *Penn State Cooperative Extension, University Park.*

The potential contribution of groups of cows within a herd to the total herd milk volume was investigated with DHIA data from 269 Pennsylvania dairy herds comprised of 24,000 Holstein cows. Milk and milk component data were collected for all December 2005 test dates. Data were analyzed using the UNIVARIATE and MIXED procedures of SAS version 9.1. The contribution potential of a cow group to the total herd milk volume was estimated as the difference between the % of the total herd milk volume produced by a defined group of cows and the % of the total number of lactating cows represented by that group of cows. For example, if cows from 41 to 100 DIM represented 25% of the lactating cows and produced 30% of the total herd milk volume, then their contribution potential would be + 5%. The statistical model included the fixed effects of DIM group, herd size group, and average daily milk yield group. DIM groupings were 1 to 40, 41 to 100, 101 to 200, 201 to 300, and 300+. Herd size groupings were < 50 cows, 51 to 100 cows, and > 100 cows. Average daily milk yield groupings were < 23.2, 23.2 – 27.3, 27.3 – 31.8, 31.8 – 36.4, >36.4 kg per cow per day. Contribution potential was affected ($P < 0.0001$) by DIM group with 2.5, 5.7, 3.8, -1.8, and -7.6% for 1 to 40, 41 to 100, 101 to 200, 201 to 300, and 300+ DIM, respectively. A significant ($P < 0.0001$) average daily milk yield group by DIM group interaction was observed with contribution potential decreasing from 2.9 to 1.1% for cows 1 to 40 DIM and increasing from -7.6 to -5.4% for cows 300+ DIM as average daily milk yield increased from < 23.2 to > 36.4 kg per cow per day. There was a trend ($P = 0.0969$) for a herd size group by DIM group interaction with contribution potential for cows < 100 DIM decreasing while contribution potential for cows > 100 DIM increased as herd size increased. These results suggest that larger herds and high producing herds are more effective at maintaining the contribution potential of cow groups in later lactation compared to smaller herds and low producing herds.

Key Words: Daily milk production, Herd size, DIM

T157 Effect of feeding method and forage type on herd mean milk urea nitrogen (MUN) levels. K. Griswold*¹, R. Goodling¹, C. Brown², T. Nauman³, N. Kohut⁴, L. Yoder⁵, and J. Mylin⁶, ¹*Penn State Cooperative Extension, University Park*, ²*F. M. Browns Sons, Inc., Birdsboro, PA*, ³*Hoover Feeds, Inc., Gordonville, PA*, ⁴*Purina Mills, Inc., Douglassville, PA*, ⁵*Homestead Nutrition, Inc., New Holland, PA*, ⁶*Lancaster DHIA, Manheim, PA.*

The effect of feeding method and forage type on herd mean milk urea nitrogen (MUN) levels was evaluated using Dairy Herd Improvement Association (DHIA) data from 202 herds in Pennsylvania. All herds using Lancaster DHIA services and having MUN analysis performed on milk samples collected from October 1 to October 31, 2005 were asked to participate in the study. If the herd owner agreed to participate, they then completed a simple survey which indicated their herd size, their feeding method as either total mixed ration (TMR) or, component-fed ration (CFR), and use of different forages including corn silage (CS), haycrop silage (HCS), baleage (BH), and dry hay (DH). Herds ranged in size from 24 to 870 cows, and 122 of the herds used TMR while 80 herds used CFR. Data from 12,718 individual cow records containing test date (TD) MUN, milk, fat%, protein %, SCC, and days in milk (DIM) were analyzed using PROC MIXED within SAS. The model included the fixed effects of TMR, CS, HCS, BS, and DH, and the random effects of herd size and milk production level. Herd mean MUN was greater ($P < 0.001$) for TMR herds compared to CFR herds (14.34 vs 13.55, respectively). Herds feeding CS had a lower ($P < 0.0119$) MUN level compared to herds not feeding CS (13.78 vs 14.11, respectively), and in contrast, herds feeding BH had a greater ($P < 0.001$) MUN level than herds not feeding BH (16.11 vs 15.22, respectively). The results would indicate that herd mean MUN levels may be affected by feeding method and the choice of forages used in the herd ration.

Key Words: MUN, Feeding method, Forage

T158 Effect of synchronization protocols on reproductive performance of Holstein heifers. J. L. Stevenson*¹, R. C. Chebel¹, J. C. Dalton¹, and J. E. P Santos², ¹*University of Idaho, Caldwell*, ²*University of California, Tulare.*

The objective of the present study was to evaluate different synchronization protocols for Holstein heifers. Holstein heifers ($n = 236$), between 13±1 mo of age, were assigned to one of four synchronization protocols. Heifers in the CON group received no treatment and were AI upon detection of estrus; heifers in the PGF group received one injection of PGF2a on study d 0 and were AI upon detection of estrus, and those not inseminated by study d 14 received a second injection of PGF2a; heifers in the CIDR group received a CIDR insert on study d 0 for 7 d and an injection of PGF2a at CIDR removal and were AI upon detection of estrus from study d 7 to 10, and those not inseminated by 72 h after PGF received an injection of GnRH and were AI at fixed time; heifers in the TAI group received one injection of GnRH on study d -6, a CIDR insert, and an injection of GnRH and PGF2a on d 0, on study d 7 CIDR was removed and heifers received an injection of PGF2a, and 48 h later heifers received an injection of GnRH and were AI at fixed time. Heifers from CON and PGF groups not inseminated by study d 28 were right censored. Pregnancy was diagnosed at 29±3 and 62±3 d after AI. Data were analyzed using the LOGISTIC, LIFETEST, and GLM procedures of SAS. Treatment affected the interval from enrollment to AI (CON = 13.6±0.9, PGF = 9.6±1.1, CIDR = 10.3±0.1, TAI = 15.0±0.0 days; $P = 0.007$) and the proportion of heifers not inseminated by study d 28 (CON = 12.7, PGF = 15.9,

CIDR = 0.0, TAI = 0.0%; P = 0.001), and tended to affect the interval from enrollment to conception (CON = 16.4±0.9, PGF = 14.5±1.2, CIDR = 10.6±0.7, TAI = 15.0±0.0 days; P = 0.06). Treatment tended to affect conception rate (CON = 66.1, PGF = 69.8, CIDR = 56.2, TAI = 44.8%; P = 0.10), but did not affect pregnancy rate after a 28 d breeding period (P = 0.63). Heifers from the CIDR group tended to become pregnant at a faster rate.

Key Words: Heifers, Synchronization

T159 Daily variation in somatic cell counts as a measure of management intensity. J. M. Lukas*, L. A. Espejo, M. I. Endres, and J. K. Reneau, *University of Minnesota, St Paul.*

Statistical process control measures quality improvement by reduction of variation in process output. Milk somatic cell counts (SCC) are a measure of milk quality that reflects the management intensity on the farm. The purpose of this study was to relate variation in bulk tank SCC with the intensity of feeding and manure management and lameness prevention on the farm. Thirty nine randomly chosen freestall dairies located in Minnesota were visited once during the summer of 2004. Information on management practices implemented on the farm was obtained through observation and a questionnaire answered by the herd manager during the farm visit. Collected data included information on alley and stall maintenance, footbath and foot trimming protocol, linear water and bunk space per cow, pushing up of feed, and time spent away from the barn. The number of cows in the milking herd was also recorded. Bulk tank SCC was determined at every milk pick up for the three months preceding the farm visit and the results were plotted on a statistical process control individual measurement chart for each farm. Resulting mean and sigma for each of the farms was recorded. For each mean SCC a high, low and medium variation was determined based on variation in bulk tank SCC observed in the Upper Midwest. Using recorded mean and sigma in SCC, each farm was classified as being characterized by low, medium or high SCC variation. Analysis of variance was performed to identify significant differences in management practices between farms characterized by different SCC variation levels. Farms with low variation in SCC were characterized by a significantly higher frequency of alley scraping and footbath treatment and tended to push up feed more frequently. Low SCC variation farms had also a significantly larger milking herd and had cows spending significantly more time away from the barn.

Key Words: BTSCC, Statistical process control, Variation

T160 Ability of consistency index to predict SCC standard violations in the next 7 or 30 days. J. M. Lukas*¹, M. L. Kinsel², and J. K. Reneau¹, ¹*University of Minnesota, St. Paul*, ²*Agricultural Information Management Inc., Ellensburg, WA.*

Statistical process control charts and indices are used to evaluate process performance. Charts distinguish between a process that is in or out of control. Indices assess process prospects of meeting desired standards. The following study examines the ability of a consistency index to predict violations of the somatic cell count (SCC) standards depending on the status of the milk production process (in or out of control) and the length of time in which the violation is said to occur or not occur (7 days or 30 days). Bulk tank SCC data from every milk pick up were collected for 12 months of 2004 from 1501 dairy herds of the Upper Midwest. A consistency index was developed that calculates the maximum allowable variation to meet the SCC standard at a given mean SCC. Indices for each herd were calculated from the last 30 bulk

tank SCC results according to the following formula: Consistency index = (standard - mean)/3 where mean is the average SCC calculated from individual values of bulk tank SCC. Five different standards were used to calculate five different indices (from 200,000 cells/mL to 600,000 cells/mL, step of 100,000). Each index was compared with the actual variation in SCC during the same 30 days and used to predict future violations. Logistic regression was used to estimate the detection probability of violators and nonviolators and certainty associated with a positive or negative result. Effect of herd status (in or out of control) and length of prediction time (7 vs 30 days) were also entered into the model. Shortening the length of the prediction time and performing the capability index test in herds that are in control improves the detection probability of all violators and increases the certainty associated with a negative result. With detection probability of all violators and certainty associated with a negative result always above 80% for all 5 SCC standards the capability index proves to be a reliable tool to predict standard violations within the next 7 days.

Key Words: Statistical process control, SCC, Standard violation

T161 The relationship between bodyweight change and disease incidence in early lactation. E. M. Marion*¹, C. D. Dechow¹, J. A. D. R. M. Appuhamy², and B. G. Cassell², ¹*The Pennsylvania State University, University Park*, ²*Virginia Polytechnic University, Blacksburg.*

The objectives of this study were to investigate the relationship between body weight change between calving and 30 days in milk and occurrence of dairy cattle disease. Daily body weight was available from 515 cows, of which 346 Holstein cows were from the Penn State herd, and 120 Holstein and 49 Jersey cows were from the Virginia Tech herd. Daily body weights were recorded twice daily by AfiFarm upon a cow exiting the milking parlor. The average of at least five weights during the first week of lactation and at least five weights between 27 and 33 days in milk were calculated for each cow. Body weight change was defined as average BW during the first week of lactation minus average body weight during the fourth week of lactation. Diseases were recorded by herd managers at the respective universities; disease categories (1 = diseased, 0 = not diseased) included displaced abomasum, ketosis, all metabolic disease, uterine disease, mastitis, and all diseases. The total disease frequency was 48% in the Penn State herd and 31% in the Virginia Tech herd. The LOGISTIC procedure of SAS was used to analyze disease from the Penn State herd with fixed lactation number, age, year-season, and body weight change effects. The average body weight change during the first 30 days of lactation was -44 kg. The effect of body weight change was significant for displaced abomasum, ketosis, metabolic disease, uterine disease, and all diseases. Odds ratios were calculated for weight change at the 75th percentile (-69 kg) to weight change at the 25th percentile (-20 kg). Cows losing more weight had higher odds of developing a displaced abomasum (1.41:1), ketosis (2.24:1), metabolic disease (1.62:1), and all diseases (1.43:1). Cows with uterine diseases (0.80:1) lost less weight. Change in body weight was significantly associated with disease, and electronically recorded body weight could be used as an indicator of a cow's health status.

Key Words: Body weight change, Disease

T162 Effects of environmental factors during rearing on milk yield after first calving. J. Broucek^{*1}, S. Mihina¹, C. W. Arave², P. Kisac¹, M. Uhrincat¹, P. Flak¹, and A. Hanus¹, ¹Research Institute of Animal Production, Nitra, Slovakia, ²Utah State University, Logan.

The objective was to find whether milk yield of primiparous cows is affected by their rearing to weaning, the sire line and the season of birth and calving. At the seventh d of life 32 heifers were randomly divided to individual hutches (H,n=9), group pen with automatic feeding station (A,n=10) or to a nursing cows pen (N,n=13). Heifers A and H received mothers milk in free choice three times a d from a bucket with nipple to seventh day. Heifers of the group N sucked a mother's udder three times per d. Mother was milked. Group A received 6 kg of milk replacer (MR) per d divided into 4 portions in 6 h intervals, group H 6 kg of MR per d from a bucket with nipple divided into 2 portions in 12 h intervals. Amount of MR was increased from the 28th d on 8 kg per d. The number of calves per one nursing cow was determined according to milk yield (6 kg milk per calf). All animals were weaned at the age of 8 wks and kept in group pens, equal conditions of nutrition were ensured in all groups. After calving, the heifers were in free-stall housing, fed a total mixed ration. Trial cows originated from four sires were divided also according to the season of birth and calving. The four-factorial ANOVA was used, only sire lineage and season of birth had significant effects. The N group tended to the highest production of milk and FCM (6894.1; 6541.9 kg), the A group the lowest (5757.5; 5820.9 kg; P=0.06) for 305-d lactation. Effects of the sire were significant for contents of fat, protein and TS (P<0.05). Cows born in March-May had the highest % of protein and cows born in June-August the lowest (3.21 vs. 3.06 %). Dairy cows born and calving in December-February had the highest production of milk, protein and TS, and dairy cows born in June-August the lowest. Results demonstrate that system of heifers rearing is an important determinant of milk production during the first lactation. Dairy cows should not be stressed by heat temperatures.

Key Words: Dairy cow, Rearing, Season

T163 Temperature influences upon vascular dynamics as measured by doppler ultrasonography. B. H. Kirch^{*1}, G. E. Aiken¹, and D. E. Spiers², ¹USDA-ARS, Forage-Animal Production Research Unit, Lexington, KY, ²University of Missouri, Columbia.

Two preliminary studies were performed using doppler-image ultrasound to document the vascular changes of cattle under hot and cold conditions. Three calves per study (320 ± 38 kg) were acclimated to thermoneutrality in the Brody Environmental Center at the University of Missouri. A minimum of three ultrasound measurements were taken of the median caudal artery at the 4th coccygeal vertebrae (Cd4) using a 13 mhz probe. The animals were then stressed by either raising air temperature to 32°C or reducing it to 8°C. The animals were housed under these conditions for 24 h and then returned to thermoneutral temperatures. Ultrasound scans were repeated at -2 (2 h prior to temperature change), 5, 23, 24 and 28 h (4 h after returning to thermoneutrality) after being put under climatic changes. Blood flow rates of heat stressed cattle significantly increased from 39.12 (-2 h) to 59.87 mm/min at 23 h of exposure (P ≤ 0.05). The vessel area tended to increase (0.047 to 0.063 cm²) with the onset of the stress but was not statistically significant. Heart rate (82 beats/min) was unchanged throughout the study, but respiration rate did increase from 82 (-2 h) to 120 breaths/min (23 h). Cattle placed under cold stress showed lower flow rates to the caudal artery after 23 h of exposure (P ≤ 0.10) (30.73 at -2 h to 18.44 mm/min at 23 h). Blood flow rates of the cold stressed

cattle initially increased after the challenge. At 5 h post temperature reduction, flow rates were 53.9 mm/min, increasing over the baseline of 30.7 mm/min (P ≤ 0.07). Under cold conditions heart rate was unchanged and averaged 79 beats/min across all five time periods while respiration rate decreased from 62 (-2) to 36 breaths/min (23 h). Arterial area increased from 0.057 to 0.072 cm² at 5 h (P ≤ 0.07) then decreased to 0.043 cm² at 23 h. The doppler-image ultrasound detected vascular changes due to environmental variation and lends itself to future studies assessing environmental stress effects on hemodynamics.

Key Words: Doppler-flow ultrasound, Cattle, Cold and heat stress

T164 The use of digital infrared thermography for monitoring environmental physiology in dairy cattle. M. B. White, M. Jones, S. Schmidt, A. Chromiak, and S. T. Willard^{*}, *Mississippi State University, Mississippi State.*

The objective of this study was to monitor the thermal environment and assess its impact on body surface temperatures in lactating dairy cattle of various breeds and coat color using digital infrared thermal imaging (DITI). Three dairy breeds were housed within freestall barns: white Holstein (n=5), black Holstein (n=5), Jersey (n=5) and Gir x Holstein (GxH; n=5). The study was conducted from May 25 (d 0) to June 15 (d 21) with ambient environment (e.g., temperature-humidity index; THI) recorded throughout the day. Cows had access to sprinklers and fans which were turned off 1 hr prior to imaging to normalize surface temperature measures. Right lateral images were obtained three times daily (0600, 1200, 1800 h) using a Thermacam S60 camera (FLIR). Intravaginal temperature loggers were inserted into all cows on d 0, with vaginal temperatures (VT) acquired every 5 min. Data was analyzed in relation to breed (coat color), day, time of day, and ambient conditions, and the warmest (d 19; maximum THI: 84.1; heat stress) and coolest (d 3; maximum THI: 71.4; no heat stress) days selected for comparative analysis of study main effects. Within breed, DITI maximum (MAX) surface body temperatures differed (P<0.05) between d 3 and 19 among all time of day measures. Among breeds, Jersey cows had higher (P<0.05) DITI MAX temperatures on d 3 at 0600 and 1800 than the other breeds, while all other breed comparisons on this day did not differ (P>0.10). DITI MAX temperatures did not differ (P>0.10) on either the coolest (d 3) or warmest (d 19) days between white and black Holstein cows. On d 19, GxH cows (38.0 ± 0.1 °C) had higher (P<0.05) DITI MAX temperatures than Holstein cows (36.9 ± 0.3 °C), yet GxH VT were lower (38.6 ± 0.1 °C; P<0.05) than Holstein cows (39.2 ± 0.1 °C). In summary, cow body surface temperatures were influenced by environmental conditions which DITI could detect, including differences in responsiveness among breeds. These data establish relationships between cow body surface thermal signatures within production environments from which further studies can assess the use of DITI for environmental monitoring of dairy cattle.

Key Words: Thermography, Dairy, Temperature

T165 Physiological responses of Holstein cows (white or black hair coat) under different solar loads: An environmental chamber study. C. N. Lee^{*1}, P. Hillman², R. Collier³, and K. Gebremedhin², ¹University of Hawaii-Manoa, Honolulu, ²Cornell University, Ithaca, NY, ³University of Arizona, Tucson.

Recent studies suggest the importance of hair coat in cattle adaptation to heat stress environments. The objective of this study was to quantify

the physiological responses of Holstein cows to two different loads of solar radiation (lo-550W/m² and hi-880W/m²). These solar loads represent the am (1000-1200) and pm (1300-1600) periods in Arizona summers. Cows (dry and pregnant) of two hair coats: a) black (n=4, >90% black) and b) white (n=3, >90% white; n=1, 60% white) were used in a switched back design in an environmental chamber study with or without solar radiation. Each exposure to solar radiation consisted of 3 days with 2 white and 2 black cows. Daytime THI for the chambers were set at 84 (38.9°C, 25% RH) and nite time THI were set at 70 (23.3°C, 56% RH). Physiological responses measured were: a) respiration rates, b) dorsal skin temperatures, c) rectal temperatures and d) sweating rates. Black hair coat absorbed 91% of the solar load while white hair coat absorbed 57%. Dorsal temperatures for black or white coat at lo solar were 39.5°C and 34.5°C and at hi solar were 41.7°C and 34.9°C, respectively. Respiration rates were not different for the coat colors; lo solar 86 breaths/min. and hi solar 99 breaths/min. Rectal temperatures at lo solar were 38.9°C for black and 38.7°C for white and at hi solar were 39.4°C for black and 39.0°C for white. Cows with black hair coat had 1.5x higher sweating rates than cows with white hair coat at both solar loads. Variations in the ability to thermal regulate by sweating within a hair coat color were observed. The study suggested that cows with black coat absorbed higher solar load and this was compensated by higher sweating rates facilitated by higher dorsal skin temperatures thus allowing for greater evaporative cooling.

Key Words: Solar load, Hair coat, Physiological responses

T166 Frequency and potential production losses from low and inverted fat-protein ratios (FPR) for Pennsylvania dairy herds.

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The frequency of low and inverted fat-protein ratios (FPR) were investigated with DHIA data from 269 Pennsylvania dairy herds comprised of 24,000 Holstein cows. Milk and milk component data were collected for all December 2005 test dates. Due to the small number of observations for herds < 30 cows and individual cows < 41 days in milk (DIM), these data were excluded from analysis. Data were statistically analyzed using the UNIVARIATE, CORR, and FREQ procedures of SAS version 9.1. A low FPR was defined as 0.9 to 1.0 and an inverted FPR was defined as < 0.9. The average FPR for all cows in the study was 1.19. However, one fifth of all cows had a low or inverted FPR with 12.7% of all cows being inverted. Within individual herds, 17(± 10 SD) % of cows had low or inverted FPR and 8 (± 10 SD) % of cows had inverted FPR. The largest percentage (21%) of inverted FPR records occurred between DIM 41 to 100, whereas the percentage of low FPR records was greatest for 300+ DIM (38%). There was a substantial negative correlation between low FPR and total milk kg (-0.49) and total fat kg (-0.53). In contrast, modest positive correlations existed between inverted FPR and total milk kg (0.19) and total fat kg (0.33). For the examined test dates, the average herd lost 3.41 kg of fat per day from inverted FPR and 1.15 kg of fat per day from low FPR. Based on the butterfat price in Federal Order 1 for December, these depressions in fat production cost the average herd \$11.27 and \$3.78 per day for inverted FPR and low FPR, respectively. The results suggest that the direct economic cost of lost fat production from inverted and low FPR cows within Pennsylvania dairy herds is relatively minor.

Key Words: Fat-protein ratio, Fat production, Economic cost

T167 Effect of dry period length on health and production of Holstein cows during the subsequent lactation. R. D. Watters*¹, J. N. Guenther¹, A. E. Kulick¹, P. W. Clark², and R. R. Grummer¹, ¹University of Wisconsin, Madison, ²University of Wisconsin, River Falls.

Recent experiments to examine the effects of dry period length on subsequent lactation have employed insufficient cows to determine effects on health disorders. This study was conducted on a large commercial dairy herd to evaluate the effect of dry period length on milk production, milk components, colostrum quality, and incidences of mastitis and metabolic disorders. Dry cows (n=772) were randomly assigned to receive a dry period of 55 (C; n=382) or 34 d (S; n=390). Dry cows on C were fed a low-energy diet until 34 d prior to expected calving and then all cows were fed a moderate-energy transition diet. Milk yield was recorded every 15 d through 150 DIM and milk was sampled every 30 d through 100 DIM to analyze milk components. Cows on C produced more milk than cows on S ($P < 0.0001$; 43.8 vs. 41.8 kg/d). Cows in their 3rd or greater lactation produced more milk than cows in their 2nd lactation ($P < 0.0001$; 41.5 vs. 44.1 kg/d). There was no treatment by time or treatment by parity interaction for milk yield. Fat percent was affected by treatment ($P < 0.05$; C = 3.35 vs. S = 3.48) and parity ($P < 0.05$; 3.36 vs. 3.47 for 2nd and 3rd and greater lactation, respectively). Fat yield was not affected by treatment, but there was a parity effect ($P < 0.0001$; 1.40 vs. 1.53 kg/d for 2nd and 3rd and greater lactation, respectively). Protein percent was affected by treatment ($P < 0.0001$; C = 2.69 vs. S = 2.82) and parity ($P < 0.0001$; 2.82 vs. 2.70 for 2nd and 3rd and greater lactation, respectively). Protein yield was not different for treatment, but was for parity ($P < 0.05$; 1.17 vs. 1.20 kg/d for 2nd and 3rd and greater lactation, respectively). IgG concentration in colostrum was not affected by treatment. The incidences of mastitis, displaced abomasum, ketosis, metritis and retained placenta did not differ between treatments. There appears to be no effect of shortening the dry period from 55 to 34 d on health.

Key Words: Dry period length, Health, Milk yield

T168 Conception rate and pregnancy loss rate in lactating Holstein cows of a single herd following timed insemination or insemination at detected estrus. D. J. Ambrose*^{1,2}, T. Govindarajan², and L. A. Goonewardene^{1,2}, ¹Alberta Agriculture Food and Rural Development, Edmonton, Alberta, Canada, ²University of Alberta, Edmonton, Alberta, Canada.

The objective of the study was to determine, retrospectively, the factors affecting conception rates and pregnancy loss rates in lactating dairy cattle. Breeding records (n=1544) for five years were obtained from one dairy herd. The effect of timed-insemination (n=1324) versus insemination at detected estrus (n= 220), and the influence of parity, stage of lactation, milk production, milk composition, body condition, body weight, year, season, and number of inseminations, on conception rate and pregnancy loss rate were determined. Conception rates were lower ($P < 0.03$) in cows that were time inseminated (29.4%) compared to cows that were inseminated at detected estrus (37.4%). Season had a significant effect on conception rate ($P < 0.01$), with lower conception rates (23.2%) in summer compared to the average of other seasons (33.0%). Interaction between season and type of insemination was significant ($P < 0.05$). During winter, insemination at detected estrus resulted in higher conception rate than timed insemination ($P < 0.01$). Overall incidence of twinning was 4.0%. Pregnancy loss was affected by type of insemination ($P < 0.01$) and body condition ($P < 0.01$). Cows that were time-inseminated had a higher rate of early embryonic loss (2.8%), abortion (2.3%), and still-births (4.5%), compared

to 0, 0 and 1.8 %, respectively, for cows that were inseminated at detected estrus.

Key Words: Timed insemination, Conception rate, Pregnancy loss

T169 Factors affecting reproductive performance of Holstein heifers. F. A. Braga*, R. C. Chebel, and J. C. Dalton, *University of Idaho, Caldwell.*

The objective of the present study was to evaluate factors affecting reproductive performance of dairy heifers. Holstein heifers (6,389) were housed in a feed lot located in Parma, ID. Weekly heifers weighing > 309 kg were initiated in the reproductive program that consisted of one injection of PGF2a and AI upon detection of estrus. Heifers not inseminated by 11 d after the first PGF2a injection received a second injection of PGF2a. Pregnancy was diagnosed at 40±3 d after AI. Environmental conditions were recorded from study d -15 to 15 (study d 0 = day of initiation of the breeding program or day of AI). Average minimum daily temperature (MDT), average temperature humidity index (THI), and average rain fall (RF) were calculated for the following periods: P1, d -15 to 0; P2, d 0 to 3; P3, d 0 to 15; and P4, d -15 to 15 (P4). Exposure to environmental conditions was classified as: no heat stress (NHS = THI < 72) and heat stress (HS = THI > 71); no cold stress (NCS = MDT > -1 °C) and cold stress (CS = MDT < 0 °C); and no RF (NRF = 0 ml/d), low RF (LRF = RF < 1.05 ml/d) and high RF (HRF = RF > 1.04 ml/d). Heifers were also classified according to body weight at initiation of the breeding program as thin (TH < 340 kg); good (G = 340 - 365 kg); and heavy (HY > 365 kg). Data was analyzed by LOGISTIC procedure of SAS. Proportion of heifers inseminated during the first 22 d of the breeding program was affected by body weight (TH = 95.4, G = 98.1, HY = 98.9%; P = 0.02) and exposure to cold stress during P1 (NCS = 99.1, CS = 97.8%; P < 0.001). Pregnancy rate 22 d after the initiation of the breeding program tended to be affected by cold stress during P3 (NCS = 68.9, CS = 66.4%; P = 0.06). Conception rate was affected by AI number (1st = 67.8, 2nd = 56.3, 3rd = 47.7, 4th = 37.2%; P < 0.001), AI technician (A = 65.5, B = 60.3%; P < 0.001), and cold stress during P3 (NCS = 63.5, CS = 59.2%; P = 0.001) and tended to be affected by exposure to high precipitation during P1 (NRF = 61.7, LRF = 62.7, HRF = 59.8%; P = 0.08). From this study it was established a correlation between exposure to cold stress and reduced reproductive performance of dairy heifers.

Key Words: Heifers, Reproduction, Environment

T170 The effects of month of insemination and temperature-humidity index on non-return rate in Pennsylvania Holsteins. C. D. Dechow¹, M. L. O'Connor*¹, A. L. Mosholder¹, G. J. Killian¹, and S. Schnell², ¹The Pennsylvania State University, University Park, ²Genex Cooperative, Inc., Shawano, WI.

A total of 1,257,333 insemination records from January of 2000 through December of 2004 were provided by Genex Cooperative, Inc. Insemination date, herd number, and cow identification number were used to determine if cows were re-inseminated within 90 days (NR90) of insemination. First and second services by Holstein sires in herd-years that had at least 300 recorded services and herd-months with at least 8 services were retained. A minimum of 10 services per sire, 50 services per technician, and a herd non-return rate between 10% and 80% were required for inclusion in the dataset. The final

dataset included 60,718 records from 152 herds. Daily maximum temperature-humidity index (THI) from weather stations representing six regions in Pennsylvania was merged with insemination data. Maximum THI on the day of insemination, 1 day after insemination, and average maximum THI for the week of insemination were analyzed. Statistical analyses were performed in ASReML with NR90 treated as a binary response variable. Fixed effects included herd-year, service number, technician and THI. Random effects were cow, bull and error. Month of insemination was included as a fixed effect for one analysis. Average NR90 was 50%, which represents the percentage of cows that were not re-inseminated within 90 days. The odds of not returning to service were highest for services in March and lowest in August, and the odds ratio for March to August non-return was 1.36 to 1. Temperature-humidity index effects were strongest when the average maximum THI for the week of insemination was considered. The odds ratio of NR90 when THI was in the 75th percentile (23°C) to NR90 at median THI (15°C) was 0.92:1.00. The odds ratios of NR90 at the 95th percentile THI (28°C) to the median THI was 0.81:1.00. Results indicated that heat stress can have severe impacts on conception rates in Pennsylvania.

Key Words: Heat stress, Temperature, Non-return

T171 Effects of management techniques and farm status on bacterial contamination of colostrum. S. I. Kehoe*, B. M. Jayarao, B. A. Straley, and A. J. Heinrichs, *The Pennsylvania State University, University Park.*

Good colostrum quality requires high immunoglobulin content; however, bacterial counts in colostrum are a problem often overlooked. A study was conducted to: 1) determine bacteriological quality of colostrum and 2) identify management factors that influenced the bacteriological quality of colostrum. Colostrum samples (~250 ml) from representative dairy herds in Pennsylvania (n=55) were analyzed for bacteriological counts. Information on farm management practices were collected through an administered questionnaire survey. Samples were analyzed for standard plate count (SPC), preliminary incubation count (PIC), laboratory pasteurization count (LPC), staphylococcus aureus (SA), streptococcus agalactiae (SAG), coagulase negative staphylococci (CNS), streptococci (SS), coliforms (CC) and non-coliforms (NC). Bacterial counts were log transformed and general linear model was used to identify management techniques that influenced bacterial results (P < 0.1). Mean bacterial counts for SPC, PIC, LPC, SA, SAG, CNS, SS, CC, NC in colostrum were observed to be 997,625; 12,040,946; 616; 306; 10,994; 164,883; 257,114; 323,390 and 111,544, cfu/ml, respectively. The findings of the study suggest that high counts of CNS in colostrum were associated with herds that had > 100 cows and SCC > 200,000. Refrigerated colostrum had higher PIC and CC than frozen colostrum or colostrum that was used for immediate feeding. Farms that did not feed calves with colostrum from their own dam had higher counts of SPC, PIC and CC. The findings of the study show that many colostrum samples have high bacterial counts. It is recommended that educational programs be developed that address hygiene practices to be followed during collection, processing and storage of colostrum.

Key Words: Colostrum, Bacterial counts, Management

Ruminant Nutrition: Acidosis

T172 Rumen and metabolic acidosis in dairy goats are independent.

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The occurrence of rumen acidosis is increasing in high producing dairy herds. Its mechanism and its impact on blood pH and blood bicarbonates need further investigation. Eight cannulated dairy goats in mid-lactation were given two total mixed diets: control (C) and acidogenic (A), differing in the % of concentrate (30 vs 60 %), in a 4 week cross-over design. Rumen pH, blood bicarbonates and blood pH were measured before the morning meal (T0) and every 2 hours thereafter for 8 hours (T2, T4, T6 and T8). Rumen pH (pHr) was significantly lower after the A compared to the C meal (5.94 vs 6.26). There was a significant goat effect (mean goat values varied between 5.58 and 6.48 for diet A and 6.03 and 6.63 for diet C). Chewing index (CI, min per kg dry matter intake) explained part of the variation because more buffers enter the rumen when chewing time is longer: $\text{pHr} = 5.38 + 0.00288 \text{ CI}$ ($r = 0.74$, $n = 16$, $\text{rmse} = 0.20$). Blood pH (pHb) and blood bicarbonates (Bb) were significantly higher after the A meal compared to the C meal (pHb: 7.41 vs 7.39 and Bb: 25.4 vs 24.7 mmol/l, respectively) and were highly correlated. Blood pH was not correlated with rumen pH, except at T4 ($r = -0.71$, $n = 8$, $\text{rmse} = 0.056$). Blood bicarbonates were highly correlated with rumen pH at T2 ($r = -0.69$, $n = 8$, $\text{rmse} = 1.02$) and T4 ($r = 0.79$, $n = 8$, $\text{rmse} = 0.79$). There was a significant goat effect. The lack of correlation between rumen and blood pH emphasizes the fact that goats can suffer from rumen acidosis without suffering from metabolic acidosis. The chewing index was negatively correlated with blood bicarbonates ($r = -0.59$, $n = 16$). This indicates that goats which chew less extract less bicarbonates from blood. The higher level of bicarbonates might counteract the decrease in rumen pH and prevent metabolic acidosis as confirmed by the negative relationship between blood bicarbonates and rumen pH, particularly at times when rumen pH is at its lowest. Chewing time influences blood bicarbonates which affects blood pH. The individual differences between goats confirm what is generally observed in a dairy herd in that only some animals suffer from acidosis.

Key Words: Rumen acidosis, Metabolic acidosis, Individual effect

T173 Effects of chronic metabolic acidosis on acid-base balance and plasma free amino acids in lambs.

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Metabolic acidosis often leads to loss of body protein due mainly to accelerated protein breakdown in muscle. The objective of the current study was to characterize the effects of chronic metabolic acidosis on acid-base balance and plasma free amino acids in lambs. Twelve fully fleeced yearling wether lambs (Canadian Arcott, 54.3 ± 6.7 kg, body weight) were fed either a control diet (CD, canola meal, dietary cation-anion difference; DCAD = 184 mEq/kg DM, $n=5$) or an acidosis diet (AD, NutriChlor™ 18-8, DCAD = -206 mEq/kg DM, $n=6$) in a randomized complete block experiment. Lambs were individually housed and limit-fed dehydrated alfalfa pellets (DM, 900 g/kg; CP, 220 g/kg DM and 1.2 Mcal NE_g/kg DM) at 1 kg DM/d offered twice daily at 0700 and 1500. Lambs were fitted with left jugular vein catheters

(0.86 mm i.d., 1.32 mm o.d.) 2 days prior to the commencement of the trial for blood sampling which was obtained daily at 1100 on day 1 to day 10. The blood was analyzed for pH, gases, hematocrit, and plasma ions. Urine samples were also obtained daily at 1100 for urine pH determination. On day 11, lambs were slaughtered by captive bolt stunning and mucosal tissue samples obtained from the rumen, ileum and colon, the liver, kidney and muscles. The AD induced a non-respiratory systemic acidosis (pCO₂, 37.4 vs. 38.3; pO₂, 38.9 vs. 40.3; $P > 0.05$, CD vs. AD, respectively). The AD was associated with reduced rumen pH (6.25 vs. 5.70, $P < 0.05$), reduced blood pH (7.47 vs. 7.39, $P < 0.05$), reduced urine pH (8.13 vs. 6.09, $P < 0.05$) and reduced strong ion difference (42.5 vs. 39.5, $P < 0.05$, CD vs. AD, respectively). The AD reduced ($P < 0.05$) the anion gap, the concentration of blood glucose, hemoglobin, base excess and bicarbonate. The AD increased ($P < 0.05$) the concentration of electrolytes K⁺, Cl⁻ and Ca²⁺ in blood and plasma free concentrations of glycine and glutamine. These results show that chronic metabolic acidosis altered acid-base parameters and amino acid concentrations.

Key Words: Metabolic acidosis, Acid-base balance, Protein mobilization

T174 The severity of ruminal acidosis in primiparous Holstein cows near parturition.

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The objective of this study was to determine the risk of acidosis near parturition in primiparous cows. We hypothesized that additional concentrate allocation pre-partum would improve rumen adaptation and reduce the severity of ruminal acidosis after parturition. Fourteen ruminally cannulated Holstein heifers were blocked by expected calving date and body condition score. Cows were assigned to: 1) control treatment consisting of a far-off diet (forage:concentrate, F:C = 80:20) fed from -60 to -25 d and a close-up diet (F:C = 54:46) fed from -24 d until parturition; or 2) an intensive grain feeding program consisting of 4 pre-partum diets, step 1 (F:C = 68:32) fed from d -60 to -43, step 2 (F:C = 60:40) from d -42 to -25, step 3 (F:C = 52:48) from d -24 to -13, and step 4 (F:C = 46:54) from d -12 until parturition. All cows received the same diet post-partum. Ruminal pH was measured from d -5 to d 5 relative to parturition using a continuous indwelling ruminal pH measurement system. Mild acidosis was considered to occur when ruminal pH was < 5.8 , severe acidosis when ruminal pH was < 5.5 , and acute acidosis when ruminal pH < 5.2 . The data were analyzed accounting for repeated measures. The main effect of treatment was not significant. DMI increased ($P < 0.01$) after parturition. Minimum ($P < 0.01$), maximum ($P < 0.01$) and mean ruminal pH ($P < 0.01$) decreased after parturition. The number of daily episodes of mild acidosis decreased to 1.6 on the day of parturition from 3.4 during the pre-partum period, but increased after parturition to 9.4 ($P < 0.01$). Consequently, the duration of mild acidosis increased ($P < 0.01$) post-partum such that ruminal pH was below 5.8 for 7.88 h/d. The number and length of severe and acute episodes of acidosis also increased ($P < 0.05$) post-partum. This study shows that the incidence and severity of ruminal acidosis increases immediately post-partum emphasizing the need to implement feeding strategies to reduce this risk.

Key Words: Ruminal acidosis, Parturition, Rumen fermentation

T175 Effects of rumen acid-load from feeds on ruminal pH, dry matter intake, fiber degradability and milk production in the lactating dairy cow. B. Rustomo*, O. AlZahal, J. P. Cant, M. P. Fan, T. F. Duffield, N. E. Odongo, and B. W. McBride, *University of Guelph, Guelph, Ontario, Canada.*

The objective of this study was to evaluate the effects of rumen acid-load from feeds on ruminal pH, dry matter intake, fiber degradability and milk production in lactating dairy cows. Two isoenergetic ($NE_l = 1.73$ Mcal/kg DM) and isonitrogenous ($CP = 22.1\%$ DM) concentrate diets with either a low (LAV) or high acidogenic value (HAV) were fed in a corn silage/alfalfa haylage based TMR. The diets, fed *ad libitum* intake, were offered twice daily at 0700 and 1300 and DM intake recorded daily. Four rumen-fistulated dairy cows (230 ± 30 DIM) were randomly assigned to one of the two treatments in a crossover design with two periods of 3 wk (14 d adaptation, 7 d data collection) each. The cows were milked twice daily at 0500 and 1500, and milk samples pooled twice weekly for compositional analysis. Ruminal pH was measured continuously for 3 d using an indwelling pH electrode. Forage degradability was determined using the *in situ* technique. Data were analyzed using PROC GLM of SAS using the model: $Y_{ijk} = \mu + \alpha_i + \beta_j + \tau_k + \epsilon_{ijk}$, where Y_{ijk} = dependent variable, μ = overall mean, α_i = effect of cow ($i = 1, 2, 3, 4$) β_j = effect of period ($j = 1, 2$) τ_k = effect of treatment ($k = 1, 2$), and ϵ_{ijk} = random residual error. The repeated measurements of ruminal pH were analyzed using PROC MIXED of SAS. Increasing dietary AV decreased maximum ruminal pH, but had no effect on minimum and mean daily ruminal pH. High AV cows had longer time spent below ruminal pH 5.6 and greater area below ruminal pH 5.6 to 6.0 than the LAV cows. The time distribution curve of HAV cows was shifted to a lower pH range and tended to have longer time spent at ruminal pH 5.0 to 5.6 and shorter time spent at ruminal pH 6.2 to 6.8 than LAV cows. Increasing dietary AV reduced the 72 h *in situ* NDF degradability of alfalfa/grass hay, increased milk yield, lactose %, lactose yield and milk protein yield. These results emphasize the significance of ruminal pH alterations when evaluating the effect of feed AV on ruminal pH and suggest that feed AV could be used to predict ruminal pH changes *in vivo*.

Key Words: Acidogenic value, Fiber degradability, Ruminal pH

T176 Effects of rumen acid-load from feed and forage particle size on ruminal pH, feed intake and milk production and composition. B. Rustomo*, O. AlZahal, N. E. Odongo, T. F. Duffield, and B. W. McBride, *University of Guelph, Guelph, Ontario, Canada.*

This study evaluated the effects of concentrate acidogenic value (AV) and forage particle size (FPS) on ruminal pH, feed intake and milk production and composition in lactating dairy cows. Four rumen-fistulated dairy cows (114 ± 14 DIM) were randomly assigned to one of four treatments in a 4 x 4 Latin square with a 2 x 2 factorial treatment arrangement. Four isoenergetic ($NE_l = 1.5$ Mcal/kg) and isonitrogenous ($CP = 17.4\%$ DM) concentrate diets with either a low (LAV) or high AV (HAV) were fed in either a coarse (CS) or finely chopped (FS) corn silage/alfalfa haylage based TMR. Production data were analyzed using PROC GLM of SAS using the model: $Y_{ijkl} = \mu + \alpha_i + \beta_j + \gamma_k + \delta_l + (\gamma \times \delta)_{kl} + \epsilon_{ijkl}$; where Y_{ijkl} = dependent variable, μ = overall mean, α_i = effect of cow ($i = 1, 2, 3, 4$), β_j = effect of period ($j = 1, 2, 3, 4$), γ_k = effect of AV ($k = 1, 2$), δ_l = effect of FPS ($l = 1, 2$), $(\gamma \times \delta)_{kl}$ = effect of $\gamma_k \times \delta_l$ interaction, and ϵ_{ijkl} = random residual error. Repeated measurements of ruminal pH data were analyzed using PROC MIXED. Increasing dietary AV increased rumen acid-load (decreased mean, minimum and maximum ruminal pH), time below rumen pH 5.6 to 6.0 and area below rumen pH 5.6 and 6.0. Increasing

FPS increased maximum ruminal pH and reduced time below pH 6.4 to 6.8 for HAV diets whereas increased FPS increased time below pH 6.4 to 6.8 for LAV diets. Time distribution for HAV diets was shifted downward to a lower pH range compared to the LAV diets. Increasing dietary AV had no effect on DMI but reduced OM and NDF intake. There was a correlation ($r = -0.54$, $P = 0.03$) between milk fat content and time below pH 5.6. The correlation between time below pH 5.6 and rumen acid-load was stronger ($r = 0.58$, $P = 0.02$) than that between time below 5.6 and the intake of starch, $r = 0.40$; NFC, $r = 0.20$; FPS, $r = 0.005$ and peNDF, $r = 0.26$; $P > 0.05$). These results suggest that coarse FPS can attenuate ruminal pH drops. However, the ameliorating effects of FPS on ruminal pH are more apparent in HAV diets than in LAV diets.

Key Words: Acidogenic value, Forage particle size, Ruminal pH

T177 Effect of physically effective fiber on chewing and ruminal pH of dairy cows fed diets containing barley or corn grains. W. Z. Yang* and K. A. Beauchemin, *Research Center, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.*

Two studies were conducted to determine the effects of physically effective (pe) NDF content of dairy cow diets on chewing and ruminal pH as influenced by type of grain. Barley and corn grains were each used in separate feeding studies. Each study was a replicated 4 x 4 Latin square design using eight lactating dairy cows with ruminal cannulas. Alfalfa silage, chopped short (5/16") and long (3/4"), was the forage in both studies. In each study, four diets were formulated using the short and long silage, combined with two forage:concentrate (F:C) ratios (35:65 or 60:40, DM basis). The peNDF contents of the diets were determined using the Penn State Particle Separator with two sieves and a pan, and the NDF content of the diets. The peNDF contents ranged from 9.6 to 19.8% for barley diets, and from 10.7 to 17.5% for corn diets (DM basis). Data were analyzed using the mixed model of SAS to account for effects of treatment (fixed) and square, period within square, cow within square (random). For diets containing barley grain, increasing particle length increased total chewing time (min/kg of DMI) for the high forage diet (34.6 vs 40.1), but not for the low forage diet (31.3 vs 30.9). However, increasing the particle length of the low forage diet increased mean ruminal pH from 5.86 to 6.17 and reduced the duration of ruminal acidosis (pH<5.5) from 7.8 to 5.9 h/d. With corn diets, increasing particle length increased mean ruminal pH of cows fed low F:C ratio (5.99 vs 6.26), but not high F:C ratio (6.46 vs 6.55). For both grain types, higher F:C ratio increased chewing activity and mean ruminal pH, and reduced ruminal acidosis. The results indicate that acidosis can be reduced by increasing the peNDF content of the diet, either by using longer chopped forage or by increasing the proportion of forage in the diet. Formulating diets for higher peNDF content to prevent ruminal acidosis is particularly beneficial when using barley grain, because cows fed barley are at greater risk of acidosis than those fed corn.

Key Words: Physically effective NDF, Grain source, Ruminal acidosis

T178 Sampling ruminal pH: How many days and how frequent within day? C. Leonardi*¹, K. M. Krause², and D. K. Combs³, ¹Louisiana State University, Baton Rouge, ²West Virginia University, Morgantown, ³University of Wisconsin, Madison.

This study evaluated how sampling schedule influenced statistical interpretation of the dietary effects on ruminal pH in lactating cows.

Data collected in two published Latin Square studies were utilized (JDS 85:1947: A, JDS 86:2433: B). Ruminal pH was continuously measured in each period for 5 d in A and 3 d in B using indwelling electrodes and averaged by hour such that each cow had 24 observations per day. Average treatment pH, calculated using the hour by treatment least square means within experiment, ranged 0.27 pH units for A and 0.50 pH units for B. In trial A equal portions of TMR were fed every 12 h, where in B 65% of the TMR was fed in the morning and 35% 12 h later. Effect of forage particle size (FPS), grain fermentability (GF) and their interaction were tested in both studies. In both studies an effect of GF was observed ($P < 0.05$). The effect of FPS was significant in A, but not in B. The GF by FPS interaction was not significant in either study. Data were re-analyzed using 3 abbreviated sampling schedules within day and for 1, 3 or 5 (only for A) consecutive days within period, utilizing rumen pH measured: 1) 8 h post am feeding, 2) every

4 h for 24 h, and 3) and every 2 h for 12 h after the am feeding. Data were analyzed as Latin Square designs utilizing the mixed procedure of SAS with repeated measures. Sampling schedules were compared by the capability to detect a treatment effect ($P < 0.05$). In study A, sampling for either 3 or 5 d utilizing either of the 3 sampling schedules produced similar results. When only 1 d was utilized in the analysis, sampling every 2 h over a 12 h period detected both treatment effects ($P < 0.05$). In study B, 3 d of multiple within day samples were required to detect a GF effect ($P < 0.05$). In contrast to the published analysis, sampling only once a day (1 or 3 d) or every 4 h for 3 d resulted in a GF by FPS interaction ($P < 0.05$). It is recommended to sample ruminal pH across multiple days and hours. It is important to consider post prandial pattern of ruminal pH when choosing the sampling schedule that will maximize the probability to detect a treatment effect.

Ruminant Nutrition: Growing/Finishing Nutrition – Beef

T179 Intake, digestibility, and performance of crossbred steers fed diets containing high levels of urea^a. F. H. M. Chizzotti^{1,2}, O. G. Pereira¹, L. O. Tedeschi², S. C. Valadares Filho¹, M. L. Chizzotti^{1,2}, L. M. Moura¹, I. C. S. Belo¹, and D. H. Pereira¹, ¹Universidade Federal de Vicosa, Vicosa, MG, Brazil, ²Texas A & M University, College Station.

True protein supplements are the most expensive ingredients in diets of beef cattle. Therefore, substitution of a true protein supplement with a non-protein N source may significantly reduce the diet costs. Studies have demonstrated that animal performance is not affected by using high levels of urea and/or replacing the true protein source by urea. A trial was conducted with twenty-four crossbred steers (Holstein x Zebu), averaging 350 kg BW, distributed in six randomized blocks to evaluate intake and digestibility of nutrients and performance. Steers were fed with four diets (TRT) containing high levels of urea. Diets consisted of 70% corn silage and 30% concentrate, formulated to be isonitrogenous (12% CP, DM basis). Treatments consisted of 0, 0.65, 1.3, and 1.95% of dietary urea (DM basis), which replaced cottonseed meal in the concentrate mixture. The experiment was conducted for 99 d (15 d for diet adaptation and 3 periods of 28 d). For each animal, the DMI was measured daily and samples of feces were collected to determine the diet digestibility using indigestible ADF as a marker. There were no differences ($P > 0.05$) in the intakes of DM, OM, ether extract (EE), CP, NDF, non-fiber carbohydrates (NFC), and TDN among treatments. Additionally, no effects of levels of urea were observed on apparent total digestibility of DM, OM, NDF, EE, and NFC, which were, on average, 70.1, 71.3, 54.0, 84.3 and 86.8%, respectively. CP apparent digestibility increased linearly ($P < 0.05$) with increasing levels of urea, but ADG was not influenced ($P > 0.05$) and averaged 1.14 kg/d. This experiment suggested that levels of urea (up to 1.95% DM) might be fed to crossbreds receiving high forage diets without affecting their growing performance.

^aSponsored by CAPES, Brazil

Key Words: Feedlot, Non-protein nitrogen, Protein supplementation

T180 Effect of corn density on growing steer intake and performance. D. M. Larson*, M. L. Bauer, and G. P. Lardy, *North Dakota State University, Fargo.*

A trial was conducted to evaluate the effect of corn density on intake and performance of growing steers (288 ± 11 kg initial weight). Previous research indicates a negative effect of decreasing corn density on finishing steer gain efficiency. Sixty crossbred and purebred beef steers were assigned randomly by weight to one of four dietary treatments. The treatments consisted of low density (50.4 kg/L; 39.1 lb/bushel; LD) corn replacing 0%, 33%, 67%, or 100% of high density corn (72.1 kg/L; 56 lb/bushel; HD). The steers were individually fed once daily using a Calan Broadbent feeding system. Body weight was measured every 28 d, individual feed offered recorded daily, and individual feed refusal was recorded weekly. The diet DM was composed of dry-rolled corn (42%), corn silage (35%), mixed hay (15%), concentrated separator byproduct (5%), and supplement (3%) that provided 27.5 mg/kg monensin (DM basis). Calves were implanted with Synovex S on d 0 and were fed for 96 d. Data were analyzed with the MIXED model of SAS with linear and quadratic contrasts of LD level ($P \leq 0.05$). In addition, G:F was analyzed with PROC REG of SAS to determine the effect of % LD inclusion ($P \leq 0.05$). There was no effect of treatment on final BW (455 ± 13 kg, $P = 0.90$), ADG (1.74 ± 0.06 kg/d, $P = 0.71$), or DMI (10.05 ± 0.30 kg/d, $P = 0.57$) or DMI as a percentage of BW (2.73 ± 0.08 %, $P = 0.44$). Calculated apparent NE_g increased linearly with increasing inclusion of LD corn in the diet (1.13, 1.18, 1.19, and 1.25 ± 0.03 Mcal/kg; 0, 33, 67, 100% LD, respectively, $P = 0.02$). Inclusion of LD corn also improved G:F (167, 174, 173, and 182 ± 5 g/kg; 0, 33, 67, and 100% LD respectively, $P = 0.03$). Regression analysis of G:F indicates an intercept of 167.2 ± 4.8 g/kg ($P < 0.001$) and a regression coefficient of 0.138 ± 0.062 g/kg/% of LD ($P = 0.03$). We conclude that corn with a density of 50.4 kg/L is a suitable substitute for regular density corn. The increase in G:F may be due, in part, to less inhibition of ruminal fiber fermentation due to the decrease of starch content in the LD corn.

Key Words: Steers, Corn density, Growing

T181 Optimal level of corn distillers dried grains in a no roughage diet for pre-conditioned calves. J. E. Williams*, F. Farias, J. M. Wilson, and M. S. Kerley, *University of Missouri, Columbia*.

Two studies were conducted to determine the optimal inclusion rate of corn distillers dried grains with solubles (DDGS) for pre-conditioned calves. In yr 1 and 2, seventy-two and ninety, respectively, Angus Simmental crossbred calves (38 steers and 34 heifers; initial BW = 249.4 ± 13.5 kg) and (44 steers and 46 heifers; initial BW = 242.2 ± 20.8 kg) were used the study. Calves were allotted by weight to eight pens and randomly assigned to one of five and one of eight treatment diets in yr 1 and 2, respectively. In both yrs, diets were a control (C) containing basal diet (38 % corn, 40 % soyhulls, 20 % wheat midds, and 2 % minerals/vitamins premix), a fat control diet (PC) containing soybean oil added to the C diet with a lipid equivalency of the high DDGS diet, and increasing levels of DDGS. In yr 1 three levels of DDGS were added (D1, D2, and D3) and in yr 2 six levels of DDGS were added (D1, D2, D3, D4, D5, and D6). The D2 (yr 1) and D4 (yr 2) diets were formulated to optimize the amino acid to energy ratio. Individual intakes were measured using the Grow Safe feed intake System and weights were taken on consecutive days at initiation and termination of the experiment. Based on DM intake for yr 1, calves consumed 1.0, 2.1, and 2.9 kg of DDGS daily in D1, D2, and D3 diets, respectively; for yr 2, calves consumed 0.8, 1.2, 1.6, 1.4, 1.8, and 2.1 kg of DDGS daily from D1, D2, D3, D4, D5, and D6 diets, respectively. In yr 1, the D2 treatment had the highest ($P < .007$; 1.5 kg/d) and PC had the lowest (1.1 kg/d) ADG as compared to D1, D3, and C (1.28, 1.33, and 1.29 kg, respectively). Likewise, the calves fed the D2 diet had the best feed conversion ratio (4.8) and the calves fed the PC had the poorest ($P < 0.05$) feed conversion ratio. In yr 2, the D3 treatment had the highest ($P < 0.07$; 1.71 kg/d) ADG and the best ($P < 0.03$) feed conversion ratio (4.14) as compared to other treatments. In yr 2, the predicted optimal dietary level of DDGS, D4, had a lower feed intake and ADG than expected. The growth response to DDGS is dependent upon the level of DDGS fed, most likely due to providing absorbable amino acids to the small intestine.

Key Words: Corn distillers grains, Gain, Pre-condition

T182 Effect of bacterial inoculants or ammonia on aerobic stability of high moisture ear corn and finishing performance of steers. E. Diaz*¹, A. Amyot², C. Thivierge¹, R. Berthiaume³, and D. R. Ouellet³, ¹Laval University, Quebec, QC, Canada, ²IRDA, Deschambault, QC, Canada, ³Dairy and Swine R&D Centre, Agriculture and AgriFood Canada, Lennoxville, QC, Canada.

High-moisture ear corn (HMEC) was treated with bacterial inoculants or ammonia to investigate their efficiency in maintaining silage quality after air exposure and their effects on finishing performance of steers. These treatments were compared 1) untreated HMEC (Control) 2) *Lactobacillus plantarum* and *Enterococcus faecium* (HOB: Homolactic bacteria; 0.91×10^5 cfu/g of fresh HMEC); 3) *Lactobacillus buchneri* (HEB: Heterolactic bacteria; 1.0×10^5 cfu/g of fresh HMEC); 4) aqueous solution of ammonia (AMMO; 16 g/kg of fresh HMEC). In the fermented material, HEB and AMMO exhibited the lowest counts of yeasts (4.2 and 4.6 log₁₀ cfu/g of fresh weight; SEM=1.21 and SEM=1.29 respectively) and molds (2.8 and 2.3 log₁₀ cfu/g of fresh weight; SEM=0.96 and SEM=0.54 respectively) and HEB presented the lowest aerobic instability index (15.3°C/day; SEM=7.4). A growth trial using 36 steers (BW 427 kg) grown over 142 d according to an incomplete block design and a digestion trial using 4 additional steers (BW 423 kg) according to a 4x4 Latin square design were conducted.

In both trials, steers fed either treated or control HMEC had similar DM intake expressed in % of BW (1.98%; SEM=0.02). Treatments had no effect on BW gain, feed efficiency, hot carcass weight, carcass yield and quality grade ($P > 0.10$). In HOB compared to control, apparent digestibility of nitrogen and ADF was increased (74.0% and 42.2% respectively; ($P < 0.05$) and DE and ME tended to be higher ($P < 0.10$). Nitrogen retention was increased ($P < 0.05$) with HOB and AMMO (34.4% and 33.9% of N intake, respectively). This study supports previous observations that bacterial inoculants and ammonia are not detrimental to growth performance, but some may be more appropriate in maintaining silage quality and avoiding biodegradation of dry matter.

Key Words: High moisture ear corn, Additives, Finishing steers performance

T183 Performance of young Angus × Nellore cattle fed with high-moisture corn or high-moisture sorghum. M. S. Igarasi, M. D. B. Arrigoni, C. L. Martins, H. N. Oliveira, A. C. Silveira, D. D. Millen*, R. D. L. Pacheco, and L. A. L. Chardulo, *FMVZ/UNESP, Botucatu, Sao Paulo, Brazil*.

The objective was to determine differences in the performance of young cattle fed high-moisture corn or high-moisture sorghum. The study had two treatments, in which the total diet was composed mainly of high-moisture corn (HMC) or high-moisture sorghum (HMS). The diet composition (dry mater basis) was: HMC - Cynodon sp hay 21%, corn silage 7%, high-moisture corn 44%, cottonseed whole 10%, and mineral protein mix 18%; HMS - Cynodon sp hay 20%, corn silage 8%, high-moisture sorghum 45%, cottonseed whole 10%, and mineral protein mix 17%. The experiment was conducted at the experimental feedlot of the Veterinary Medicine and Animal Science College, Sao Paulo State University, Botucatu campus (UNESP-Botucatu), Brazil. Ninety 8-month-old Angus x Nellore crossbred steers (240± 19 kilos) were divided in two experimental treatments (HMC and HMS), and fed during 172 days. Treatments did not affect ($P>0.05$) ADG (HMC=1.41 kilos, HMS=1.43 kilos), total weight gain (HMC=186.74 kilos, HMS=189.23 kilos), and final weight (HMC=482.54 Kilos x HMS=486.81 Kilos). Treatments did not affect ($P>0.05$) Longissimus dorsi area (HMC=73.67 cm², HMS=73.81 cm²) or subcutaneous fat thickness (HMC=4.28 mm, HMS=4.16 mm). In conclusion, high-moisture corn should be able to be totally substituted for high-moisture sorghum without altering the performance or carcass characteristics of young Angus x Nellore cattle. The use of high-moisture sorghum instead of high-moisture corn should be able to reduce feed costs by as much as 10% without impacting performance.

Key Words: Nellore, Red Angus, High-moisture

T184 Evaluation of chop length in two brown midrib sorghum hybrids silage on feedlot animal performance. G. J. Depetris*, M. D. Montiel, F. J. Santini, A. Chicatún, and E. L. Villareal, *EEA INTA Balcarce-Fac. Cs. Agrarias, UNMdP, Balcarce, Buenos Aires, Argentina*.

This trial was designed to study the effects of brown midrib (BMR) sorghum hybrids silages with different chops length on feedlot performance steers. Experimental design was randomized blocks with 2x2 factorial arrangement: two chops length (short fiber: SH (3mm) and large fiber: LO (15mm)) and two BMR hybrids (CH and DM), adding 4 treatments. Sixty Aberdeen Angus steers (215±13.5 BW) were blocked by weight (light, medium and heavy) and fed with TMR

(79.2% silage, 20% sunflower meal and 0.8% urea) offered *ad libitum* once a day for 87-d. Dry matter intake (DMI) was recorded daily and animals were weighed at the start and the end of the trial and at 2-wk intervals to obtain ADG. Ultrasound subcutaneous backfat (SBF) was measured to estimate fat deposition rate (FDR). The ADG and FDR were estimated individually by linear regression. When the interactions were not significant, hybrids and chops length factors were analyzed like a principal effect and the means were compared using Tukey. Use of BMR hybrids did not affect ($P>0.05$) neither of variable evaluated. ADG and DMI were affected ($P<0.05$) by the chop length, and were higher in SH than LO (0.98 vs. 0.90 kg/d and 9.55 vs. 8.79 kg/d, respectively). Feed efficiency (feed/gain) was not affected (9.68 ± 0.035 ; $P=0.86$) for chop length. BMR-hybrids x chops length interaction was significant ($P<0.05$) for FDR. CH hybrids SH resulted in higher FDR than LO (1.006 vs. 0.634 mm/30d, respectively). We conclude that chop length is the principal factor that affects animal performance, increasing ADG and DMI when chop length of BMR sorghum silage is short.

Key Words: Brown midrib sorghum hybrid, Chops length, Feedlot performance

T185 Feedlot performance of heifers fed with three sorghum hybrids silage or one corn silage diets. G. D. Depetris*, M. D. Montiel, F. J. Santini, A. Chicatun, and E. L. Villarreal, *EEA INTA Balcarce- Fac. Cs. Agrarias, UNMdP, Balcarce, Buenos Aires, Argentina.*

The objective of this study was to examine dietary effects on performance of heifers fed with three different sorghum silages and one corn silage. Sixty Aberdeen Angus heifers (184 ± 13.7 kg BW) were blocked by weight (light, medium, heavy) and randomly assigned to one of four dietary treatments: BMR (brown midrib sorghum), HT (high tannin sorghum), WS (white sorghum) and C (corn silage). The TMR consisted of: 79.2% silage, 20% sunflower meal and 0.8% urea and were offered *ad libitum* once a day for 87 d. During the experiment DMI was recorded daily and animals were weighed at the start and the end of the trial and at 2-wk intervals during the trial to obtain ADG. Ultrasound subcutaneous backfat (SBF) was measured on 2 consecutive days at the start and at the end of the experiment to estimate fat deposition rate (FDR). A randomized block design was utilized; data were analyzed with SAS and means were compared with Tukey. The results of least squares mean comparisons are detailed in the table below. These results show treatments effects on animal performance. The diet containing high tannin sorghum silage was clearly inferior for LWG and presented the worst feed efficiency (FE). Corn silage showed the highest final SBF and FDR and there were not difference among sorghum silages for this two traits.

Table 1.

Item	BMR	HT	WS	C	SEM
DMI, kg/d	8.37	8.52	8.90	8.49	0.28
Initial BW, kg	184	184	184	183	2.34
Final BW, kg	244 ^a	236 ^b	251 ^a	251 ^a	2.83
LWG, kg/d	0.69 ^{ab}	0.59 ^b	0.76 ^a	0.79 ^a	0.28
FE, feed/gain	12.2 ^{ab}	14.2 ^a	11.7 ^b	10.7 ^b	0.44
Initial SBF, mm	3.68	3.41	3.40	3.69	0.17
Final SBF, mm	4.36 ^b	3.99 ^b	4.73 ^b	6.02 ^a	0.22
FDR, mm/30d	0.26 ^b	0.31 ^b	0.46 ^b	0.81 ^a	0.07

^{ab}Means within a row with unlike superscripts differ ($P < 0.05$).

Key Words: Sorghum and corn silage, Sorghum hybrids, Feedlot performance

T186 Performance of feedlot heifers fed with high-tannin high-moisture sorghum treated with urea compared with high moisture corn. M. D. Montiel*, G. J. Depetris, F. J. Santini, A. Chicatun, and E. L. Villarreal, *EEA INTA Balcarce-Fac. Cs. Agrarias, UNMdP, Balcarce, Buenos Aires, Argentina.*

Condensed tannins are responsible for low digestibility of sorghum grain and reduce animal performance. This trial was designed to determine the effects of adding urea to a high tannin high moisture sorghum diets on feedlot heifer performance. Sorghum was harvested with 35% moisture content and treated with two levels of urea (either 0 or 1.4% urea on DM basis), and conserved under anaerobic conditions. Corn was harvested and conserved under similar conditions to sorghum. Forty-five Angus heifers (179 ± 13 kg BW) were blocked by weight (light, medium, heavy) and randomly assigned to one of three treatments: sorghum with urea (1.4U), sorghum without urea (0U) and high moisture corn (C), and fed *ad libitum* a TMR comprising 70% high moisture grain, 12% corn silage and 18% sunflower meal for 63 d. To obtain similar CP (15%) content in all diets 0U and C were supplemented with urea. Feed intake (DMI) was recorded daily and animals were weighed at the start and end of the trial and at 2 wk intervals to obtain live weight gain (LWG). Fat deposition rate (FDR) was estimated measuring ultrasound subcutaneous backfat depth (SBF). A randomized block design was utilized; data were analyzed with SAS and means were compared with Tukey. The least squares mean comparisons are detailed in the table below. Adding urea was effective to reduce the anti-nutritional effects of tannins because DMI and LWG were greater for 1.4U than 0U. Moreover, 1.4U and C treatments presented similar LWG. However, there were not differences in feed efficiency (FE), final SBF and FDR between treatments.

Table 1.

Item	1.4U	C	0U	SEM
DMI, kg/d	6.79 ^a	6.20 ^b	6.11 ^b	0.10
DMI, kg/d	6.79 ^a	6.20 ^b	6.11 ^b	0.10
DMI, kg/d	6.79 ^a	6.20 ^b	6.11 ^b	0.10
Initial BW, kg	182	179	174	2.47
Final BW, kg	245 ^a	237 ^a	228 ^b	3.39
LWG, kg/d	0.89 ^a	0.84 ^{ab}	0.78 ^b	0.03
LWG, kg/d	0.89 ^a	0.84 ^{ab}	0.78 ^b	0.03
LWG, kg/d	0.89 ^a	0.84 ^{ab}	0.78 ^b	0.03
FE, feed/gain	7.66	7.39	8.01	0.22

^{a,b}Means within a row with unlike superscripts differ ($P < 0.05$)

Key Words: High moisture sorghum and corn, Urea, Feedlot performance

T187 Effect of corn processing and soybean meal treatment on performance of finishing beef steers fed corn silage based diet. D. R. Ouellet*¹, M. D'Amours², R. Berthiaume¹, L. Faucitano¹, and D. Pellerin², ¹Dairy and Swine R&D Centre, AAFC, Lennoxville, Quebec, Canada, ²Laval University, Quebec, Canada.

Forty crossbred steers (456 ± 14 kg BW) were used in a study with a 2×2 factorial arrangement of treatments to determine the effect of corn particle size (cracked or ground) and soybean meal processing (solvent extracted 48% CP soybean meal or lignosulfonate treated soybean

meal; Soypass™) on feed intake, weight gain and feed-to-gain ratio during the finishing phase. Corn silage (31.7, 8.4, and 47.6% of DM, CP, and NDF, respectively) was offered for *ad libitum* consumption, while corn and soybean meal were fed at 6.6 and 0.54 kg DM/d, respectively. Animals received the corn silage individually once a day and half of the supplement was added on the top of the silage in the morning and the remainder in the afternoon. Dry matter offered and orts were recorded daily. Animals were treated against internal parasites (Ivermectin) and received an ionophore (Bovatec®), and growth stimulant (Revalor S®). Steers were weighed on three consecutive days at the beginning and at the end of the experiment. Animals were slaughtered when ultrasound backfat thickness was between 4 - 10 mm (Canada grade A). Duration of the experiment was not affected ($P > 0.10$) by treatment and averaged 99 d (SEM = 4). Dry matter intake, ADG, and feed-to-gain ratio were not affected ($P > 0.10$) by treatment and averaged 11.1 ± 0.3 kg/d, 1.65 ± 0.08 kg/d, and 6.7 ± 0.3 kg DMI/kg gain, respectively. No interaction between soybean meal treatment and corn processing was observed. During a digestion trial run concomitantly, results indicated that reducing particle size of corn increased apparent total tract digestibility of starch (0.96 vs 0.91 ± 0.01 ; $P < 0.01$) while neutral detergent fiber digestibility tended to decrease (0.24 vs 0.37 ± 0.06 ; $P < 0.07$). In conclusion, although starch was more digestible, reducing corn particle size had no effect on performance of finishing steers fed a corn silage-based diet. This could be partly explained by reduction in fiber digestion. No effect soybean meal sources or interaction between supplements was observed when performance of finishing steers was compared.

Key Words: Corn processing, Soybean meal, Finishing steers

T188 Influence of supplements on performance of grazing steers during the dry season in Brazil. C. E. S. Baroni¹, R. P. Lana^{1,2}, A. B. Mâncio¹, D. M. Lambertucci^{1,2}, and B. P. C. Mendonça¹, ¹Universidade Federal de Viçosa, Viçosa, MG, Brazil, ²CNPq, Brasília, DF, Brazil.

Two experiments were conducted to evaluate the effects of supplements on performance of finishing cattle on pasture of *Brachiaria brizantha* Stapf. The supplements were fed at levels of 0.05, 0.25, 0.5, 1.0, 2.0, and 4.0 kg/animal/day, and were based on mineral mixture (100, 25, 15, 10, 5, and 2.5%, respectively), urea (0, 25, 15, 10, 5, and 2.5%, respectively), corn meal and soybean meal. The protein sources were used in the amount necessary to reach approximately 10 and 13% CP levels in the total diet of the first and second experiment, respectively. This was possible based in estimatives of pasture and supplement intakes, in which the last one was controlled by the mineral and urea levels in the supplements. Each experiment contained 48 Nellore steers (412 ± 16 kg) allotted at random in six paddocks of 90,000 m². The animals and supplements switched three times among the paddocks at each 21 days. The average daily gain (ADG) and carcass weight (CW), both in kilograms, responded linearly to supplement intake (SI), in kg, as follow: 1st Experiment: $ADG = 0.207 + 0.0739$ SI, $r^2 = 0.43$; $CW = 240 + 3.83$ SI, $r^2 = 0.21$. 2nd Experiment: $ADG = 0.174 + 0.0994$ SI, $r^2 = 0.45$; $CW = 239 + 6.20$ SI, $r^2 = 0.41$. The supplement conversions (kg of supplement as fed/kg of ADG), obtained by the reciprocal of the coefficients of the linear regressions, were 13.5 and 10.1 for the experiment 1 and 2, respectively. The carcass yield was $56 \pm 0.7\%$ and fat thickness 2.0 ± 0.4 mm, with low effect of supplementation. The high cost of concentrate feeds compared to the pasture and the low efficiency of the concentrate conversion in weight gain even under tropical pastures can explain the low use of concentrate by

Brazilian farmers, which can have greater profitability in spite of low cattle performance.

Key Words: Carcass characteristics, Concentrate conversion, Daily gain

T189 Effects of different growing systems on performance of feedlot cattle. J. T. Vasconcelos^{1,2}, J. E. Sawyer¹, L. O. Tedeschi¹, L. W. Greene², and F. T. McCollum, III², ¹Texas A&M University, College Station, ²Texas A&M University, Amarillo.

Forty eight steers (BW = 296 ± 16.7 kg) were individually fed to evaluate the effects of different growing diets on performance of feedlot cattle. Steers were fed one of four treatments for 56d: 1 - limit fed (LF) high starch, 2 - ad lib (AL) low starch, 3 - AL intermediate starch, and 4 - AL high starch. On d57, steers were placed on treatment 4 for finishing until d140. Orthogonal contrasts were used to compare LF to all other treatments. Linear and quadratic contrasts were applied across increasing starch content of the diets within AL treatments. During d0-56, LF reduced ADG ($P < 0.01$) compared to AL treatments. Increasing starch concentration increased ADG quadratically in AL treatments ($P = 0.04$; 1.86, 2.40, 2.32 ± 0.12 kg/d for 2, 3, and 4, respectively). By design, LF resulted in reduced DMI ($P < 0.01$). Increasing starch content resulted in a quadratic DMI response ($P < 0.01$; 10.0, 11.6, 10.2 ± 0.28 kg/d). LF tended to increase G:F, and increasing starch resulted in a linear increase in G:F ($P = 0.02$; 0.17, 0.21, and 0.22 ± 0.01). During d57-140, LF steers had ADG similar to AL treatments ($P = 0.9$). Increasing starch resulted in a quadratic ADG response in AL treatments ($P = 0.06$; 1.88, 1.63, 1.70 ± 0.07). DMI was reduced for previously LF steers ($P = 0.04$) but was not different among AL treatments ($P > 0.5$; 10.6, 10.5, 10.9 ± 0.4). LF resulted in increased G:F ($P = 0.04$) and increasing starch resulted in a linear decrease in G:F ($P = 0.02$; 0.18, 0.15, 0.15 ± 0.004). Across the 140-d trial, LF reduced ADG ($P < 0.01$), reduced DMI ($P < 0.01$), and tended to improve G:F ($P = 0.07$), while minimum separations were observed among AL treatments. LF enhanced feed efficiency at the expense of productivity. These data suggest that growing systems relying on low starch diets do not affect productivity of feedlot cattle when compared to intermediate and high starch based growing systems.

Key Words: Steers, Starch, Finishing

T190 Influence of Ractopamine-HCl and ground white corn or steam-flaked white corn based-diets on growth performance of finishing Brahman cross bulls. R. Barajas¹, J. M. Romo¹, B. J. Cervantes¹, R. J. Virgilio², and J. J. Lomeli¹, ¹FMVZ-Universidad Autonoma de Sinaloa, Culiacan, Sinaloa, Mexico, ²Tecnología de Máxima Producción, S.A. de C.V., Culiacan, Sinaloa, Mexico.

With the objective of determine the influence of Ractopamine-HCl and ground white corn or steam-flaked white corn based diets on growth performance of finishing Brahman cross bulls, fifty six bulls proximately 75% Brahman (BW 383.75 ± 5.47 kg) were used in a 33 days feedlot experiment. Agreement with its BW animals in groups of seven was housed in ground flour pen (6 x 12 m). Accord to a complete randomly block design experiment with a 2 x 2 factorial arrangement, animals were designed to receiving or not 300 mg of ractopamine-HCL per head per day from Optaflexx 100® (Elanco), during 30 to 36 days before slaughter (RAC), and receive white ground corn (WGC) based-diet (68% grain; CP 13.17%; NEM 2.048 Mcal/kg) or steam-flaked white corn (SFC) based-diet (68% grain; CP 13.17%; NEM 2.15 Mcal/kg). Ractipamine increased ($P = 0.02$) 14.9% ADG (1.34 vs.

1.54 kg/d), not affected ($P = 0.15$) DMI, and enhanced ($P = 0.04$) 18% feed/gain ratio (6.77 vs. 5.5 kg/kg). Ractopamine supplementation improved ($P = 0.02$) 12% NEm (2.13 vs. 2.38 Mcal/kg) and 15% NEg (1.458 vs. 1.684 Mcal/kg) retained from the diet. SFC had no effect ($P = .73$) on ADG, diminished ($P = 0.04$) 7.5% DMI (8.5 vs. 7.86 kg/day), without changes in feed/gain ratio. SFC increased ($P = 0.05$) 8.7% the NEm (2.165 vs. 2.353 Mcal/kg) and 10.8% NEg (1.489 vs. 1.65 Mcal/kg) of the diet. Interactions ractopamine x corn processing method were not observed ($P > 0.10$). It is concluded that, ractopamine supplementation improves feedlot performance, in cross Brahman bulls eating either ground or steam flaked white corn-based finishing diets.

Key Words: Ractopamine, Corn processing method, Feedlot performance

T191 Effect of Ractopamine-HCl and ground white corn or steam-flaked white corn based-diets on carcass characteristics of finishing Brahman cross bulls. R. Barajas^{*1}, J. M. Romo¹, B. J. Cervantes¹, R. J. Virgilio², and J. J. Lomeli¹, ¹FMVZ-Universidad Autonoma de Sinaloa, Culiacan, Sinaloa, Mexico, ²Tecnología de Máxima Producción, S.A. de C.V., Culiacan, Sinaloa, Mexico.

With the objective of determine the effect of Ractopamine-HCl and ground white corn or steam-flaked white corn based-diets on carcass characteristics of finishing Brahman cross bulls, fifty six bulls proximately 75% Brahman (BW 383.75 ± 5.47 kg) were used in a 33 d feedlot experiment. Agreement with its BW animals in groups of seven was housed in ground flour pen (6 x 12 m). Accord to a complete randomly block design experiment with a 2 x 2 factorial arrangement, were designed to receiving or not 300 mg of ractopamine-HCL per head per d from Optaflexx 100[®] (Elanco), during 30 to 36 d before slaughter (RAC), and receive white ground corn (WGC) based-diet (68% grain; CP 13.17%; NEm 2.049 Mcal/kg) or steam-flaked white corn (SFC) based-diet (68% grain; CP 13.17%; NEm 2.15 Mcal/kg). Mean ractopamine supplementation period was 33 d, after that, bulls were sacrificed in a slaughterhouse. Ending weight (428.68 ± 7.38 kg) was not affected ($P > 0.35$) by treatments. Ractopamine increased ($P = 0.06$) 2.6% hot carcass weight (264.91 vs. 271.79 kg), and improved ($P = 0.04$) 0.7% carcass dressing (62.13 vs. 62.59%). Back fat thickness (0.69 ± 0.08 cm) was similar ($P > 0.32$) across treatments. Longissimus dorsi area (68.67 ± 2.99 cm²) was not modified by treatments ($P > 0.20$). Marbling score was not influenced by RAC or corn processing method. Ractopamine diminished ($P = 0.05$) 6.5% KPH fat (2.43 vs. 2.27%). Corn processing method, had no effect ($P > 0.30$) on any studied variables. Interactions ractopamine x corn processing method were not found ($P > 0.20$). It is concluded that, ractopamine supplementation improves hot carcass weight and carcass dressing, in cross Brahman bulls eating either ground or steam flaked white corn-based finishing diets.

Key Words: Ractopamine, Corn processing method, Carcass characteristics

T192 Effect of Synovex-S and ractopamine on serum concentration of IGF-I, performance and carcass characteristics of finishing steers. A. J. M. Rosa^{*}, J. L. Clapper, A. M. Sanborn, S. L. Lindblom, C. Smith, D. M. Wulf, C. L. Wright, and J. A. Clapper, *South Dakota State University, Brookings.*

Twenty-nine Angus yearling steers (BW=417.3 ± 31.3 kg) were used in a 2X2 factorial experiment conducted over 105 d feeding period

to determine the effects of Synovex-S and ractopamine on serum concentration of IGF-I, performance and carcass characteristics. Traits analyzed were ADG from 0 d to 105 d after implant (ADG1) and ADG from 70 d to 105 d (ADG2), after starting ractopamine administration, HCW, LMA area (LMA), back fat thickness (BF), marbling score (MARB), KPH and Yield Grade (YG), IGF-I and estradiol-17β (E2) concentrations. Treatments included: 1) control (C), 2) ractopamine (R), 3) Synovex-S implant (I) and 4) ractopamine and implant (RI). Weights were collected monthly, while blood samples were drawn on 0, 7, 35, 79 and 105 d. No interactions were found for any trait analyzed. ADG1 were 1.42, 1.55, 1.70 and 1.72 kg/d while ADG2 were 1.43, 1.73, 1.67 and 1.81 kg/d for C, R, I and RI respectively. Synovex-S affected ADG1 ($P=0.02$) but did not affect ADG2 ($P=0.17$). Ractopamine tended to increase ADG2 ($P=0.06$). No significant differences were found for HCW, LMA, BF, MARB, KPH or YG. Average carcass traits were HCW=357.8kg, LMA=83.1cm², BF=1.12cm, MARB=415 (SM15), KPH=1.93% and YG=2.87. Synovex-S increased mean serum concentrations of E2 by 44% at 7 d ($P=0.0003$), by 42% at 35 d ($P=0.0001$), by 46% at 79 d ($P=0.0001$) and 13% at 105 d ($P=0.012$). Synovex-S increased mean serum concentrations of IGF-I by 43% at 7 d ($P=0.036$), by 51% at 5 d ($P=0.007$), by 60% at 79 d ($P=0.011$) and 25% at 105 d ($P=0.063$). Ractopamine did not alter serum concentration of E2 or IGF-I. Results indicate an effect of Synovex-S on IGF-I concentrations as well as on ADG1. Reduced increase on E2 and IGF-I might explain the lack of significance on ADG2 from the implant. Gene expression analysis using microarray will be performed on mRNA extracted from muscle biopsies (79 d) to identify changes in response to ractopamine and Synovex-S.

Key Words: Beef cattle, Implant, Ractopamine

T193 Effects of ractopamine and implant regimens containing trenbolone acetate and estradiol on growth and carcass characteristics of feedlot steers. T. C. Bryant^{*1,2}, J. J. Wagner², S. B. Laudert³, and M. L. Galyean⁴, ¹Five Rivers Cattle Feeding, Loveland, CO, ²Colorado State University, Fort Collins, ³Elanco Animal Health, Greenfield, IN, ⁴Texas Tech University, Lubbock.

Beta-adrenergic agonists and steroidal implants elicit responses via separate modes of action to increase protein deposition. Yearling steers (n = 486; initial BW = 305 kg ± 10.4 kg) were used to evaluate the effects of ractopamine (Optaflexx; Elanco; RAC) and implant/reimplant (IMP) regimen on performance and carcass traits. Steers were blocked by initial BW into six replicates and assigned randomly to treatments (9/pen). The 3 x 3 factorial arrangement included RAC doses of 0 (R0), 100 (R1), or 200 (R2) mg•steer⁻¹•d⁻¹ and IMP regimens of None/None (N/N), Revalor-S/None (S/N), or Revalor-IS/Revalor-S (I/S). Except for KPH and skeletal maturity, no RAC x IMP interactions were noted ($P > 0.10$). Compared with R0, steers fed R2 had 26% ($P < 0.001$) greater ADG and 27.6% ($P < 0.001$) greater G:F during the final 28-d supplementation period, resulting in 4.7% ($P = 0.009$) greater G:F from d 0 to slaughter. Carcasses from R2 were 6.3 kg ($P = 0.042$) heavier than those from R0. Marbling, empty body fat (EBF), and quality grade did not differ among RAC treatments ($P > 0.10$). For IMP, I/S cattle had 7.7% ($P < 0.001$) and 23.8% ($P < 0.001$) greater ADG and 4.6% ($P = 0.007$) and 12.3% ($P < 0.001$) greater G:F over the 168-d feeding period than S/N and N/N, respectively. The I/S steers had 12.6 kg ($P = 0.001$) and 41.1 kg ($P < 0.001$) greater HCW than S/N and N/N, respectively. Despite no difference ($P > 0.10$) in EBF, marbling score was decreased for I/S ($P < 0.001$) and S/N ($P = 0.001$) relative to N/N, resulting in 14.6 and 11.4 percentage unit fewer Prime and Choice carcasses with I/S ($P = 0.002$) and S/N ($P = 0.012$) than

with N/N. These data suggest that the effects of IMP and RAC are independent. Further research is needed to elucidate the lipogenic and/or lipolytic effects of these classes of growth-enhancing products among the multiple fat depots.

Key Words: Carcass, Implants, Ractopamine

T194 Influence of live weight at first implanting on growth performance and carcass characteristics of calf-fed Holstein steers. R. A. Zinn¹, N. Torrentera^{*2}, and F. Calderon², ¹University of California, Davis, ²UABC, Mexicali, BC, MX.

Ninety-six calf-fed Holstein (264 ± 2.8 kg) were used in a 224-d growing-finishing trial to evaluate effects of live weight (LW) at first implanting on growth performance and carcass characteristics of calf-fed Holstein steers. Treatments were: control (non-implanted) versus first implanting (Revalor-S) when calves achieve LW of 264, 295, or 327 kg. All calves were reimplanted (Revalor-S) on d 112. Steers were fed a steam-flaked corn-based growing-finishing diet. Over the 224-d feeding period, implanting increased ($P < 0.01$) ADG (9%), DMI (5.3%), gain efficiency (10.3%), and dietary NEM (7.3 %) and NEg (8.8%). As LW at first implanting increased, ADG during the initial 56 d tended (linear effect; $P < 0.10$) to decrease. This effect was attenuated over time. Overall, LW at first implanting did not affect ($P > 0.20$) ADG. Hip height explained 70 to 81% of the variation in LW. At slaughter, implanted calves were heavier than non implanted calves, at similar HH, indicative of a greater muscle:bone ratio. There were no treatment effects on dressing percentage, averaging 62.3%. The LW at first implanting did not affect ($P > 0.20$) carcass characteristics. Adjusting to a constant carcass weight, longissimus muscle area was greater (7%, $P < 0.05$) for implanted than for non-implanted steers. Yield grade, fat thickness, and marbling score were not different ($P > 0.10$) for implanted vs non-implanted steers. Although, implanting tended to decrease (14%, $P < 0.10$) KPH. We conclude that in delay-implant programs, applying the first implant between 260 and 300 kg LW will optimize ADG and gain efficiency. When calf-fed Holsteins are slaughtered at a similar final degree of finish (fat thickness) implanting effects on growth performance efficiency are appreciable, whereas, effects on carcass quality grade are small.

Key Words: Holstein, Implant, Growth

T195 Effects of supplement type and feeding frequency on performance and physiological responses of yearling Brahman-crossbred steers. R. F. Cooke^{*}, C. R. Staples, X. Qui, and J. D. Arthington, University of Florida, Gainesville.

The objective of this experiment was to investigate the effects of supplement type and feeding frequency on BW gain, plasma metabolites and hormones, and voluntary forage DMI of yearling steers. Twenty four steers (Brahman x British; avg. age = 12 mo) were stratified by initial BW and randomly allocated to 12 pens (2 steers/pen). Pens were randomly assigned to one of three treatments: 1) molasses-based supplement fed 3x/wk (ML), 2) citrus pulp-based supplement fed 3x/wk (CT), or 3) citrus pulp-based supplement fed daily (CD). Treatments were formulated to be iso-caloric and iso-nitrogenous and fed at 2.1 kg of DM/steer/d. Limpoglass (Hemarthria altissima) hay was offered in amounts to ensure ad libitum intake. Steer shrunk BW was obtained at the beginning and at the end of the experiment. During the first 3 wk (d 1 to d 21), blood samples were collected immediately prior to and 4, 8, 24, 32 and 48 h after the first

supplement feeding of the week for determination of glucose, blood urea nitrogen (BUN), insulin, IGF-I, and GH concentrations. For the second phase of the experiment (d 22 to d 40), forage DMI was recorded daily. Mean BW gain was greater ($P < 0.05$) for CD vs. ML, tended to be greater for CD vs. CT ($P < 0.15$), but did not differ for CT vs. ML (0.30, 0.18 and 0.10 kg/d for CD, CT and ML respectively; SEM = 0.05). Forage DMI did not differ among treatments, however, a treatment x day interaction was observed ($P < 0.05$) revealing a difference in forage intake pattern among treatments, whereas during non-feeding days forage DMI was greater for CT vs. ML and CD. Mean plasma concentration of glucose was lesser for CD vs. ML and CT ($P < 0.05$). Mean insulin was greater for CT vs. CD and ML ($P < 0.05$). Forage-fed steers offered a citrus pulp-based supplement daily had greater BW gain compared to steers offered a molasses-based supplement 3x/wk and tended to have greater BW gain compared to steers fed citrus pulp-based supplements 3x/wk.

Key Words: Steers, Supplement, Frequency and performance

T196 Relative abundance of mRNA UCP2 and UCP3 in skeletal muscle and their relationship to metabolic rate in three breeds of beef heifers. K. M. Brennan, J. J. Michal, K. A. Ross, and K. A. Johnson^{*}, Washington State University, Pullman.

The relative abundance of UCP2 and UCP3 mRNA from skeletal muscle of three breeds of cattle was measured to examine the variation among breeds and to relate these differences to measures of whole animal metabolic rate. Ten-month old Angus (A), Holstein (H), and Wagyu (W) heifers (N=8/breed) were used. Muscle biopsies were obtained from the biceps femoris and immediately placed in liquid nitrogen. Tissue was pulverized in liquid nitrogen and total RNA was extracted with Trizol and reverse transcribed into cDNA with Superscript III according to manufacturer's instructions. Gene specific primers for UCP2 (Forward: 5'-GTGCTGAGCTGGT-GACCTAC-3'; Reverse: 5'- CCCGAAGGCAGAAGTAAAGT-3') and UCP3 (Forward: 5'- GGGAGGCAACAGAAAGTACA-3'; Reverse: 5'- ATGTTGGCAGAATTCCTTT-3') were designed based on available bovine sequences (Accession #AF127029 and AF092048, respectively). Relative abundances of UCP2 and UCP3 were quantitated by real-time PCR using SYBR green fluorescence and normalized to expression of β -actin. Open-circuit, indirect respiration calorimetry was used to determine oxygen consumption (O_2), heat production (HP) at maintenance and fasting, and MEM requirements. There were no breed differences in abundance of UCP2 or UCP3 mRNA and breed explained less than 10% of the variance observed. Relative abundance of UCP2 for A, H, and W was 0.71, 0.57, 0.58 ± 0.08 , respectively. Relative abundance of UCP3 for A, H, and W was 2.02, 1.80, and 1.35 ± 0.37 , respectively. Angus (113.5 kcal/kg⁷⁵) and Wagyu (105.2 kcal/kg⁷⁵) had lower ($P < 0.01$) MEM requirements than Holstein (137.1 kcal/kg⁷⁵). There was more variation in MEM between breeds (72%) than within breed (28%). When mRNA abundance was related to individual whole animal metabolic rate measurements across all breeds both UCP2 and UCP3 tended to be related to O_2 consumption at maintenance ($r = .32$; $P > .13$). Within breed, UCP3 mRNA was correlated to MEM ($r = -.76$; $P > .02$) and O_2 consumption ($r = .83$; $P > .06$) in W only. Breed differences in whole animal metabolic rate are not reflected in mRNA abundance of UCP2 and UCP3.

Key Words: Beef, Energetics, Uncoupling

T197 Physical and chemical traits of cattle carcasses from different genetic groups slaughtered at three back fat thickness end points.

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The objective was to study the physical and chemical traits of the carcasses of 75 steers from the breeds Caracu (16), Gir (10), Guzera (19), Nellore Selection (18), which were submitted for selection of weight at 375 days of age, and 12 steers from the Nellore control group. The animals were slaughtered at three back fat thickness end points (3.0, 5.0, and 7.0 mm), assessed by ultrasound. As the animals reached the desired fat end point, they were slaughtered and their carcasses were evaluated. The Caracu animals had larger ($P < 0.05$) percentage of muscle (Caracu=62.16; Gir=58.75; Guzera=58.42; Nellore Control=56.69; Nellore Selection=56.34), a smaller percentage of fat (Caracu=22.58; Gir=26.16; Guzera=27.10; Nellore Control=29.28; Nellore Selection=29.09) and a higher muscle/fat ratio (Caracu=2.75; Gir=2.24; Guzera=2.16; Nellore Control=1.94; Nellore Selection=1.94). The greatest proportion of fat was observed in the Nellore Selection and Nellore Control animals. As the fat end point got thicker (7.0 mm), the proportions ($P < 0.05$) of muscle decreased and the percentage of fat increased (muscle/fat ratio at: 3.0mm=2.44; 5.0mm=2.11; 7.0mm=2.02). The subcutaneous fat thickness (in mm) estimated by ultrasound (US) and the actual (AC) subcutaneous fat thickness, obtained by direct carcass measurement (Caracu - US=4.51, AC=4.57; Gir - US=5.29, AC=5.88; Guzera - US=5.91, AC=5.86; Nellore Control - US=5.24, AC=5.22; Nellore Selection - US=5.39, AC=6.17) did not differ ($P > 0.05$) within groups, with the exception of Nellore Selection group ($P < 0.05$). The same was observed in the rib eye area (measured in cm²), by ultrasound, and in the actual loin eye area, obtained by direct carcass measurement, which, with exception of Guzera group, did not differ ($P > 0.05$) within groups (Caracu - US=72.02, AC=77.92; Gir - US=64.61, AC=64.19; Guzera - US=73.44, AC=69.83; Nellore Control - US=68.97, AC=70.25; Nellore Selection - US=71.80, AC=71.06). In conclusion, ultrasonography is a reliable tool to assess carcass characteristics in live animals across groups and back fat end points.

Key Words: Ultrasound, Rib eye area, Subcutaneous fat thickness

T198 Comparison of net protein requirements for growth of bulls, steers, and heifers of Nellore x Red Angus crossbreds.

M. L. Chizzotti*^{1,2}, S. C. Valadares Filho¹, L. O. Tedeschi², G. E. Carstens², F. H. M. Chizzotti^{1,2}, P. M. Amaral¹, T. I. Rodrigues¹, D. M. Oliveira¹, and P. D. B. Benedeti¹, ¹Universidade Federal de Vicosa, Vicosa, MG, Brazil, ²Texas A & M University, College Station.

Net protein requirement for gain (NPg) depends on the lean tissue content of the empty body gain (EBG), which may vary among gender, breed, and growth rate. A comparative slaughter trial was conducted at the Federal University of Vicosa in Brazil with 36 F1 Nellore x Red Angus calves (12 steers, 12 bulls, and 12 heifers), averaging 274 kg BW. Three animals from each gender were slaughtered at the beginning of the trial to determine the initial body composition. The remaining calves (3 animals of each gender) were randomly assigned to three treatments: maintenance level (70% of corn silage, DM basis) or fed at 0.75 or 1.5% of BW with corn silage being offered ad libitum. The diets were isonitrogenous (12.5% CP, DM basis). After three growing periods of 28 d, all animals were slaughtered. The cleaned gastrointestinal tract, organs, carcass, head, hide, tail, feet, blood and tissues were weighed to assess empty BW (EBW). These parts were ground separately and subsampled for chemical analyses. For each animal, within a period, the DMI was measured daily. There were no

differences ($P > 0.05$) in the NPg among genders. The NPg (g/kg EBG) equation of the pooled data was $0.5795 \times \text{EBG} \times \text{EBW}^{-0.2425}$, indicating an NPg requirement of 148 and 128 g for animals with 250 and 450 kg BW, respectively. The percentage of RE deposited as protein (REp) increased as content of RE in the gain (REc, Mcal/kg EBG) decreased. The REp equation of the pooled data was $0.3671 - 0.0461 \times \text{REc}$. Our findings support the hypothesis that REp is negatively correlated with REc. However, our data indicated no differences in NPg for bulls, steers and heifers of Nellore x Red Angus crossbreds fed high levels of forage.

Sponsored by FAPEMIG/CAPES, Brazil.

Key Words: Cattle, Comparative slaughter, Growth

T199 Comparison of energy requirements for maintenance and growth of steers, bulls, and heifers of Nellore x Red Angus crossbreds.

M. L. Chizzotti*^{1,2}, S. C. Valadares Filho¹, L. O. Tedeschi², G. E. Carstens², F. H. M. Chizzotti^{1,2}, D. M. Oliveira¹, P. D. B. Benedeti¹, P. M. Amaral¹, and T. I. Rodrigues¹, ¹Universidade Federal de Vicosa, Vicosa, MG, Brazil, ²Texas A & M University, College Station.

The Beef Cattle National Research Council recognizes the effect of species (*Bos Taurus* and *Bos Indicus*) and gender (steers, bulls, and heifers) on energy requirements for maintenance and growth. A comparative slaughter trial was conducted at the Federal University of Vicosa in Brazil with 36 F1 Nellore x Red Angus calves (12 steers, 12 bulls, and 12 heifers), averaging 274 kg BW. Three animals from each gender were slaughtered at the beginning of the trial, to determine the initial body composition. The remaining calves (3 animals of each gender) were randomly assigned to three treatments: maintenance level (70% of corn silage, DM basis) or fed at 0.75 or 1.5% of BW of concentrate with corn silage being offered ad libitum. The diets were isonitrogenous (12.5% CP, DM basis). After three growing periods of 28 d, all animals were slaughtered. The cleaned gastrointestinal tract, organs, carcass, head, hide, tail, feet, blood, and tissues were weighed to assess empty BW (EBW). These parts were ground separately and subsampled for chemical analyses. For each animal within a period, the DMI were measured daily and samples of feces were collected to determine the diet digestibility, using indigestible ADF as a marker. There were no differences ($P > 0.05$) in the energy requirements for maintenance and growth among genders. The combined data indicated a NEM of 71.25 kcal/kg^{0.75} EBW and a MEM of 100.4 kcal/kg^{0.75} EBW, with a partial efficiency of use of ME to NE for maintenance of 0.71. The average partial efficiency of use of ME to NE for growth was 0.52. The RE (Mcal/d) equation of the pooled data was $\text{RE} = 0.0575 \times \text{EBW}^{0.75} \times \text{EBG}^{1.1030}$. These findings suggest the energy requirement of crossbred *Bos Indicus* x *Bos Taurus* for maintenance might be lower than that of pure *Bos Taurus*.

Sponsored by FAPEMIG/CAPES, Brazil.

Key Words: Cattle, Comparative slaughter, Growth

T200 Maintenance energy requirements of Nellore bulls in Brazil.

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It is well established that the net energy required for maintenance of *Bos taurus* beef cattle is approximately 77 kcal.kg^{-0.75}. However, for *Bos indicus* cattle, particularly the Nellore breed that comprises more

than 85% of the Brazilian herd, the energy required for maintenance appears to be lower. The maintenance energy requirements of Nellore cattle have been estimated in Brazil, but little effort has been made to gather data from different studies and to analyze them as a whole to increase confidence in the estimates. Therefore, the objective in this study was to estimate the energy required for maintenance of Nellore cattle, using data obtained from the Brazilian literature. Individual observations were collected from seven different trials comprising 135 intact Nellore males that averaged 303 kg (SD = 62.0 kg) empty body weight. Retained energy (RE) was obtained by comparative slaughter, metabolizable energy (ME) intake (MEI) was measured directly, and heat production was calculated as the difference between MEI and RE. Metabolizable energy intake ranged from 122 kcal.kg^{-0.75} (maintenance level) to 352.02 kcal.kg^{-0.75} (high energy intake). The ME required for maintenance (ME_m) was estimated using traditional and orthogonal regressions. The orthogonal regression equation obtained for RE on MEI was: RE = - 0.0457 + 0.398 * MEI (r² = 0.67). Rearranging and solving for RE = 0, ME_m = 0.114 Mcal.kg^{-0.75}.d⁻¹. Considering efficiency of utilization of ME for maintenance as 0.64 (the mode of the 7 experiments), a value of NE_m = 0.73 Mcal.kg^{-0.75}.d⁻¹ was obtained, which is 18% lower than the NRC (2000) recommendation for intact males (0.77 x 1.15 = 0.89 Mcal.kg^{-0.75}.d⁻¹). It can be concluded that Nellore cattle indeed have lower endogenous energy expenditures than *Bos taurus* cattle.

Key Words: Beef cattle, Energy, Nellore cattle

T201 Predicting dry matter intake of Nellore cattle in Brazil. P. V. R. Paulino^{*1}, S. C. Valadares Filho¹, E. Detmann¹, J. A. G. Azevêdo², D. S. Pina¹, M. I. Marcondes¹, M. A. Fonseca¹, and R. D. Sainz³, ¹Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil, ²Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil, ³University of California, Davis.

Dry matter intake (DMI) is a factor that must be estimated before an animal's diet can be properly calculated. Given the fact that it is almost

impossible to account for the many factors that control feed intake, empirical equations have been developed for its prediction. Almeida et al. (2005) published an equation to predict feed intake of Nellore cattle in Brazil, based on BW and NE_m, (Eq. 1), but limited validation has been conducted. Thus, the objective in this study was to test that equation and to develop an alternative one that could be largely adopted by the Brazilian beef cattle industry. A data set of 144 individual observations (8 experiments) was used to challenge Eq. 1. A second data set comprised of 155 records on Nellore males (14 trials) was used to develop the new equation, which was validated using a third independent data set of 66 animals. Eq. 1 did not precisely predict the DMI of Nellore cattle, as evidenced by both the slope (β₁) and intercept (β₀) of the regression of observed on estimated values, which were significantly different from 1 and 0 (P<0.01) respectively. The evaluation of the MSPE indicated that Eq. 1 was accurate but lacked in precision. The equation overpredicted DMI when actual DMI was low. Conversely, as DMI increased it was underestimated by the equation, showing a not precise prediction pattern. The equation developed using the backward regression procedure of SAS was: DMI (kg/d) = 0.872 + 5.1645 * ADG - 1.6624 * ADG² + 0.00002882 * BW² (r² = 0.79); where ADG = average daily gain (kg/d) and BW = body weight (kg). The variables presented in the model are easily measured and are frequently available, making the adoption of this equation by the Brazilian cattle industry a more practical approach. The validation of this new equation showed that β₁ and β₀ were not statistically different from 1 and 0 respectively (P>0.22). The correlation between predicted and observed values (r=0.89) was high. It can be concluded that the equation based on ADG and BW predicts DMI of individual Nellore cattle more accurately and precisely than the Eq. 1. Depending upon the purpose, nutritionists have another alternative to estimate DMI.

Key Words: Beef cattle, Feed intake, Validation

Ruminant Nutrition: Minerals & Vitamins

T202 Net requirements of macrominerals for growth of steers, bulls, and heifers of Nellore x Red Angus crossbreeds. M. L. Chizzotti^{*1,2}, S. C. Valadares Filho¹, L.O. Tedeschi², G. E. Carstens², F. H. M. Chizzotti^{1,2}, M. A. Fonseca¹, L. F. C. Silva¹, and M. I. Marcondes¹, ¹Universidade Federal de Vicosa, Vicosa, MG, Brazil, ²Texas A & M University, College Station.

A comparative slaughter trial was conducted at the Federal University of Vicosa in Brazil aiming to determine the net requirements of Ca, P, Na, K and Mg. Thirty-six F1 Nellore x Red Angus calves (12 steers, 12 bulls, and 12 heifers), averaging 274 kg BW, were utilized. At the beginning of the trial, three animals from each gender were slaughtered to determine the initial body composition. Three animals of each gender were randomly assigned to two treatments in which diets were offered at 0.75 or 1.5% of BW of concentrate. The diets were based on corn silage and were isonitrogenous (12.5% CP, DM basis). After three growing periods of 28 d, all animals were slaughtered. The cleaned gastrointestinal tract, organs, carcass, head, hide, tail, feet, blood, and tissues were weighed to determine the empty BW (EBW). These parts were ground separately and subsampled for chemical analyses. The log of the contents of each mineral in the empty body was regressed on the log of the EBW to estimate the net requirement for each mineral per kg of empty body gain (EBG). There were no differences (P>0.05) in the net requirements for growth of all macrominerals among genders.

The equations of the pooled data of the net requirements for growth (g/kg EBG) were: 0.33256×EBW^{-0.63666} for Ca, 0.11214×EBW^{-0.56146} for P, 0.01085×EBW^{-0.39924} for Na, 0.00401×EBW^{-0.15304} for K, and 0.00359×EBW^{-0.46205} for Mg. The mean EBW was 0.9244×BW. Our findings indicated that an animal of 250 kg BW would require 9.342, 4.804, 1.155, 1.698, and 0.269 g/kg EBG of Ca, P, Na, K, and Mg, respectively, and an animal of 450 kg BW would require 6.426, 3.453, 0.913, 1.552, and 0.205 g/kg EBG of Ca, P, Na, K, and Mg, respectively. The net requirements of Ca, P, Na, K, and Mg for growth decrease as BW increase.

^aSponsored by FAPEMIG/CAPES, Brazil.

Key Words: Cattle, Comparative slaughter, Growth

T203 Dietary factors affecting phosphorus digestion in lactating cows. T. H. Yang^{*1}, K. F. Knowlton¹, C. Shang¹, E. Schwab², D. Berry¹, L. Zelazny¹, N. Whitehouse³, K. Pence¹, and C. Schwab³, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²University of Wisconsin, Madison, ³University of New Hampshire, Durham.

The objective of the study was to evaluate the effect of forage and non-fiber carbohydrate content on duodenal and fecal P flow. Eight

Holstein cows (4 primiparous) fitted with ruminal and duodenal cannulae were fed diets containing either 60 or 35% forage and either 30 or 40% NFC in a 2x2 factorial with a replicated 4x4 Latin square design. Dietary P content (% DM) was 0.0.36, 0.36, 0.35, and 0.36 for 60:30, 60:40, 35:30 and 35:40 respectively. Duodenal digesta and feces were collected for 3 d at the beginning of wk 3, every 3 h, advanced 1 h/d. Samples were composited by cow within period and analyzed for total P. Increasing dietary forage content decreased P intake and fecal P excretion, and salivary P flow (daily duodenal P - P intake) tended to increase with increased forage (49.9 vs. 55.8 g/d, $P < 0.11$). Duodenal P flow and apparent P digestibility were unaffected by forage content. Increasing dietary NFC content increased P intake and increased apparent P digestibility (32.8 vs. 41.5%; $P < 0.02$). Cows were in negative P balance but cows fed high NFC diets had less negative P balance. In a subset of samples (4 cows fed diets with 40% NFC and 60 or 35% forage in sequential 3 wk periods), P compounds were extracted with 0.1M NaOH-EDTA and quantified by NMR spectroscopy. Duodenal digesta was higher in orthophosphate, pyrophosphate and lipid phosphate concentration than were feces. Concentration of myo-inositol hexakisphosphate (IHP, or phytic acid) was higher in feces, but duodenal and feces IHP flows were similar. Concentration and flow of "other" P (primarily degradation products of IHP) was higher in duodenal digesta than in feces, indicating post-ruminal degradation. Increasing dietary forage increased orthophosphate concentration in both duodenal digesta and feces, but flow of ortho-P was unaffected by diet. Increased understanding of form and amount of P flow through the digestive tract will support refinements to more accurately match absorbable P supply to P requirements of the lactating cow.

Key Words: Phytic acid digestion, Dairy cattle, Nuclear magnetic resonance spectroscopy

T204 Exogenous phytase plus cellulase and nutrient excretion and digestibility in lactating cows. M. S. Taylor*¹, S. R. Hill¹, K. F. Knowlton¹, K. Wilson², and C. Cobb², ¹*Virginia Polytechnic Institute and State University, Blacksburg*, ²*Animal Feed Technologies, Greeley, CO*.

The effect of exogenous phytase + cellulase (CattleAse PTM) on nutrient digestibility and excretion was evaluated in 46 Holstein cows (n=23 per trt). Cows were fed corn silage and alfalfa silage based diets with or without a cellulase-phytase blend for 31 days in a CRD. Treatment groups were balanced for parity, days in milk and M.E. projected milk yield (mean = 2.2, 100 and 25,574, respectively). Diets were 37% forage, 18.3% CP, 35.4% NDF, 18% ADF, and 0.42% P (no supplemental P). Cows were fed 1X in Calan doors and milked 2X. Body weight and milk yield were recorded at each milking. Milk samples were collected on d 28 to 31 at 8 consecutive milkings. On d 28 to 31, fecal grab samples were collected from 24 cows (12 per treatment) every 8 h, with sampling times advanced by 2 h each day. Feces samples were pooled by cow. Feed and feces samples were analyzed for sulfuric acid lignin (used as an internal marker) and for N, P, ADF, and NDF. Effect of diet on milk yield and components, body weight, and feed intake was analyzed using PROC Mixed with day as a repeated measure. The effect of treatment on nutrient digestibility and excretion were analyzed with PROC GLM. The phytase + cellulase tended to increase milk yield efficiency (1.68 vs. 1.77 kg milk/kg feed) and milk urea N content was lower in cows fed the enzyme. DMI tended to be lower in cows fed the enzyme (24.4 vs. 22.8 kg/d; $P < 0.10$), and body weight and milk yield were unaffected by treatment. During the feces collection period (d 28-31) DMI was similar between

treatments (25.5 kg/d), and cows fed the enzyme formulation had reduced feces DM excretion (9.55 vs. 7.66 kg/d; $P < 0.01$) and reduced fecal excretion of N (252 vs. 203 g/d; $P < 0.01$) and P (66.9 vs. 55.2 g/d; $P < 0.01$). Apparent digestibility of DM, ADF, NDF, and N tended to increase with the enzyme formulation. Utilization of an exogenous phytase + cellulase formulation reduced fecal nutrient excretion by lactating cows.

Key Words: Manure excretion, Phytase, Lactating cows

T205 Clinical responses to SelenoSourceAFTM supplementation in commercial dairy herds. M. Engstrom*¹, B. Crochet², J. Rortvedt², W. Sanchez¹, and I. Yoon¹, ¹*Diamond V Mills, Inc, Cedar Rapids, IA*, ²*Hubbard Milling Co., Mankato, MN*.

A commercial field trial with selenium yeast (SelenoSourceAF, Diamond V Mills, Cedar Rapids, IA) was conducted from Nov 2004-Apr 2005 in 6 commercial dairy herds. Herd sizes ranged from 600 to 2200 cows, and total database included 9000 cows. Trial design was a randomized switchback in which herds received either sodium selenite as the sole source of supplemental selenium (Control), or 3 mg/hd/d of supplemental selenium from SelenoSourceAF (SSAF), with the remainder from sodium selenite (about 50% of supplemental selenium from SelenoSourceAF during the lactation, and 80% during the dry period). After 90 days on Control or SSAF, treatments were switched for each herd. Clinical responses (pregnancy rates, abortions, retained placenta, metritis, cystic) were analyzed from DairyCOMP305, and bulk tank somatic cell counts (SCC) were obtained from creameries from 3 of the herds. Reproductive data were analyzed by logistic regression using SAS Proc Genmod, with the model containing terms for farm, period, and selenium source. Results are reported as least squares means in Table 1. A partial replacement of inorganic Se with organic Se from SelenoSourceAF increased 1st-cycle pregnancy rates and decreased % abortions and SCC in commercial dairy herds.

Table 1. Effects of selenium yeast on clinical responses in dairy cows

Item	Control	SSAF
1st-cycle pregnancy rate, %	20 ^a	24 ^b
% Aborted	8.3 ^a	7.0 ^b
% Retained placenta	6.0	5.4
% Metritis cases	8.5	8.7
% Cystic cases	3.8	3.4
Avg SCC X 1000	225 ^a	212 ^b

^{a,b}Means within a row with different superscripts differ ($P < 0.05$)

Key Words: Organic selenium, Dairy cows, Clinical responses

T206 Selenium deficiency in dual purpose cows and its correction with an intraruminal device in a tropical environment. E. Martínez Cuevas*¹, M. Huerta Bravo¹, R. Lopez Arellano², J. G. Garcia Muñoz¹, and R. Ramírez Valverde¹, ¹*Universidad Autonoma Chapingo, Chapingo, Mexico, Mexico*, ²*Universidad Nacional Autonoma de Mexico, Cuautitlan, Mexico, Mexico*.

Objectives of this study were to evaluate the effectiveness of supplementing boluses containing 1.8 g of selenium to correct its deficiency, and to evaluate the effect of selenium supplementation on blood plasma concentration of Se, Cu, Zn, Fe, Ca, P, Mg, Na, and

K. Twenty dry crossbred Zebu-Brown Swiss cows grazing tropical pastures were used. The experiment lasted 98 days, and on day zero each of ten cows was drenched with a bolus; the remaining cows acted as a control group. Jugular blood samples were collected on days 0, 49, and 98 of the experiment. Mineral concentration on blood plasma were analyzed fitting a mixed linear model including the fixed effects of treatment, time, their interaction, and the random effect of cow nested within treatment. Linear and quadratic contrasts were obtained to evaluate the effect of time of sampling on selenium blood plasma concentration. Drenching with selenium boluses increased ($P < 0.05$) selenium blood plasma concentration, and reduced ($P < 0.05$) the daily loss of blood plasma Cu on supplemented cows. Blood plasma concentrations of Zn, Fe, Ca, P, Mg, Na y K, were not affected by selenium supplementation. Time of sampling had a linear effect ($P < 0.05$) on selenium and Cu blood plasma concentrations, whereas for Fe and P the effect was quadratic ($P < 0.05$). Time of sampling had linear ($P < 0.05$) and quadratic ($P < 0.05$) effects on the concentrations of Zn, Ca, Mg, Na, and K. It is concluded that administering boluses containing 1.8 g of selenium corrected selenium deficiency and reduced the loss of plasmatic Cu on the animals utilized in this experiment.

Key Words: Grazing, Cattle, Tropics

T207 Effects of nutrient restriction during early or late gestation and dietary Se supply on cell proliferation and vascularity in maternal jejunal tissue of sheep. J. J. Reed^{*1}, P. P. Borowicz¹, R. Reddy¹, S. L. Julius¹, J. B. Taylor², T. L. Neville¹, L. P. Reynolds¹, D. A. Redmer¹, K. A. Vonnahme¹, and J. S. Caton¹, ¹North Dakota State University, Fargo, ²USDA-ARS, US Sheep Experiment Station, Dubois, ID.

Pregnant Targhee ewe lambs ($n = 64$; 50.7 ± 2.8 kg) were allotted randomly to one of eight treatments arranged in a $2 \times 2 \times 2$ factorial design. Factors were Se level, early gestational nutrition, and late gestational nutrition. At breeding, ewes were assigned to two levels of Se supplementation, adequate-Se (ASe; $8.5 \mu\text{g Se/kg BW}$) or a high-Se (HSe; $85 \mu\text{g Se/kg BW}$) diet, formulated using a Se-yeast product. Each diet was similar in CP (13.8%) and ME (2.66 Mcal/kg). Early nutritional treatments (initiated on d 50 of gestation) were control (early-C; fed to NRC recommendations) and restricted (early-R; fed 60% of controls). Late gestation nutritional treatments were the same (late-C vs. late-R) as used during early gestation, but were initiated on d 92. On d 132 of gestation, ewes were slaughtered and tissues harvested. Level of Se had no affect ($P = 0.51$) on percentage of proliferating nuclei in jejunal tissue. Early and late nutrition interacted ($P = 0.04$) and resulted in ewes fed early-R-late-C diets having a greater ($P = 0.09$) proportion of crypt cell proliferating nuclei (11.59%) compared with early-C-late-C (8.44%) and early-R-late-R (8.90%) fed ewes. Ewes fed early-C-late-R diets had similar crypt cell proliferating nuclei (9.97%) compared with other treatments. Total jejunal proliferating cells were reduced ($P = 0.02$) in Se treated ewes and early x late nutrition interactions were present ($P = 0.05$). Ewes fed early-C-late-R diets had greater ($P = 0.06$) total jejunal cell proliferation when compared with early-C-late-C and early-R-late-R fed ewes. Ewes fed early-R-late-C diets had similar total jejunal cell proliferation compared with other treatments. Interestingly, total mucosal cell proliferation data were unaltered treatment. Treatments had no affect on percent jejunal vascularity ($P = 0.80$), capillary area ($P = 0.65$), or total microvascular volume ($P = 0.61$).

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Key Words: Intestinal cellular proliferation, Sheep, Vascularity

T208 Effects of nutrient restriction during early or late gestation and dietary Se supply on Se concentrations in maternal and fetal tissues in sheep. T. L. Neville^{*1}, J. J. Reed¹, R. Reddy¹, M. A. Ward¹, P. P. Borowicz¹, J. B. Taylor², K. A. Vonnahme¹, M. Kappahan¹, D. A. Redmer¹, L. P. Reynolds¹, and J. S. Caton¹, ¹North Dakota State University, Fargo, ²USDA-ARS, US Sheep Experiment Station, Dubois, ID.

Pregnant Targhee ewe lambs ($n = 64$; 50.7 ± 2.8 kg) were randomly allotted to one of eight treatments arranged in a $2 \times 2 \times 2$ factorial design. Factors were Se level, early gestational nutrition, and late gestational nutrition. At breeding, ewes were assigned to two levels of Se supplementation, an adequate-Se (ASe; $8.5 \mu\text{g Se/kg BW}$) or a high-Se (HSe; $85 \mu\text{g Se/kg BW}$) diet, formulated using a Se-yeast product. Each diet was similar in CP (13.8%) and ME (2.66 Mcal/kg). Early nutritional treatments (initiated on d 50 of gestation) were control (early-C; fed to NRC recommendations) and restricted (early-R; fed 60% of controls). Late gestation nutritional treatments were the same (late-C vs. late-R) as used during early gestation, but were initiated on d 92. On d 132 of gestation, ewes were slaughtered and tissues harvested. Supplementation of Se increased ($P < 0.01$) Se concentration (ppm) of all maternal and fetal tissues tested. Selenium x late gestational nutrition interactive ($P = 0.07$) means for liver Se concentration were greater ($P < 0.01$) in ewes fed HSe-late-R compared with those fed HSe-late-C diets (14.7 vs. 9.8 ± 1.13 ppm). Nutrition restriction during both early ($P = 0.09$) and late ($P = 0.01$) gestation decreased total maternal kidney Se content (μg). Fetal heart Se concentrations (late nutrition x Se interaction; $P = 0.03$) were greatest in HSe-late-R ($P < 0.01$), intermediate in HSe-late-C ($P < 0.01$), and least ($P < 0.01$) in ASe-late-C and ASe-late-R fed ewes (1.79, 1.49, 0.35, and 0.33 ± 0.07 ppm, respectively). Fetal skeletal muscle Se concentrations were greater ($P = 0.09$) when ewes were early-R compared with early-C fed ewes. Dietary Se levels and maternal nutrient restriction alter maternal and fetal liver, kidney, and muscle, and fetal heart tissue Se concentrations.

Supported by USDA CSREES NRI Competitive Grant no. 2005-35206-15281.

Key Words: Nutrient restriction, Pregnancy, Selenium

T209 Effects of nutrient restriction during early or late gestation and dietary Se supply on maternal and fetal intestinal growth in sheep. R. Reddy^{*1}, J. J. Reed¹, T. L. Neville¹, J. B. Taylor², L. P. Reynolds¹, D. A. Redmer¹, K. A. Vonnahme¹, and J. S. Caton¹, ¹North Dakota State University, Fargo, ²USDA-ARS, US Sheep Experiment Station, Dubois, ID.

Pregnant Targhee ewe lambs ($n = 64$; 50.7 ± 2.8 kg) were allotted randomly to one of eight treatments arranged in a $2 \times 2 \times 2$ factorial design. Factors were Se level, early gestational nutrition, and late gestational nutrition. At breeding, ewes were assigned to two levels of Se, an adequate-Se (ASe; $8.5 \mu\text{g Se/kg BW}$) or a high-Se (HSe; $85 \mu\text{g Se/kg BW}$) diet, formulated using a Se-yeast product. Each diet was similar in CP (13.8%) and ME (2.66 Mcal/kg). Early nutritional treatments (initiated on d 50 of gestation) were control (C; fed to NRC recommendations) and restricted (R; fed 60% of controls). Late

gestation nutritional treatments were the same (C vs. R) as used during early gestation, but were initiated on d 92. On d 132 of gestation, ewes were slaughtered and tissues harvested. Maternal jejunal DNA concentrations (mg/g) and contents (g) were decreased ($P < 0.04$) by HSe and R when fed during early gestation. Maternal jejunal RNA:DNA were not altered by treatment, while protein:DNA were increased ($P = 0.03$; 23.92 vs. 16.70 \pm 2.43) by R during early and decreased ($P = 0.05$; 17.01 vs. 23.61 \pm 2.37) by R during late gestation compared with C. Fetal intestinal DNA, RNA, and protein concentrations were unaltered by treatments, while RNA:DNA were increased ($P = 0.09$) by nutrient restriction during early gestation. These results indicate that both nutrient restriction and dietary Se supply alter indices of hyperplasia and hypertrophy in sheep intestinal tissues. Supported by USDA CSREES NRI Competitive Grant no. 2005-35206-15281.

Key Words: Growth, Intestine, Sheep

T210 Quality assessment of drinking water offered to dairy cows in central Iran. A. A. Najafi¹, G. R. Ghorbani¹, M. Alikhani¹, and A. Nikkhah*², ¹Isfahan University of Technology, Isfahan, Iran, ²University of Manitoba, Winnipeg, MB, Canada.

As the largest portion of body and milk, water has a unique capacity to affect the cow production and longevity. Our objective was to measure cations and anions, nitrate, and total salts in drinking water used by dairy farms in Isfahan province. The province was divided into four regions of north, south, east, and west. At each region, 10 dairy farms with as similar health and nutritional conditions as possible were selected. The drinking water and milk were sampled monthly from each farm for 2 consecutive summer months. Data were analyzed with SAS to compare the chemical properties of water among different regions as a complete randomized block design. The water level of K⁺ was highest ($P < 0.05$) in north (4.58 mg/L) and lowest in west (2.38 mg/L). The Na⁺ level in drinking water was lower ($P < 0.05$) in western Isfahan (164 mg/L) compared to the province average (339 mg/L) and north (422 mg/L), south (395 mg/L), and east (363 mg/L) regions. Dairy farms in south had the highest (166 mg/L) and those in east had lowest (90 mg/L) levels of Ca⁺⁺ in drinking water ($P < 0.05$). No differences ($P > 0.05$) existed in water levels of Mg⁺⁺ and SO₄⁻ among four regions. The water Cl⁻ was lower in west than was in east, south, and north (249 vs. 481, 721, and 676 mg/L). Although water nitrate was greater in west than in east, south, and north (50 vs. 15.9, 13.1, and 16.2 ppm), the province average was significantly below the maximum allowance (23.9 vs. 100 ppm). The respective total levels of soluble salts in drinking water were 2075, 1960, 1797, and 1126 mg/L in north, south, east, and west. The average milk yields were 22.9, 20.8, 20.3, and 20.2 kg/d; and the average milk fat percents were 2.80, 2.79, 2.60, and 2.80 for dairy farms in north, south, east, and west. In summary, water supplies of K⁺ and Ca⁺⁺ need to be complemented accurately by dietary sources to meet cow requirements. In contrast, the levels of Cl⁻, Mg⁺⁺, and SO₄⁻ in drinking water would potentially exceed the requirements, thus, needing care in their dietary provision. Overall, the western farms appeared to have a higher drinking water quality compared to farms in other regions of the province.

Key Words: Drinking water, Quality, Dairy cow

T211 Silage to reduce dietary cation-anion difference. E. Charbonneau*¹, P. Y. Chouinard¹, G. F. Tremblay², G. Allard¹, A. Brégar¹, and D. Pellerin¹, ¹FSAA, Université Laval, Québec, QC, Canada, ²Agriculture and Agri-Food Canada, Ste-Foy, QC, Canada.

Decreasing dietary cation-anion difference (DCAD) using anion sources before calving lowers hypocalcaemia of cows at calving. Reducing DCAD using CaCl₂ fertilized forage should achieve similar results as using anion sources. The objective of this study was to evaluate the impact of low DCAD silage on dry cows. Six non lactating and non pregnant Holstein cows were used in a replicated 3 x 3 latin square. Treatments were: 1) Control (Ctrl; DCAD= 232 meq/kg); low DCAD diet using silage (LS; DCAD= -21 meq/kg); low DCAD diet using Bio-Chlor[®] (LB; DCAD= -32 meq/kg). Treatments were considered statistically different at $P < 0.05$ and a tendency was considered at $P < 0.10$. Compared to Ctrl, feeding LS tended to decrease DMI (10.6 vs. 12.5 kg/d; $P = 0.06$) and decreased urinary pH (6.15 vs. 8.18; $P < 0.001$) as well as digestibility of organic matter (67 vs. 69%; $P = 0.04$). Blood pH (7.37 vs. 7.42; $P = 0.02$), HCO₃ (25.3 vs. 27.5 mM; $P < 0.01$) and base excess (0.4 vs. 3.1 mM; $P < 0.001$) were decreased and blood ionized Cl (29.6 vs. 29.1 mg/dl; $P < 0.01$) was increased with LS compared to Ctrl. There was a decrease in K intake, absorbed as well as retained and an increase in Cl intake as well as Na and Cl absorbed with LS compared to Ctrl. There was no difference in S, Mg and N absorption, and retention, but P and ADF had a lower digestibility, and P was less retained with LS compared to Ctrl. The DMI did not vary, but cow gained weight when fed LS compared to LB (0.8 vs. -0.6 kg/d; $P = 0.05$). Urinary pH had a tendency to be higher (6.15 vs. 5.98; $P = 0.06$) and digestibility of organic matter was lower (67 vs. 70%; $P < 0.01$) with LS compared to LB. Blood ionized Ca (5.3 vs. 5.4 mg/dl; $P = 0.06$) and Cl (29.6 vs. 30.1 mg/dl; $P < 0.001$) tended and was lower respectively while blood pH (7.37 vs. 7.33; $P = 0.02$), HCO₃ (25.3 vs. 21.5 mM; $P < 0.001$) and base excess (0.4 vs. -3.8 mM; $P < 0.001$) were higher with LS compared to LB. There was no difference for Ca absorbed or retained, but Na, Cl, S, P, ADF, NDF and N had lower digestibility and K, Cl, S, P, Mg and N were less retained with LS compared to LB. Results confirm that low DCAD silage can be used to decrease DCAD of rations served to transition dairy cows.

Key Words: DCAD, Non lactating cow, Silage

T212 Hay to reduce dietary cation-anion difference (DCAD). E. Charbonneau*¹, P. Y. Chouinard¹, G. F. Tremblay², G. Allard¹, A. Brégar¹, and D. Pellerin¹, ¹FSAA, Université Laval, Québec, Québec, Canada, ²Agriculture and Agri-Food Canada, Ste-Foy, Québec, Canada.

Studies have shown that timothy grass had the lowest DCAD [(Na + K) - (Cl + S)] compared to other grass species. Adding CaCl₂ to low potassium fields could decrease it further. The objective of this study was to evaluate the effect of low DCAD timothy hay on dry dairy cows. Six non pregnant and non lactating cows were used in a replicated 3 x 3 latin square. Treatments were: 1) Control diet (Ctrl; DCAD = 296 meq/kg DM); 2) low DCAD diet based on a low DCAD hay (L-HAY; DCAD = -24 meq/kg DM); and 3) low DCAD diet using HCl (L-HCl; DCAD = -19 meq/kg DM). Treatments were considered statistically different at $P < 0.05$ and a tendency was considered at $P < 0.10$. Decreasing DCAD with L-HAY had no impact on DMI (11.8 kg/d) and digestibility of organic matter (71.5%). Urine pH decreased from 8.21 to 5.89 when L-HAY was fed instead of Ctrl. Compared to Ctrl, L-HAY resulted in more Ca in urine (13.4 vs. 1.2 g/d), less K intake

and K digested but similar K retained (18 g/d) as well as more Cl intake and Cl digested but similar Cl retained (12 g/d). Sodium, S, P, and Mg intake, digested and retained did not vary for L-HAY as compared to Ctrl. There was a tendency for higher ionized (i) Ca (5.3 vs. 5.1 mg/dl), lower HCO₃ (23 vs. 27 mM) and higher iNa (60.8 vs. 60.1 mg/dl), and there were lower base excess (-0.4 vs. 3.8 mM) and higher iCl (30.5 vs. 29.5) in blood with L-HAY compared to Ctrl. Cow DMI tended to be higher (11.5 vs. 9.8 kg) with L-HAY than with L-HCl. Urine pH, organic matter, Ca, K, P, Mg digested and Ca, K, Na, Cl, S, P, Mg retained were similar with L-HAY and L-HCl. Digestibility of Na and Cl were lower for L-HAY as compared to L-HCl but only a tendency was observed for S. Blood pH was higher for L-HAY (7.37) compared to L-HCl (7.31). In an EDTA-challenge test, cows fed L-HAY regained faster the initial level of blood iCa compared to Ctrl (339 vs. 708 mn), but there was no difference between L-HAY and L-HCl. This experiment confirmed that feeding low DCAD hay works as well as added HCl to decrease DCAD of rations served to dry dairy cows.

Key Words: DCAD, Non lactating cow, Hay

T213 Effect of high-sulfate water on trace mineral status of beef steers. C. L. Wright* and H. H. Patterson, *South Dakota State University, Brookings.*

Two experiments were conducted to determine the effect of high-sulfate water on the trace mineral status of growing steers. In experiment 1 (Exp. 1; 7/20/01 to 9/12/01) 81 steers (initial BW = 317 kg) were stratified by weight and randomly assigned to 12 pens. Pens were then randomly assigned to one of three water quality treatments: 1) 404, 2) 3087, or 3) 3947 mg SO₄/L. From 6/20/01 to 7/19/01, steers were fed a diet consisting of grass hay and wheat middlings (DM basis; 14.3% CP, 0.84 Mcal NEg/kg, 0.19% S). From 7/20/01 to 9/12/01, steers were fed a diet of grass hay and wheat middlings (DM basis; 14.9% CP, 0.93 Mcal NEg/kg, 0.19% S). In experiment 2 (Exp. 2; 5/23/02 to 9/4/02), 84 steers (initial BW = 290 kg) were stratified by weight and randomly assigned to 12 pens. Pens were then randomly assigned to one of four water quality treatments: 1) 441, 2) 1725, 3) 2919, or 4) 4654 mg SO₄/L. Steers were fed a diet of grass hay and wheat middlings (DM basis; 15.7% CP, 0.97 Mcal NEg/kg, 0.17% S). In each experiment, white salt was offered *ad libitum*; however, supplemental trace minerals were not provided. Initial and final liver biopsy samples were collected from 10 randomly selected steers from each treatment (n=30 in Exp. 1; n=40 in Exp. 2). In Exp. 1, liver Cu was lower ($P < 0.01$) in steers that received water containing 3087 or 3947 mg SO₄/L than in those that received water containing 404 mg SO₄/L (26.3, 35.2, and 84.8 mg Cu/kg DM, respectively). In Exp. 2, liver Cu was lower ($P < 0.01$) in steers that received water containing 1725, 2919, or 4654 mg SO₄/L than in those that received water containing 414 mg SO₄/L (24.8, 7.7, 6.5, and 56.8 mg Cu/kg DM, respectively). In Exp. 1, liver Fe was greater ($P < 0.01$) in steers that received water containing 3947 mg SO₄/L than in those that received water containing 404 mg SO₄/L (332 and 258 mg Fe/kg DM, respectively). Treatment did not affect liver Mn, Mo, and Zn concentrations. These results demonstrate the impact high-sulfate water can have on liver Cu stores in growing cattle.

Key Words: Sulfate, Water, Trace minerals

T214 Effect of dried and ensiled sainfoin, a tanniferous temperate climate forage legume, on the mineral metabolism of lambs. A. Scharenberg¹, A. Gutzwiller¹, Y. Arrigo¹, U. Wyss¹, H. D. Hess¹, M. Kreuzer², and F. Dohme*¹, ¹*Agroscope Liebefeld-Posieux, Swiss Federal Research Station for Animal Production and Dairy Products (ALP), Posieux, Switzerland*, ²*Institute of Animal Sciences, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland.*

Condensed tannins (CT) are polyphenols with a broad variety of binding sites and properties with respect to nutrients including minerals thus influencing their digestibility. The experiment was carried out with 12 lambs in a cross-over design with each lamb being consecutively fed three different diets (n=6). Either dried or ensiled sainfoin (S) were tested against the same diets (SPEG) supplemented with polyethylene glycol (PEG) to inactivate the tannins and dried or ensiled CT-free ryegrass-clover mixtures (RC). Effects on apparent digestibility and retention of minerals were determined. The lambs received 66 g/d organic matter per kg metabolic live weight (LW^{0.75}) as forage plus 20 g/d of a mineral supplement. Each experimental period consisted of a 14-d adaptation period and a 7-d balance period where feed intake was recorded daily and feces and urine were collected quantitatively. Lambs receiving S and SPEG had a lower ($P < 0.001$) intake of Mg and P and a higher ($P < 0.001$) intake of Ca compared to lambs offered RC. The apparent digestibilities of all minerals were increased when SPEG was fed instead of S (by 3.1, 2.1, 1.1 and 1.9 times for Ca, Mg, Na and P, respectively; $P \leq 0.01$) and consequently their retention was elevated ($P < 0.05$; not significant for Na). By contrast, when comparing treatment S with treatment RC, only the apparent digestibility of Na ($P = 0.07$) and the retention of Mg and P ($P \leq 0.07$) were higher with the CT-free forage. The influence of the forage conservation method on the mineral metabolism was not consistent. Apparent digestibility and retention were higher ($P < 0.001$) with P and lower ($P \leq 0.01$) with Mg when lambs were fed dried instead of ensiled forage. In conclusion, PEG seems to improve the digestibility and body retention of minerals possibly by binding the tannins. Since the differences between sainfoin and CT-free ryegrass-clover mixture were much smaller than the PEG effects, the question arises whether there is an impact of PEG on mineral digestion independent from that mediated by the binding of CT.

Key Words: Condensed tannins, Minerals, Polyethylene glycol

T215 Mineral characterization of cattle in Juan Rodríguez Clara, Veracruz, México. E. Martínez Cuevas, M. Huerta Bravo*, J. G. García Muñiz, and R. Ramírez Valverde, *Universidad Autónoma Chapingo, Chapingo, México, México.*

Objective of this study was to determine the mineral content of pasture, soil, drinking water, and blood plasma samples from cows and calves taken from five farms of dual purpose cattle from the state of Veracruz, Mexico. Minerals determined in blood plasma samples were Zn, P, Ca, Mg, Na, K, Cu, and Fe. The same minerals, plus Mn, were determined for both pasture and soil samples. For drinking water, the concentrations of Zn, P, Ca, Mg, Na, K were determined. The mineral content of plasma blood samples was analyzed with a general linear model including the fixed effects of farm, animal type, and their interaction. A model including only the effect of farm was fit to analyze the mineral content of soil and pasture samples. The mineral content of drinking water did not differ between farms. The concentrations of Cu, Mn, Ca, and Mg in soil samples, and those of Mn, Zn, P, and the ratio Ca:P in pasture samples differed ($P < 0.05$) between farms.

Concentrations of Cu, Fe, P, Ca, Na, K, and the ratio Ca:P in blood plasma samples depended of the farm by animal type interaction ($P < 0.05$). The concentrations of Ca and P in pasture were adequate for the level of milk production of the cows used in this experiment. The concentrations of Fe, Mn, Mg, and K in both pasture and blood plasma samples were adequate. However, the concentrations of Cu, and Na in soil, pasture and blood plasma samples were below critical limits. Additionally, Zn was also deficient in soil and pasture samples. Therefore, it is recommended to supplement Cu, Na, and Zn to cattle from these farms.

Key Words: Tropics, Dual purpose cattle, Grazing

T216 Supplementing grazing heifers with copper oxide needles in a tropical environment. E. Martínez Cuevas, M. Huerta Bravo, J. G. García Muñiz*, and R. Ramírez Valverde, *Universidad Autónoma Chapingo, Chapingo, México, México.*

Objective of this study was to evaluate the effectiveness of supplementing copper oxide needles on blood plasma concentrations of Cu, Se, Na, K, Mg, Zn, Fe, Ca, and P in grazing heifers. Twenty crossbred Zebu-Brown Swiss heifers grazing tropical pastures were used. The experiment lasted 98 days, and on day zero each of ten heifers was drenched with a capsule containing copper oxide needles ($10\text{g } 100\text{kg}^{-1}$ BW), with the remaining heifers acting as a control group. Jugular blood samples were collected on days 0, 49, and 98 of the experiment. Mineral concentration on blood plasma were analyzed fitting a mixed linear model including the fixed effects of treatment, time, their interaction, and the random effect of animal nested within treatment. Orthogonal contrasts were obtained to evaluate the effect of sampling time on mineral blood plasma concentration. Drenching with copper oxide needles increased ($P < 0.01$) blood plasma concentrations of Se and Na on day 49, and of Mg on day 98 of the experiment. Blood plasma concentrations of Cu, Zn, Fe, Ca, and P were not affected by copper supplementation. Blood plasma Cu concentration decreased ($P < 0.05$) linearly after capsule insertion, whereas for Se, P, and Na the effect was quadratic ($P < 0.05$). Time of sampling had linear ($P < 0.05$) and quadratic ($P < 0.05$) effects on the concentrations of Zn, Fe, Ca, K, and the ratio Ca:P. It is concluded that administering capsules containing $10\text{ g } 100\text{kg}^{-1}$ BW of copper oxide needles were not capable of maintaining adequate levels of plasmatic Cu in the experimental animals.

Key Words: Cattle, Pastures, Minerals

T217 Interaction of concentrate: Forage ratio and type of concentrate fed on growth performance and health of growing steers. P. Walker¹, D. Adams¹, and R. Hall², ¹*Illinois State University, Normal*, ²*Cooperative Research Farms, Richmond, VA.*

An 84-d trial utilizing 192 Angus based steers (mean wt. = 259 ± 2.1 kg) were assigned to 24 pens containing 6 or 10 steers per pen (6 dietary treatments in each of 4 blocks) to determine the value of soybean hulls and distillers dried grains/solubles (DGS) in low and high concentrate pre-finishing diets. The diets consisted of grass hay fed ad libitum and one of six pelleted supplements: shelled corn based fed at 1% BW (SC1) or 2% BW (SC2), soybean hull based fed at 1% BW (SH1) or 2% BW (SH2), shelled corn/DGS based fed at 1% BW (DGS1) or 2% BW (DGS2). More ($P < 0.05$) cattle fed SC1 and SC2 required respiratory treatment than steers fed SH1, SH2, DGS1 and DGS2. During the first 12d SH2 fed steers had higher ($P < 0.05$) and SC2 fed steers had lower ($P < 0.05$) ADG than steers fed other treatments. Over

the 84d trial steers fed SC2, SH2 and DGS2 had greater ($P < 0.05$) ADG and DMI than steers fed SC1, SH1 and DGS1. Steers fed supplement at 2% BW had higher ($P < 0.05$) DMI than steers fed at 1% BW. Steers fed SH at 1% BW had the lowest ($P < 0.05$) DMI. No significant differences in DMI were observed for steers fed the 1% SC or 1% DGS diets. Steers fed 2% SC and 2% SH had higher ($P < 0.05$) DMI than steers fed 2% DGS and higher ($P < 0.05$) G:F ratios than steers receiving other treatments. Over the 84d trial actual ADG exceeded NRC 2000 predicted ADG on all treatments except on the SC2 where actual ADG (1.18 kg) was similar to predicted ADG (1.15 kg). An adjusted predicted ADG was calculated based on the actual ADG relative to the SC1 and SC2 treatments. These ADG were used to estimate NEm and NEg that would be necessary in SH and DGS for these ADG to be achieved. Based on these calculations, soybean hulls have an energy value equal to 104 to 105% of corn grain, compared to current NRC values which are 79 to 83% of corn grain. This trial suggests an energy value for DGS of 110% of corn grain. Fecal grab samples found P concentrations in SH2 and DGS2 significantly lower than in SC2 grab samples. The data suggest that feeding SH or DGS at 2% BW results in similar to superior performance compared to feeding SC at 2% BW.

Key Words: Distillers grains, Soybean hulls, Steers

T218 Effects of organic zinc, manganese and copper on mineral content of rumen bacteria and microbial fermentation in continuous culture. P. W. Cardozo¹, S. Calsamiglia*¹, and S. Andrieu², ¹*Universitat Autònoma de Barcelona, Bellaterra, Spain*, ²*Alltech, Lexington, KY.*

The objective of the study was to determine the fate of organic minerals (organic Zn, Cu and Mn; Bioplex[®], Alltech, KY) in the liquid (LAB) and solid (SAB) associated rumen bacteria and their effects on rumen microbial fermentation. Eight 1,320-mL dual flow continuous culture fermenters were used in two replicated periods of 7 d. On the first day of each period, all fermenters were inoculated with rumen fluid. All fermenters were fed 95 g of DM/d of a diet (18.9% CP; 36.6% NDF) consisting of alfalfa hay (27%), dehydrated whole corn plant (20%), barley straw (5%), soybean meal (16%), ground corn grain (15%), ground barley grain (15%), and a vitamin and mineral mixture, in DM basis. Temperature (38.5°C), pH (6.4 ± 0.05) and liquid (10%/h) and solid (5%/h) dilution rates were maintained constant. Treatments were control (CTR: no substitution); substitution of inorganic Zn by organic Zn (BZn); substitution of inorganic Cu by organic Cu (BCu); and substitution of inorganic Mn by organic Mn (BMn). On days 1, 2, 3, 5 and 7, samples for volatile fatty acid (VFA) and ammonia N were taken, and liquid (LAB) and solid (SAB) associated bacteria were collected from effluents to determine the content of Zn, Cu and Mn. Data were analyzed using PROC MIXED of SAS (1996). Replacement of inorganic by organic trace elements did not affect total (average of 108.6 mM) or individual VFA. Ammonia N concentration (mg N/dL) was lower ($P < 0.05$) in Zn (9.91) compared with CTR (11.9). The use of organic minerals had no effect on mineral content of SAB (average of 64.9 ± 29.8 , 52.1 ± 4.9 , 175.1 ± 26.5 ppm, for Cu, Mn and Zn, respectively) and LAB (averages of 51.6 ± 22.7 , 53.7 ± 6.54 , 142.4 ± 18.2 ppm for Cu, Mn and Zn, respectively), except for the increase in Mn content of SAB from fermenter supplemented with organic Mn compared with CTR (59.1 vs 50.1 ppm). This trial demonstrates that organic Zn, Cu or Mn do not interfere with normal rumen function.

Key Words: Organic minerals, Rumen fermentation

T219 Effect of zinc source and level of on feedlot performance and carcass characteristics of finishing beef steers. J. C. Silva^{*1}, M. S. Brown¹, E. M. Cochran¹, E. Lauterbach¹, C. E. Smith Sr¹, L. D. Mitchell¹, C. K. Larson², and T. Ward², ¹West Texas A&M University, Canyon, ²Zinpro Corporation, Eden Prairie, MN.

Two experiments were conducted to examine the effects of zinc source and concentration on feedlot performance and carcass characteristics of beef steers. In Exp. 1, 179 crossbred steers (325 kg initial BW) were blocked by BW, assigned to four treatments (5 pens/treatment), and fed for 152 d. Steers were fed a 92% concentrate diet based on whole corn and supplemented with 60 mg Zn from ZnSO₄/kg DM (CT), 90 mg Zn from ZnSO₄/kg DM (30S), CT plus 30 mg Zn from ZINPRO[®]/kg DM (30M), and CT plus 30 mg Zn from Availa[®]Zn/kg DM (30A). Steer DMI, carcass-adjusted ADG (1.67, 1.65, 1.66, and 1.72 ± 0.04 kg/d for CT, 30S, 30M, and 30A, respectively), and adjusted ADG:DMI (169, 168, 171, 174 ± 3.7 g/kg) were not altered ($P > 0.10$) by additional dietary Zn above 60 mg/kg. Carcass characteristics were similar across treatments. In Exp. 2, 262 crossbred steers (281 kg initial BW) were blocked by BW, assigned to three treatments (10 pens/treatment), and fed for 176 d. Steers were fed a 90% concentrate diet based on steam-flaked corn without supplemental Zn (NC), NC plus 90 mg Zn/kg DM from ZnSO₄ (S), or NC plus 35 mg Zn/kg DM from Availa[®]Zn and 55 mg Zn/kg DM from ZnSO₄ (AS). Steer DMI (8.59, 8.45, 8.40 ± 0.12 kg/d for NC, S, AS, respectively) and adjusted ADG (1.74, 1.73, and 1.76 ± 0.03 kg/d) were similar. Adjusted ADG:DMI was improved by feeding Zn ($P = 0.06$); ADG:DMI did not differ between NC and S ($P > 0.15$; 203 vs 205 ± 2.9 g/kg), but ADG:DMI tended ($P = 0.13$) to be greater for AS than for S (205 vs 209 ± 2.9 g/kg). Fewer carcasses graded at least low Choice when Zn was fed ($P < 0.10$), but marbling score was at the juncture between Small and Slight marbling ($P < 0.05$; 404, 385, and 387 ± 8 for CT, S, and AS, respectively) and net return was not affected. Hot carcass weight, fat thickness, Longissimus muscle area, and yield grade were similar ($P > 0.10$) among treatments. Gain efficiency by feedlot cattle was improved by providing supplemental Zn, and efficiency tended to favor feeding a blend of Availa[®]Zn and zinc sulfate.

Key Words: Beef cattle, Feedlot performance, Zinc chelated

T220 Effect of cobalt supplementation during late gestation and early lactation on performance and serum concentrations of cobalt and vitamin B₁₂. R. L. Kincaid^{*1} and M. T. Socha², ¹Washington State University, Pullman, ²Zinpro Corporation, Eden Prairie, MN.

Thirty-six multiparous cows were assigned to a study to determine the effects of dietary cobalt (Co) supplementation during late gestation and early lactation on milk yield, milk yield efficiency, concentrations of Co in serum and liver, and vitamin B₁₂ concentrations in serum. Cows received either 0, 12, or 25 mg added Co from cobalt glucoheptonate (CoPro[®], Zinpro Corp., Eden Prairie, MN), from 55 d prior to expected parturition through 120 d postpartum. The basal dry and lactation diets contained 0.15 ppm and 0.19 ppm Co, respectively. Data were analyzed by general linear model of PROC MIXED procedures for a completely randomized design with repeated measures. There was no effect of Co supplementation ($P > 0.15$) on dry matter intake (DMI) and milk yield and composition. Response to treatment was inconsistent during lactation (treatment by week interaction, $P < 0.01$) for DMI and yields of fat, protein 3.5 fat-corrected milk (FCM) and energy corrected milk (ECM), with cows fed added Co consuming more DM and producing more fat, protein, 3.5 FCM and ECM with the progression of lactation. Cobalt supplementation tended to increase

efficiency of production (FCM/DMI) with progression of lactation (treatment by week interaction, $P = 0.10$). Cobalt intake did not affect ($P > 0.15$) concentrations of Co in liver or serum, but did increase Co concentration ($P < 0.05$) of milk (0.089, 0.120, and 0.130 µg Co/mL) at 120 DIM. Serum vitamin B₁₂ concentrations, although not affected by Co intake ($P > 0.15$), declined sharply in all cows between 55 and 20 d prepartum. In conclusion, added dietary Co increased FCM yield as lactation progressed but did not affect vitamin B₁₂ or Co concentrations in serum.

Key Words: Cows, Cobalt, Vitamin B₁₂

T221 Effects of supplementary folic acid and vitamin B₁₂ and rumen-protected methionine on lactational performance of multiparous dairy cows. A. Preynat^{*1,2}, M. C. Thivierge², H. Lapierre¹, J. J. Matte¹, A. Desrochers³, and C. L. Girard¹, ¹Agriculture and Agri-Food Canada, Lennoxville, ²Université Laval, Québec, ³Université de Montréal, St-Hyacinthe, QC, Canada.

Separate previous findings (J. Dairy Sci. 1998. 81:1412; 2005. 88:660 and 88:671) showed that, in early lactation, either with low or adequate supply of methionine (M), a positive response of milk production and milk component yields to supplementary folic acid was observed in cows with a high vitamin B₁₂ status. In cows with a low vitamin B₁₂ status, milk production and milk protein yield were either unchanged or depressed following folic acid supplementation. The present experiment was conducted to precise the interactions between folic acid, vitamin B₁₂ and their link with the metabolic pathway involving methionine. Sixty multiparous cows were assigned to 10 blocks of 6 cows according to their previous milk production; treatments were tested according to a 2 x 3 factorial arrangement. From 3 wk before until 16 wk after calving, half the cows were fed diets calculated to cover 80% of the M requirement (M-; NRC, 2001) while the other half received rumen-protected M (M+: 9 and 18 g Mepron-85/d, pre and post-calving). Within each level of M, the cows received no vitamin supplement (C) or intramuscular injections of folic acid (160 mg/wk) alone (F) or with B₁₂ (10 mg/wk; FB₁₂). Feed intake and milk production were recorded daily, milk composition was determined on 4 consecutive milkings at 2, 4, 8, 12 and 16 wk of lactation. Vitamin supplements modified milk production ($P = 0.06$), averaging 37.7, 36.9 and 38.6 (SE 0.8) kg/d for C, F and FB₁₂ but did not alter DMI (21.9 ± 0.1 kg/d; $P > 0.14$). Milk fat components were similar among treatments (36.7 ± 0.3 g/kg, 1380 ± 14 g/d; $P > 0.12$). M supplements increased ($P = 0.01$) milk protein concentration from 29.4 to 30.5 (SE 0.3) g/kg. Milk protein yield was higher with FB₁₂ during the first weeks of lactation but this effect faded out as lactation progressed (vitamin x time, $P = 0.03$). As there was no interaction between vitamins and M, these preliminary results confirm the limitation of B₁₂ on folic acid action independently of the level of M.

Key Words: Folic acid, Vitamin B₁₂, Methionine

T222 Effects of rumen protected choline and dry propylene glycol supplements on plasma folates and vitamin B₁₂ in periparturient dairy cows. C. L. Girard^{*1}, Y. H. Chung², and G. A. Varga², ¹Agriculture and Agri-Food Canada, Lennoxville, QC, Canada, ²The Pennsylvania State University, University Park.

A factorial experiment was conducted using 82 cows fed 2 levels of rumen protected choline (RPC; 0 or 50 g) from 20d before until 21d after calving and 2 levels of dry propylene glycol (PG; 0 or 250 g) from 0 to 21d after calving. Production data has been partially reported

previously (J. Dairy Sci. 2004. 88(Suppl.1):61). In ruminant, choline requirements are generally supplied by endogenous synthesis which requires 3 methyl groups provided by folate metabolism through the action of methionine synthase, a vitamin B₁₂-dependent enzyme. PG is partially transformed in propionate in rumen and a B₁₂-dependent enzyme, methylmalonylCoA mutase, is essential to propionate metabolism and its use for gluconeogenesis in gastrointestinal walls and liver. The present experiment was undertaken to determine if plasma concentrations of folates and B₁₂, 21, 14 and 1d before and 7, 14 and 21d after calving were influenced by RPC and PG supplements. Pre and postpartum data were analyzed separately (Mixed models with cow as random effect). A natural log transformation was used to correct for a lack of normality in the distribution of data which are then reported as antilog and confidence interval at 95%. Before calving, there was no RPC effect on the 2 vitamins (P>0.1). After calving, RPC increased plasma folates by 15%, from 8.0 to 9.2 ng/ml (SE 0.4; P=0.05). This increase could reflect a reduced utilization of folates in hepatic tissue because RPC decreased methylneogenesis both by providing pre-formed choline and as donor of methyl groups in liver. Without RPC, plasma B₁₂ was not influenced by PG supplements (208 pg/ml; 183-237) whereas with RPC, plasma B₁₂ was 23% lower with (181 pg/ml; 152-216) than without PG (234 pg/ml; 197-277)(RPCxPG, P=0.03). While supplementing RPC, adding PG probably increased the demand of B₁₂ for propionate metabolism and therefore, decreased plasma B₁₂. The absence of response of plasma B₁₂ to PG in cows fed no RPC, along with their lower plasma folates, suggest an impairment of both the efficiency of gluconeogenesis in liver and the utilization of B₁₂ by methylmalonylCoA mutase.

Key Words: Choline, Propylene glycol, B Vitamins

T223 Apparent ruminal synthesis and intestinal absorption of free and total biotin in dairy cows. D. E. Santschi* and C. L. Girard, *Agriculture and Agri-Food Canada, Lennoxville, QC, Canada.*

Biotin, a B vitamin, is present in nature in two forms: free and bound to the amino acid lysine (biocytin). Traditional assays used to measure biotin in various samples only accounted for its free form. Accordingly, these methods revealed higher flows at the ileal level than in the duodenum, resulting in an apparent biotin synthesis in the small intestine. Biocytin can not be degraded by proteases; it requires the activity of a specific enzyme, biotinidase, present in pancreatic secretions and intestinal mucosa. A new method for sample preparation using this enzyme was developed in our laboratory to release biotin from lysine before analysis by ELISA (J. Dairy Sci.2005.88:2043). Three cows equipped with duodenal and ileal cannulae were used to compare these two methods of sample preparation on apparent ruminal synthesis and intestinal absorption of free and total biotin (2 repetitions/cow). A paired t-test was performed to compare the mean values between the two methods of analysis used. Only a small proportion of total biotin was under a free form in the feed (5.8%) and duodenal digesta (6.6%). Daily ileal flows of biotin suggested that the vitamin was exclusively under a free form at this site. There seemed to be no apparent ruminal synthesis of biotin, and this observation was not influenced whether free or total biotin was measured (P=0.84). However, apparent intestinal absorption of biotin was greatly influenced by the sample preparation method (P=0.002). Analysis of free biotin suggested a synthesis of this vitamin in the small intestine, whereas analysis of total biotin concentration showed that absorption was taking place. Although detection of biotin analogues others than biocytin was not ascertained by our ELISA method, these results clearly indicate that the sample preparation method used has a great impact on the

levels of biotin detected and leads to contradictory results regarding apparent intestinal absorption.

Table 1. Apparent Ruminal Synthesis and Intestinal Absorption of Free and Total Biotin (Mean ± SEM)

	Feed	Duodenum	Ileum	Apparent ruminal synthesis	Apparent intestinal absorption
	(mg/d)	(mg/d)	(mg/d)	(mg/d)	(mg/d)
Free Biotin	8.0±0.4	9.3±1.1	105.6±8.8	1.3±1.1	-96.3±9.1
Total Biotin	137.0±6.1	140.1±10.0	87.3±5.9	3.1±11.4	52.8±12.4
P value	0.004	0.003	0.08	0.84	0.002

Key Words: Dairy cow, Apparent ruminal biotin synthesis, Apparent intestinal biotin absorption

T224 Effect of biotin supplementation on enzyme activity and gene expression of biotin-dependent carboxylases in the liver of dairy cows. G. Ferreira and W. P. Weiss*, *The Ohio State University-OARDC, Wooster.*

The mechanism by which biotin supplementation increases milk production is not known. Biotin is a cofactor of the gluconeogenic enzymes, propionyl-CoA carboxylase (PCC) and pyruvate carboxylase (PC). We hypothesized that biotin supplementation increases the activity and the gene expression of PCC and PC, and the gene expression of phosphoenolpyruvate carboxykinase (PEPCK) in the liver of lactating dairy cows. Eight multiparous Holstein cows (40±2 kg/d milk yield and 162±35 days after parturition) were assigned randomly to two diet sequences (Control→Biotin and Biotin→Control) according to a cross-over design with two 22-d periods. Treatments consisted of a basal diet (60% concentrate) containing 0 or 0.96 mg/kg of supplemental biotin (approximately 20 mg/d of supplemental biotin). On d 21 of each period, liver tissue was collected by percutaneous liver biopsy. Activities of PCC and PC were determined by measuring the fixation of [¹⁴C]O₂ in liver homogenates. Abundance of mRNA for PCC, PC and PEPCK was determined by quantitative RT-PCR. Biotin supplementation tended (P < 0.12) to increase the activity of PC (11 vs. 15 nmol CO₂•min⁻¹•mg protein⁻¹), but did not affect the activity of PCC (20 nmol CO₂•min⁻¹•mg protein⁻¹). The differential response to biotin supplementation suggests that PCC may have a higher priority for biotin than PC. Biotin supplementation did not affect the gene expression of PCC, PC and PEPCK. We attributed the increased activity of PC without changes in mRNA abundance to an increased activation of the apoenzyme by holocarboxylase synthetase. In conclusion, biotin supplementation can affect the activity of biotin-dependent carboxylases in the liver of lactating dairy cows. Whether biotin supplementation increases glucose production in the liver still needs to be evaluated.

Key Words: Biotin, Pyruvate carboxylase, Propionyl-CoA carboxylase

T225 Effect of supplemental biotin to dairy cows on in sacco forage NDF disappearance. C. W. Cruywagen* and G. Bunge, *Stellenbosch University, Stellenbosch, South Africa.*

Six non-lactating ruminally cannulated Holstein cows were used to determine the effect of supplemental biotin on in sacco NDF

disappearance. Cows were randomly assigned to two groups in a 2 x 3 cross-over experiment. All cows received oat hay ad libitum and one of two concentrate feeds at a level of 4 kg/cow daily to provide either 0 or 40 mg supplemental biotin/cow/day. The concentrate was provided twice daily as a top dressing at 2 kg per feeding and all the cows consumed all of the concentrate feed daily. Cows were adapted to the diet for 21 days before the onset of the in sacco trial. Samples of alfalfa hay (440 g NDF/kg DM), oat hay (680 g NDF/kg DM) and wheat straw (798 g NDF/kg DM) were incubated in the rumen for 0, 4, 8, 18, 24, 30, 48, 72 and 96 hours. Data were fitted to a non-linear model $Y = a + b(1 - \exp^{-c})$ to obtain a-, b- and c-values that were subjected to an analysis of variance. Biotin supplementation had a significant effect ($P < 0.05$) on rate of degradation (c-value) and effective degradability of NDF in oat hay and wheat straw, but not in alfalfa hay. Potential degradability of NDF (b-value) was not affected by treatment in any of the forages. For alfalfa hay, rates of NDF degradation were 2.6%/h (control) and 2.5%/h (biotin), while effective degradability values were 16.5% (control) and 16.4% (biotin). For oat hay, rates of NDF degradation were 1.3%/h (control) and 1.9%/h (biotin), while effective degradability values were 12.1 and 14.6%. For wheat straw, rates of NDF degradation were 1.6%/h (control) and 1.8%/h (biotin), while effective degradability values were 10.3% (control) and 11.6% (biotin). It was concluded that biotin supplementation to dairy cows may affect the rate of NDF degradation in certain forages.

Key Words: Biotin, In sacco, NDF degradation

T226 Effect of feeding whole raw soybean and niacin to lactating cows in early lactation. M. Sari, A. A. Naserian*, R. Valizadeh, and S. Salari, *Ferdowsi University of Mashhad, Mashhad, Khorasan, Iran.*

Nine multiparous and primiparous Holstein cows were used in a 3x3 Latin square design; to investigate effect of whole raw soybeans and niacin on milk production and composition. The experimental treatments were 1) The control diet, 2) Diet with whole raw soybean, and 3) Diet with Whole raw soybean plus 12 g/d niacin. Cows were fed complete mixed rations consisting of 40% forage and 60% concentrate. The dry matter intake per cows per day did not differ among treatments. Dry matter, organic matter, NDF and ADF digestibilities were not affected by treatment. Protein and ether extract digestibility were decreased in cows receiving the whole raw soybean ($p < 0.05$). No significant difference was found between treatments for ruminal pH, ruminal ammonia, plasma glucose, albumin, cholesterol and triglyceride concentrations. Blood urea nitrogen was significantly lower in cows fed whole raw soybeans with or without niacin ($p < 0.05$). Milk, solids-corrected milk and 4% fat corrected milk production were not altered by treatment application. Milk production and its protein efficiency was not affected by treatments but energy efficiency of milk was decreased by whole raw soybeans. Results of this experiment indicated that whole raw soybeans with or without niacin did not improve milk production and composition in early lactation. More research with various particle size of raw soybeans are recommended.

Key Words: Dairy cattle, Full fat soybean, Niacin

T227 The effects of nicotinic acid supplementation during late-gestation on lipolysis and feed intake during the transition period. J. L. Chamberlain* and P. D. French, *Oregon State University, Corvallis.*

The objective of this study was to determine if nicotinic acid (NA) supplementation during the transition period decreases lipolysis and

improves dry matter intake (DMI). Twenty seven multiparous Holstein cows and 27 multiparous Jersey cows were assigned at random to one of three prepartum dietary treatments in a 2 x 3 factorial plan. Prepartum dietary treatments were 0, 49, or 98 mg NA/kg BW. Cows were group housed in freestalls and fed individually via Calan® gates from 30 d prepartum to 21 d postpartum. Cows were offered a dry cow TMR twice daily and NA was hand mixed in the morning feeding. Following parturition all cows received the same lactation TMR. Data were analyzed as repeated measures using the MIXED procedure of SAS. Dry matter intake -3 wk prepartum was used as a covariate for analysis of prepartum and postpartum DMI. Prepartum and postpartum BW and BCS were similar for NA treatments. Prepartum DMI was similar for NA treatments (1.76, 1.64 and 1.75% of BW for 0, 49, or 98 mg NA/kg BW, respectively; $P > 0.05$). Postpartum DMI differed among treatment groups (2.59, 2.78 and 2.46% of BW for 0, 49, or 98 mg NA/kg BW, respectively; $P < 0.05$). Dietary treatment had no effect on prepartum or postpartum nonesterified fatty acids (NEFA), β -hydroxybutyrate, and glucose. Prepartum DMI depression was greater for Holsteins compared with Jerseys, 32 and 14%, respectively (breed x day interaction; $P < 0.05$). The magnitude of increase of NEFA as parturition approached was greater for Holsteins compared with Jerseys (breed x day interaction; $P < 0.05$). In addition, plasma NEFA of Jersey cows were lower than Holstein cows during the postpartum period (613 vs 862 $\mu\text{Eq/L}$ for Jersey and Holstein, respectively; $P < 0.01$). In summary, supplemental NA during the last 3 wk of gestation did not affect DMI or plasma metabolites during the transition period. Lipid metabolism and prepartum feed intake depression does differ for the two major breeds of dairy cattle.

Key Words: Transition cows, Breed, Nicotinic acid

T228 Comparative evaluation of the transfer of two forms of Vitamin A into milk of dairy cows. S. Jurjanz*¹, Y. Le Roux¹, F. Rouffineau², and J. C. Robert², ¹*Laboratoire de Sciences Animales, INRA-ENSALA, Vandoeuvre, France,* ²*Adisseo France SAS, Commeny, France.*

Eight Holstein lactating dairy cows (6 primiparous and 2 multiparous) were assigned in a cross over design with two treatments and two periods. The two treatments consisted of spot supply of 2 different forms of Vitamin A containing 1 million IU Vitamin A per g (300 mg retinol): products A (Microvit A Supra™ 1000, Adisseo France SAS) and B (Rovimix™ A 1000, DSM) differed by their coating technology. Each period consisted of 3 weeks depletion (ration without Vitamin A supplementation) and one week measurements. A basal diet without Vitamin A supplementation, consisting of (%DM): corn silage (68.2), wheat straw (6.7), cracked wheat (9.5), SBM (14.2) and minerals (1.4), was supplied during all the trial. During the measurement week, control milk was collected during the 2 milking times on the first experimental day. The second day a spot dose of 1 Million IU of vitamin A was orally supplied and milk samples were collected for 8 consecutive milkings. Milk yield was individually recorded and retinol concentrations determined in milk samples. The variations of retinol concentrations and quantities were used to calculate the Area Under the Curves (AUC), which were statistically compared for the two treatments. Although large variations between cows, AUC values were respectively for products A and B, 4068 and 3068 for milk retinol concentrations, ($p < 0.01$) (SED: 433) and 52.9 and 35.9 for milk retinol quantities ($p < 0.01$) (SED: 4.8). The increases of retinol quantities passed into the milk (quantities in the milk after spot supply minus control values) were 68.2 mg and 41.5 mg respectively for products A and B ($p < 0.01$) (SED: 7.2). The retinol transfer ratios

were: (%) 22.7 and 13.8 respectively for products A and B ($p < 0.01$) (SED: 2.4). In conclusion, the higher transfer of retinol into milk with Microvit A Supra 1000 shows its better bioavailability in relation

with its specific coating technology preventing it from ruminal degradation.

Key Words: Dairy cow, Vitamin A, Milk

Ruminant Nutrition: Rumen Fermentation Modifiers

T229 Effects of high and low inclusion rate yeast culture products on in vitro batch culture ruminal fermentations. H. M. Sullivan* and R. A. Halalshah, *New Mexico State University, Las Cruces.*

In vitro mixed culture ruminal microorganism fermentations were conducted to determine the effects of two high (DVXP and WY2XP) and two low (WCC5 and YS) inclusion rate *Saccharomyces cerevisiae* cultures on batch fermentations of no substrate (NS), ground corn (GC), starch (S), high quality alfalfa hay (HA), low quality alfalfa hay (LA) and a dairy TMR (TMR). The TMR was formulated for a high producing cow to meet 2001 NRC requirements. Yeast products were included according to label directions for high and low dose products at 0.73 and 0.35 g/L. All substrates were fermented for 24 hours. Additional fermentations were conducted at 0, 24 and 48 hours using HA, LA and NS to determine in vitro DMD over time. Fermentations were done in duplicate over three days ($n=6$). Data were analysed using the GLM procedure of SAS. There was no significant difference among treatments in pH. The addition of each of yeast cultures increased ammonia concentrations in the presence of NS ($P < 0.05$). Ammonia concentrations were significantly lower for HA fermentations containing WCC5, DVXP and WY2XP ($P < 0.05$). Conversely, LA fermentations with DVXP and WY2XP had significantly higher ammonia concentrations ($P < 0.05$). Ammonia concentrations were numerically higher with yeast cultures for TMR; however, only WCC5, WY2XP and DVXP had significant increases. There was no difference among treatments in in vitro DMD of LA or HA. There was no significant difference among treatments in VFA concentrations of GC, LA, HA, S or TMR; however NS fermentations with yeast were significantly higher for all measured VFA. Lactate concentrations were not different among treatments. In conclusion, the incorporation of the high and low dose yeast culture products into mixed ruminal microorganism fermentations of GC, S, HA, LA and TMR had little effect on final pH and VFA products. Ammonia concentrations were lower in HA fermentations with yeast, especially for the high dose products, while the reverse was true for LA fermentations with yeast product added. The addition of yeast culture products to fermentations of alfalfa hay did not affect forage dry matter digestion in this study.

Key Words: In vitro, Yeast

T230 Evaluation of the protective effect of probiotics given to dairy cows during a lactic acidosis challenge. J. Chiquette*, *Dairy and Swine Research & Development Centre, Lennoxville, Quebec, Canada.*

Sub-acute rumen acidosis can be extremely costly when it occurs in dairy cows. The use of probiotic supplements to stabilize the rumen during the transition period could attenuate the symptoms of this metabolic disorder. Four ruminally-fistulated Holstein dairy cows in mid-lactation were assigned to the following experimental treatments in a 4 x 4 Latin Square design: 1) control; 2) 0.6g per head, per day of a fermentation extract of *Aspergillus oryzae* (AO-0.6); 3) 3g per

head, per day of AO (AO-3.0); 4) a probiotic combination consisting of *Enterococcus faecium* and *Saccharomyces cerevisiae* (ES) at a level of 1×10^5 cfu/ml of rumen fluid. Each period of the Latin Square consisted of 3 weeks of adaptation to the respective treatments followed by 4 days of lactic acidosis challenge and 3 days of resting period. During the week of induction of sub-acute ruminal acidosis (SARA), 30% of ad libitum intake of the TMR was replaced by pellets containing 50% ground wheat and 50% ground barley (WBP). Ruminal pH was recorded continuously using an indwelling pH probe, over a 24 h period for each week of the adaptation period and continuously over the 4 days of SARA induction. Average ruminal pH was lower during SARA than during the weeks of adaptation to the different treatments (5.6 vs 6.1) ($P < 0.0001$). The difference in average pH recorded during the adaptation weeks and the week of SARA was greater when animals were controls (0.73) than when they received AO-0.6, AO-3.0 or ES (0.32, 0.51, 0.24, respectively) ($P = 0.002$). The ES treatment tended to sustain a higher pH during the SARA period compared to the control (5.8 vs 5.4, $P = 0.06$). Accordingly, minimum pH recorded during SARA was higher when animals were on ES than control (5.0 vs 4.4, $P = 0.01$). Adding ES or AO-0.6 did not affect milk production compared to the control (average milk production = 26.6 kg per day) whereas milk production decreased (23.4 kg per day) ($P = 0.04$) when cows received AO-3.0.

Key Words: Probiotics, Acidosis, Dairy cows

T231 Effect of feeding Fermenten® to Holstein dairy cows on milk production, composition and blood metabolites. C. M. Martinez*¹, Y-H. Chung¹, M. E. White¹, E. Block², and G. A. Varga¹, ¹*The Pennsylvania State University, University Park,* ²*Church & Dwight Co., Inc., Princeton, NJ.*

The objective of this study was to evaluate the effects of feeding Fermenten to Holstein dairy cows on milk production, milk composition and blood metabolites. Thirty mature Holstein cows were assigned to either a control diet or to a diet formulated for the same nutrient specifications as the control diet but including FERMENTEN® based on ME305 and lactation number. FERMENTEN® feeding began the third week after calving and continued until week-8 of lactation. FERMENTEN® was fed at a rate of 0.37 kg/cow/day. Diets contained 15.5% CP, 34 % NDF and 1.64 Mcal NE_L/kg of DM. Milk yield and dry matter intake (DMI) were recorded daily. Blood, milk and TMR samples were taken weekly. Blood samples were taken 3 h after morning feeding. Data were analyzed using MIXED procedure of SAS and cow nested in treatment was used as the random effect. There were no differences in DMI or milk yield (23.3 ± 0.86 and 46.1 ± 1.95 kg/day, respectively). Cows supplemented with FERMENTEN® had numerically higher fat percentage (3.57%) compared to the unsupplemented group (3.39%). Protein percentage and protein yield were higher ($P < 0.09$) for cows provided FERMENTEN®. Milk urea N concentration was higher (10.8 mg/dl, $P < 0.04$) for the FERMENTEN® supplemented cows compared to the control group (9.67 mg/dl).

There were no differences in blood concentrations of urea N or glucose. Mature high producing Holstein cows did not respond to FERMENTEN® supplementation either in DMI or milk yield when compared to unsupplemented cows; however trends were observed for positive effects on milk composition.

Key Words: Fermenten, Milk composition

T232 Effect of Virginiamycin and Poulcox, or both, on performance of Holstein cows. L. Erasmus*¹, C. Muya¹, R. Coertze¹, S. Erasmus², and G. Catton³, ¹University of Pretoria, Pretoria, South Africa, ²ARC-LBD, Irene, South Africa, ³D.G.Catton, Irene, South Africa.

Virginiamycin (VM) and ionophores, such as Poulcox (P), are antimicrobial feed additives approved for use in cattle to improve performance. The effect of VM on Gram positive bacteria is similar to that of P (active ingredient monensin sodium) although the modes of action differ. Very little information is available on the potential synergistic effects of VM and P, especially in dairy cattle diets. The objectives of this study were to investigate the effect of various combinations of VM and P on the performance of dairy cows. Forty high producing multiparous Holstein cows were blocked according to previous milk production and randomly allocated to one of the following lucerne based total mixed rations : 1) Control, no medication; 2) Control plus 20 ppm VM; 3) Control plus P (15 ppm monensin); 4) Control plus VM plus P. The experimental period was from 21 days prepartum until 60 days postpartum. Data were analysed according to a randomised block design, using the GLM procedure (SAS, 2001). Dry matter intake varied from 23.6 kg /d to 25.4 kg /d and did not differ between treatments ($P > .10$). Milk production was higher ($P < .10$) for cows receiving VM + P (41.2 kg /d) when compared to cows receiving only VM (36.6 kg /d), but did not differ from the other treatments ($P > .10$). Milk fat % was lower for cows receiving treatments P (3.88%) and the Control (4.11%) when compared to treatment VM + P (4.39%) ($P < .10$). Milk protein and MUN did not differ. Body weight loss, for the period from calving until day 60 postpartum, tended ($P < .15$) to be less for cows receiving VM + P (-8.1 kg) when compared to the Control (-34.2 kg) and P (-31.9 kg) treatments. Results suggest a positive synergistic interaction between Virginiamycin and Poulcox.

Key Words: Virginiamycin, Ionophores, Dairy cattle

T233 Effects of monensin and dietary soybean oil on milk fatty acid profile in lactating cows. O. AlZahal*¹, N. E. Odongo¹, M. Or-Rashid¹, T. Mutsvangwa², T. F. Duffield¹, R. Bagg³, P. Dick³, G. Vessie³, and B. W. McBride¹, ¹University of Guelph, Guelph, Ontario, ²University of Saskatchewan, Saskatoon, Saskatchewan, ³Elanco Animal Health, Division Eli Lilly Canada Inc., Guelph, Ontario, Canada.

Seventy-two lactating Holstein dairy cows (100-150 DIM) were used in a 2 x 3 factorial experiment to investigate the effects of monensin (MN; 0 and 22 ppm Rumensin Premix®, DM basis) and dietary soybean oil inclusion (SBO; 0, 1.7, and 3.5%, DM basis) on milk fatty acid (FA) profile. A TMR (% DM; corn silage, 34; haylage, 22.7; hay, 4.5; high moisture corn, 20; and protein supplement, 18.8 %) was offered *ad libitum*. The trial consisted of a 2-wk baseline period, a 3-wk adaptation period, a 2-wk treatment period, and a 4-wk wash-out period. Feed and milk samples were collected three times per wk and composited over

each experimental period. Soybean oil linearly reduced total short- and medium-chain ($\leq C_{14}$) and saturated FA concentrations. Soybean oil linearly increased total mono- and polyunsaturated, t11-C_{18:1}, and total CLA. Monensin had no effect on concentrations of total short- and medium-chain ($\leq C_{14}$), saturated, mono- and polyunsaturated FA. Monensin, SBO, and their interaction increased total trans- and t10-C_{18:1} FA. This translated into a significant drop of 11 and 23% in fat percentage when MN was used with 1.7 and 3.5% SBO, respectively. These results show that MN lowers milk fat percentage and the magnitude of this response is dependent upon the level of dietary SBO inclusion.

Table 1.

Item / SBO, %	Control			Monensin			P value		
	0	1.7	3.5	0	1.7	3.5	A	B	C
Milk fat (%)	3.76	3.59	3.14	3.74	3.21	2.43	<0.01	<0.01	0.07
Total $\leq C_{14}$ (g/100g)	24.7	22.0	18.5	23.2	21.2	17.3	0.07	<.0001	0.93
Total Saturates	73.1	69.2	63.5	73.9	67.1	60.5	0.09	<.0001	0.17
Total Monosat	23.5	26.8	32.1	23.0	28.9	34.5	0.09	<.0001	0.25
Total Polysat	3.35	4.00	4.45	3.14	3.98	5.03	0.29	<.0001	0.01
Total <i>trans</i> -C _{18:1}	2.71	4.31	6.46	2.78	4.78	8.74	<0.01	<.0001	0.01
t10-C _{18:1}	0.32	0.62	1.39	0.37	0.84	2.62	0.02	<.0001	0.05
t11-C _{18:1}	0.90	1.47	2.12	0.91	1.64	2.74	0.02	<.0001	0.06
Total CLA	0.47	0.741	1.11	0.476	0.878	1.474	<0.01	<.0001	0.06

A = main effect of MN, B = main effect of SBO (linear), C = MN x SBO

Key Words: Monensin, Soybean oil, Milk fatty acid profile

T234 Effect of lasalocid or monensin supplementation on nitrogen metabolism in midlactating dairy cows. R. Martineau*¹, C. Benchaar², H. V. Petit², H. Lapierre², D. R. Ouellet², D. Pellerin¹, and R. Berthiaume², ¹Université Laval, Québec, Canada, ²Dairy and Swine R&D Centre, AAFC, Lennoxville, Québec, Canada.

Six Holstein cows (BW=728 ± 59 kg; DIM=90 ± 30 d) were used in a replicated 3 x 3 Latin square design with 35-d periods to determine the effect of ionophore (IOP) supplementation on N metabolism. Cows were fed for *ad libitum* intake a legume silage-based TMR (17.5 % CP) without IOP (C) or either with lasalocid (L) or monensin (M) at a dose of 24 ppm on a DM basis. Orthogonal contrasts were used to compare IOP (L + M) vs. C, and L vs. M. Significance was declared at $P \leq 0.05$. Milk production and DMI averaged 36.6 and 23.5 kg, respectively and were not affected by IOP supplementation. Milk fat and milk protein concentrations were similar among treatments and averaged 3.35 and 3.38 %, respectively. Compared to C, IOP supplementation tended ($P=0.07$) to reduce ruminal NH₃-N concentration and significantly increased N apparent digestibility, but with no difference between L and M. Urinary urea N excretion was not different between C and IOP supplementation, but was lower with L than with M (112 vs. 143 g/d). In parallel, plasma urea N concentration tended ($P=0.06$) to be lower and milk urea N concentration was lower with L compared to M (11.0 vs. 12.3 mg/dL). Data from this study demonstrate that ionophores have similar effects on N metabolism in the gastrointestinal tract but differences in urea excretion and concentrations indicate a possible decrease in amino acid catabolism with lasalocid.

Key Words: Dairy cow, Lasalocid, Monensin

T235 Effects of rumensin and bovine somatotropin (bST) on productive and physiological parameters of Newzeland Holstein cows grazing alfalfa pasture. M. Tarazon*, S. Araiza, E. Rueda, and A. Nuñez, *Universidad de Sonora, Santa Ana, Sonora, Mexico.*

The objective of the current study was to evaluate the addition of Rumensin in the complementary diet and the injection of bST in Newzeland Holstein cows grazing alfalfa pasture on productive and physiological variables. Thirty-six cows averaging 15.6 kg/d of milk, 242.2 DIM, 448.2 BW and 2.96 BCS were assigned to one of the four treatments in a completely randomized block design with 2 x 2 factorial arrangement of treatments using milk production during a 14 d pretreatment period as the blocking criterion and balanced with DIM. Data from the pretreatment period were used for a covariate adjustment. Treatments were as follows: 1). CON, cows without Rumensin or bST; 2). RUM, cows with only Rumensin; 3). BST, cows with only Somatotropin; and 4). RYS, cows with Rumensin and Somatotropin. Cows were on treatment for 70 days. During both periods, cows were grazing alfalfa pasture and received 2 kg of commercial ration containing 16% protein and 3% fat. Cows were milked twice a day and milk productions were measured three times a week. All cows received a Rumensin Controlled releasing Capsule, containing 32 g of monensin for 95 d to control bloat. The ration of cows on Rumensin received 164 mg in the daily supplement and cows in bST were injected with 500 mg each 14 days. All cows were weighted and BCS determined at the beginning and final of the experimental period. Data were analyzed by ANOVA using GLM procedure of SAS (SAS Institute, 2001). Milk yields were increased by bST ($P < 0.01$) from 14.3 to 16.4 kg/d, but were not influenced by Rumensin. Body weight and BCS were not altered by bST nor Rumensin.

Key Words: Rumensin & bST, Productive & physiological, Newzeland Holstein cows

T236 Effect of monensin supplement during prepartum and transition phase on rumen fermentation and microbial efficiency. D. Srichana*^{1,2}, M. S. Kerley¹, and J. N. Spain¹, ¹*University of Missouri, Columbia,* ²*Thammasat University, Phatumthani, Thailand.*

The effect of monensin (M) supplement in transition dairy cow diets on fermentation and microbial efficiency (g N/Kg OM truly digested; MOEFF) was evaluated in 2 experiments using a continuous culture system. In experiment one, the treatments were arranged as completely randomized design with 12 replicates and 2 treatments, prepartum diet without M (control) and with M (24 mg/Kg DM). Fermentors were set at 6%/h dilution rate and incubated at 39°C and allowed to equilibrate for 3 days followed by 3 day collection phase. Data were analyzed using Proc GLM procedures of SAS. Ammonia, VFA and pH were measured at 2 h after feeding. Supplemental M increased ($P < 0.05$) propionic acid (14.8 vs 12.4 mM) and decreased ($P < 0.05$) A:P ratio (3.6 vs 4.2) when compared to the control. Ammonia, total VFA, acetic acid, butyric acid, BCFVA and pH were not altered by M ($P > 0.05$). There was no difference ($P > 0.05$) in MOEFF for the diet with and without M (12.0 vs 14.4). In experiment two, the treatments (4 fermentors/treatment) were arranged as 2X2 factorial and analyzed using Proc GLM procedures of SAS that included two levels of M (without or with M, 24 mg/kg DM) and 2 phases of prepartum phase (fermentors fed dry cow diet; PP) and transition phase (fermentors fed lactating cow diet; TP) as main effects. Fermentors were set as in experiment one and allowed to equilibrate for 3 days followed by 3 day PP and 3 day collection phase (TP). Supplemental M during PP

increased ($P < 0.05$) total VFA (113.9 vs 110.1 mM), acetic acid (81.7 vs 73.6 mM), organic matter truly digested (OMTD; 31.52 vs 30.21 g) but did not alter ($P > 0.05$) MOEFF (16.61 vs 14.93). Supplemental M during TP increased OMTD (31.3 vs 30.5 g) but did not alter ($P > 0.05$) MOEFF (15.59 vs 15.96). There were no interactive effects of M supplement during PP and TP on fermentation products and MOEFF. In summary, the results of these experiments show that the addition of monensin during both phases of transition increased OMTD and Total VFA which would increase energy available to the transition dairy cow.

Key Words: Monensin, Prepartum and transition diet, Microbial efficiency

T237 Anise and capsicum as alternative to monensin in beef heifers fed a high-concentrate diet. I. Fandiño*¹, S. Calsamiglia¹, A. Ferret¹, and C. Kamel², ¹*Universitat Autònoma de Barcelona, Bellaterra, Spain,* ²*Pancosma, SA, Bellegarde-sur-Valserine Cedex, France.*

Four Holstein heifers (229 ± 24 kg BW) fitted with ruminal trocars were used in a 4 x 4 Latin square design to evaluate the effects of monensin (MON), anise extract (ANI) and capsicum (CAP) on rumen fermentation. Heifers were fed a 10:90 forage:concentrate ratio (16% CP and 22% NDF). Treatments were: no extract (CTR), 35 mg/kg of MON, 500 g/d of ANI and 500 g/d of CAP. Each period consisted of 15 d of adaptation and 9 d for sampling. On d 16 to 21 of each period, dry matter intake (DMI) was measured. On d 22 to 24 ruminal content was sampled at 0, 4, 8 and 12 h after feeding to determine ruminal pH, and the concentration of volatile fatty acids (VFA), large peptide (LPep), small peptide plus amino acid (SPep+AA), and ammonia (NH₃ N). Statistical differences were declared at $P < 0.05$. Compared to CTR, MON reduced total VFA (from 112.6 to 108.8 mM), acetate proportion (from 55.3 to 54.4 mol/100 mol), acetate to propionate ratio (from 2.03 to 1.92), branch-chained VFA (BCVFA) concentration (from 2.5 to 2.1 mM) and NH₃ N concentration (from 15.3 to 13.4 mg/100 mL), and increased propionate proportion (from 25.2 to 27.5 mol/100 mol), SPep+AA N (from 15.3 to 18.1 mg/100 mL) and LPep N (from 11.2 to 14.3 mg/100 mL). Compared to CTR, CAP increased DMI (from 6.57 to 7.42 Kg/d) and butyrate proportion (from 13.0 to 14.1 mol/100 mol), and reduced acetate proportion (from 55.3 to 54.0 mol/100 mol). Compared to CTR, ANI reduced total VFA (from 112.6 to 110.8 mM), acetate proportion (from 55.3 to 53.5 mol/100 mol), acetate to propionate ratio (from 2.03 to 1.90), BCFVA concentration (from 2.5 to 2.1 mM) and NH₃ N concentration (from 15.3 to 13.6 mg/100 mL), and increased propionate proportion (from 25.2 to 26.9 mol/100 mol) and SPep+AA N (from 15.3 to 18.0 mg/100 mL). The effects of ANI were similar to MON with the exception of the effects on the molar proportion of butyrate, which suggests that it may have a different mode of action.

Key Words: Rumen fermentation, Plant extract

T238 Optimal dose and combination of anise and capsicum as modifiers of ruminal fermentation in beef heifers. I. Fandiño*¹, S. Calsamiglia¹, A. Ferret¹, and C. Kamel², ¹*Universitat Autònoma de Barcelona, Bellaterra, Spain,* ²*Pancosma, SA, Bellegarde-sur-Valserine Cedex, France.*

Twelve Holstein heifers (229 ± 24 kg BW) fitted with ruminal trocars were used in three 4 x 4 Latin squares to evaluate the effects of different doses (100, 250 and 500 mg/d) and proportions of anise extract (A) and capsicum (C) (25%A+75%C, 50%A+50%C and 75%A+25%C)

on rumen fermentation and protein degradation. Heifers were fed a 10:90 forage:concentrate ratio diet (16% CP and 22% NDF). Each period consisted of 15 d of adaptation and 9 d for sampling. On d 16–21 of each period, dry matter intake (DMI) was measured. On d 22–24 ruminal content was sampled at 0, 4, 8 and 12 h after feeding to determine ruminal pH and the concentration of volatile fatty acids (VFA), large peptide N (LPep), small peptide plus amino acid N (SPep+AA) and ammonia N (NH₃). Data were analyzed using PROC MIXED of SAS (1996). Contrasts were conducted within dose between each treatment and control, and differences were declared at $P < 0.05$. Treatments had no effect on ruminal pH. At 100 mg/d treatments had no effect on DMI and rumen fermentation. At 250 mg/d, 75%A+25%C reduced the concentration of total VFA, the acetate proportion, the acetate to propionate ratio and the branch chained VFA (BCVFA) and the NH₃ N concentration, and increased the propionate proportion and SPep+AA N concentration. At 500 mg/d, 25%A+75%C increased DMI and SPep+AA N concentration and reduced the BCVFA and the NH₃ N concentration. At 500 mg/d, 50%A+50%C reduced the concentration of total VFA, the acetate proportion, and the BCVFA and the NH₃ N concentration, and increased the propionate proportion and SPep+AA N concentration. At 500 mg/d, 75%A+25%C reduced the concentration of total VFA, the acetate proportion, the acetate to propionate ratio, and the BCVFA and the NH₃ N concentration, and increased the propionate proportion and SPep+AA N concentration. Results indicate that 250mg/d of 75%A+25%C and 500mg/d of 75%A+25%C may be useful as modifier of rumen fermentation in beef production systems.

Key Words: Rumen fermentation, Plant extract

T239 Effects of alfalfa extract and a mixture of cinnamaldehyde and eugenol on rumen fermentation in beef heifers fed a high-concentrate diet. P. W. Cardozo¹, S. Calsamiglia*¹, A. Ferret¹, and C. Kamel², ¹Universidad Autonoma de Barcelona, Bellaterra, Spain, ²Pancosma SA, Bellegarde-sur-Valserine Cedex, France.

Four Holstein heifers (360 BW) fitted with ruminal trocars were used in a 4x4 Latin square design to evaluate the effects of no extract (CTR), 30 g/d of alfalfa extract (AEX; 10% malate, and 1.5% saponins), a mixture of 180 mg/d of cinnamaldehyde and 90 mg/d of eugenol (CIE), and the combination of the two treatments (MIX) on rumen fermentation. Heifers were fed a 10:90 straw to concentrate ratio diet. Each period consisted of 15 d for adaptation and 6 d for sampling. On d 16, 17 and 18 of each period, DM and water intake were measured. On d 19, 20 and 21 ruminal content was sampled at 0, 3, 6, 9, and 12 h after feeding to determine ruminal pH and the concentrations of volatile fatty acids (VFA), L-lactate, large peptides (LPep), small peptides plus AA (SPep+AA), and ammonia N. On d 20 and 21, samples of rumen fluid were also taken at 0 and 3 h after feeding to determine protozoa counts. On the last day, rumen fluid was used to determine in vitro DM and CP degradation of alfalfa hay (AH), ryegrass hay, barley grain, wheat grain, corn grain (CG) and soybean meal (SBM) after 4 and 24 h incubation. Relative to CTR, CIE and AEX reduced ($P < 0.05$) DM and water intake, and Entodiniomorphs counts, but did not affect pH, total VFA concentration, propionate and butyrate proportions, and LPep N concentration. The CIE tended ($P = 0.08$) to reduce ammonia N, and to increase SPep+AA N concentrations. The AEX increased ($P < 0.05$) the acetate to propionate ratio and reduced ($P < 0.05$) Entodiniomorphs counts. The MIX tended ($P = 0.06$) to reduce DM intake, water intake and ruminal pH. In vitro, CIE and MIX reduced ($P < 0.05$) CP degradation of SBM and CG, and MIX also reduced ($P < 0.05$) CP degradation of AH at 4 h after incubation, but all differences disappeared after

24 h of incubation. Results suggest that CIE and AEX had some effects on DM intake and rumen fermentation, but the effects of their combination were not additive.

Key Words: Rumen fermentation, Plant extracts

T240 Anise, capsicum, and a mixture of cinnamaldehyde and eugenol modified rumen fermentation in beef heifers fed a high-concentrate diet. P. W. Cardozo¹, S. Calsamiglia*¹, A. Ferret¹, and C. Kamel², ¹Universidad Autonoma de Barcelona, Bellaterra, Spain, ²Pancosma, PA, Bellegarde-sur-Valserine Cedex, France.

Four fattening Holstein heifers (450 kg BW) fitted with ruminal trocars and fed a 10:90 straw to concentrate ratio diet were used in a 4x4 Latin square design to evaluate the effects of no extract (CTR), 2 g/d of anise oil (ANI; 10% of anethole), 1 g/d of capsicum extract (CAP; 15% of capsaicin), and a mixture of 0.6 g/d of cinnamaldehyde and 0.3 g/d of eugenol (CIE) on rumen fermentation. Each period consisted of 15 d for adaptation and 6 d for sampling. On d 16, 17 and 18 of each period, DM and water intake were measured. On d 19, 20 and 21 ruminal content was sampled at 0, 3, 6, 9 and 12 h after feeding to determine ruminal pH and the concentration of volatile fatty acids (VFA), L-lactate, large peptides (LPep), small peptides plus AA (SPep+AA) and ammonia N. On d 20 and 21, samples of rumen fluid were also taken at 0 and 3 h after feeding to determine protozoa counts. On d 21, rumen fluid was used to determine in vitro DM and CP degradation of alfalfa hay, ryegrass hay, barley grain, wheat grain, corn grain and soybean meal (SBM) after 4 and 24 h incubation. Relative to CTR, treatments had no effect on ruminal pH, total VFA concentration and butyrate proportion. The CAP increased ($P < 0.05$) DM and water intake, and SPep+AA N concentration, reduced ($P < 0.05$) acetate proportion and LPep N concentration. The CIE reduced ($P < 0.05$) water intake, acetate proportion, L-lactate, and ammonia N concentrations, and total protozoa counts, and increased ($P < 0.05$) propionate proportion and SPep+AA N concentration. The ANI reduced ($P < 0.05$) acetate to propionate ratio, and ammonia N concentrations, and total protozoa counts. In vitro, ANI, CAP, and CIE reduced ($P < 0.05$) CP degradation of SBM at 4 h after incubation, and only ANI reduced CP degradation of SBM at 24 h after incubation. Results indicate that CIE, ANI and CAP may be useful as modifiers of rumen fermentation in beef production systems.

Key Words: Rumen fermentation, Plant extract

T241 In vitro effects of eleven essential oils on ruminal fermentation. A. V. Chaves*¹, G. Fraser^{2,1}, Y. Wang¹, K. A. Beauchemin¹, T. A. McAllister¹, and C. Benchaar³, ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, Canada, ²Nova Scotia Agricultural College, Truro, NS, Canada, ³Agriculture and Agri-Food Canada Research Centre, Lennoxville, QC, Canada.

The effects of eleven essential oils (EO) on ruminal fermentation were studied in vitro batch culture of mixed ruminal microbes to assess their potential for use as alternatives to antibiotics. Carvacrol, cinnamaldehyde, eugenol, thymol, D-limonene, L-limonene, and extracts of cinnamon leaf, clover leaf, sweet orange, oregano, and red thyme were included in anaerobic batch culture incubations of a forage:concentrate mixed diet (18% CP; 33% NDF) in buffered ruminal fluid. Gas production (GP), pH, NH₃, total VFA, and in vitro DM disappearance (IVDMD) were assessed after 24 h ($n = 3$). Data were analyzed by the PROC MIXED procedure of SAS. The EO were included at the lowest levels (ppm; vol/vol) at which each had

decreased ($P \leq 0.05$) GP during preliminary 24-h incubations with 0 to 100 ppm and then with 0, 200, 400, 800, and 1000 ppm EO included. Neither D- nor L-limonene at 1000 ppm affected GP ($P > 0.31$). The other nine EO were assessed in two incubation groups. In the first incubation, GP, IVDMD, and total VFA concentrations were decreased ($P \leq 0.002$) by eugenol (800) and carvacrol (400) as compared with control (no EO), cinnamon leaf (400), clover leaf (200), and thymol (200), whereas NH_3 concentrations were unaffected by EO. In the second incubation, GP was decreased ($P \leq 0.0001$) by red thyme (200), oregano (200), and cinnamaldehyde (200) compared to control, but was similar ($P \geq 0.054$) between control and sweet orange (200). Concentrations of NH_3 were unaffected although total VFA concentrations were decreased ($P \leq 0.035$) by cinnamaldehyde (200) compared to other treatments. Effects of EO on pH were variable. On the basis of these results, carvacrol and cinnamaldehyde will be validated in animal trials aiming at developing alternatives feed antibiotics in ruminant diets.

Key Words: Essential oils, Gas production, Ruminant

T242 Effects of enzymes and herbal extracts on in vitro fermentation kinetics of ruminant feeds. D. Colombatto^{*1}, A. D. Garcarena², G. Lagos², C. Lago³, and F. Nahara³, ¹University of Buenos Aires, Argentina, ²EEA Balcarce INTA, Argentina, ³Porfenc SRL, Argentina.

The potential of fibrolytic enzymes and herbal extracts (HE) as ruminal modifiers was examined in vitro in a completely randomized design with a factorial arrangement of treatments. Half gram of alfalfa hay, corn silage or a finishing feedlot diet consisting of 70% corn grain, 20% corn silage, and 10% sunflower meal (DM basis) were weighed in triplicate in fermentation flasks, to which 40 ml of anaerobic buffer and 10 ml ruminal fluid were added. Treatments consisted of control (CON), two fibrolytic enzyme cocktails (mainly xylanase and cellulase, denoted A and B), added at 25, 50 and 100 mg kg^{-1} (DM basis) (0.5X, 1X, and 2X, respectively), and HE added at 750, 1500, and 3000 mg kg^{-1} (DM basis). Gas production (GP) kinetics was determined using a portable manometer at 2, 4, 6, 8, 10, 12, 15, 19, 24, 30, 36, 48 and 72 h post inoculation. DM and fiber degradability (DEG) at 24 h incubation was also determined by incubating filter bags containing 0.5 g of each substrate in ruminal fluid (same proportions as above). The experiment was replicated on three occasions for GP, and on four for DEG. Enzymes A and B cubically tended to increase GP at 2 h incubation time in alfalfa hay ($p=0.07$ and $p=0.09$, respectively), with Enzyme B linearly increasing ($p=0.05$) GP at 4 h in corn silage. HE did not affect ($p>0.05$) GP at any time, but rate of alfalfa hay GP linearly decreased ($p=0.04$) with HE addition after 48 h incubation. HE also linearly decreased ($p=0.02$) rate of GP of corn silage after 10 h incubation. Enzyme A increased Alfalfa DM DEG at 1x (571.9 vs. 541.2 g kg^{-1} for 1x and CON, respectively), but decreased that of the feedlot ration when applied at 2x (536.7 vs. 581.5 g kg^{-1} for 2x and CON, respectively). Because fiber DEG remained unaffected, it is suggested that non-fibrous fractions were responsible for the differences in DM DEG with Enzyme A. Enzyme B did not affect any of the treatments. Addition of HE did not affect DM DEG, although a trend towards higher ADF DEG was detected in all forages. Although responses to enzymes and HE appear to be dose and feed-specific, some enzyme mixtures can positively impact ruminal degradation of alfalfa hay.

Key Words: Enzymes, Digestion

T243 Effects of specific herbal extracts on in vitro fermentation kinetics of oats, alfalfa hay or a total mixed ration. D. Colombatto^{*1}, A. D. Garcarena², A. J. Flores², J. M. Hernandez Vieyra³, L. Mazuranok⁴, and C. Ionescu⁴, ¹University of Buenos Aires, Argentina, ²EEA Balcarce INTA, Argentina, ³Argent Export SA, Argentina, ⁴Pancosma Bioactives, France.

The potential of herbal extracts (HE) as modifiers of ruminal fermentation was examined in vitro in a completely randomized design with a factorial arrangement of treatments. One gram of grazing oats, alfalfa hay, or a total mixed ration consisting of 30% oats, 30% corn silage, 22% corn grain and 12% sunflower meal (DM basis) were weighed in triplicate in fermentation flasks, to which 40 mL of anaerobic buffer and 10 mL ruminal fluid were added. Treatments consisted of control (CON); monensin (added to an equivalent of 300 mg $\text{animal}^{-1} \text{d}^{-1}$; MON); and cinnamaldehyde (CIN), eugenol (EUG) or a combination of the two (62% eugenol and 38% cinnamaldehyde; MIX) added at the equivalent rates of 3, 30 and 300 mg $\text{animal}^{-1} \text{d}^{-1}$. A cow that consumes 20 kg feed d^{-1} was used as standard for application rates. Gas production (GP) kinetics was determined using a portable manometer at 2, 4, 6, 8, 10, 12, 15, 19, 24, 48 and 72 h post inoculation. Dry matter (DM) and fiber degradability at 24 h was also determined by incubating filter bags containing 0.5 g of each substrate in ruminal fluid (same proportions as above). The experiment was replicated on three occasions. Effects of HE on rate and extent of GP varied according to the substrate, as the lowest level of CIN and MIX increased ($p<0.05$) GP in alfalfa hay at 24 h fermentation. Monensin decreased ($p<0.05$) both rate and extent of GP in all feeds. Adding CIN increased ($p<0.05$) DM degradability of oats (44.3, 44.2, 46.2 and 47.3 % for CON and the three CIN levels, respectively), and fiber degradability of alfalfa hay (5.6, 4.8, 4.9, and 8.5%). A trend ($p<0.10$) towards a quadratic increase in oats NDF and ADF degradability was also detected. No differences ($p>0.05$) were detected when EUG or MIX were added to the feeds. Addition of MON did not alter ($p<0.05$) DM degradability, but reduced ($p<0.05$) NDF degradability of alfalfa hay. Although responses to pure herbal extracts appear to be feed-specific, addition of cinnamaldehyde has the potential to positively impact fermentation and degradation of selected feeds.

Key Words: Herbal extracts, Rumen, Fermentation

T244 Effects of five botanicals on rumen microbial fermentation profile. M. Blanch^{*1}, S. Calsamiglia¹, P. Chicoteau², and B. Nielsen², ¹Universidad Autonoma de Barcelona, Bellaterra, Spain, ²NOR-FEED, Denmark.

The effects of five botanicals on rumen fermentation were evaluated using the gas production technique. Treatments were: control (CTR, no additive), monensin (M, positive control), chestnut wood (CW), grape pomace (GP), Quillaja saponaria (QS), yucca (YC), and fenugreek (FG). Two levels of each additive were evaluated (CW1, CW2, GP1, GP2, QS1, QS2, YC1, YC2, FG1, FG2, M1 and M2; equivalent to 3, 30, 5, 50, 2, 20, 2, 20, 5, 50, 0.4 and 4 g per cow per day, respectively). The ruminal fluid inoculum was obtained from rumen fistulated heifers fed a 50:50 forage to concentrate ratio diet. The experimental diet consisted of a 15 g of 50:50 dairy cow diet (29.9% NDF, 16.8% CP). The production of gas was measured in each vial after 3, 6, 9, 12, 15, 24, 36 and 48 h in triplicate and two days ($n=6$). After incubation samples of fermentation fluid and the solid were collected to determine DM degradation, and volatile fatty acid (VFA) and ammonia-N concentrations. Differences were declared at $P<0.05$. The total gas production was higher in CW2 (+22%) compared with CTR. No

differences were observed in total VFA (75.0 mM). Acetate proportion in M2 was lower (-6%) compared with CTR. Propionate proportion of M2 was higher (+18%) compared with CTR. Butyrate proportions of CW2 and FG1 were higher (+15% and +10%, respectively) and M2 was lower (-18%) compared with CTR. The acetate to propionate ratio was lower in M2 (1.42) compared with CTR (1.86). The ammonia N concentration (mg/100mL) was higher in CW1 (23.0) compared with CTR (18.7) and M2 (16.2), and in GP1 (20.4) and YC2 (20.7) compared with M2. Botanicals may help modify rumen microbial fermentation, but effects are dose-dependent. Further research is necessary to study long term effects on rumen fermentation and animal performance.

Key Words: Plant extracts, Rumen fermentation, Gas production

T245 Evaluation of level of plant botanicals in diets fed to lactating dairy cows. K. J. Daniels*, P. H. Doane, and M. J. Cecava, *ADM Animal Nutrition Research, Decatur, IN.*

Our objective was to examine the effect of specific plant botanicals on performance of lactating dairy cattle. Holstein cows (n=260) were divided into three groups balanced upon parity, stage of lactation (DIM), and mean milk production measured one week before the co-variant adjustment period. A 1-week, co-variant adjustment period was followed by a 42-day study. The standard lactation diet served as the control ration (CTL). Treatment diet was supplemented to provide 28 g/cow/d (LO) or 56 g/cow/d (HI) of plant botanicals (RumeNext D™; ADM Alliance Nutrition, Inc., Quincy, IL) to deliver 250 and 500 mg/d, respectively, of the active botanical components. Individual data was collected for milk production on a daily basis and milk composition on a weekly basis, while group DMI was calculated daily. Data was analyzed using the Proc Mixed procedure of SAS for a repeated measures, completely randomized design. There was no effect of treatment on milk protein content, milk yield or SCC. Milk urea nitrogen linearly decreased with treatment (P<0.05). There was an increase (P<0.05) in milk fat content for LO (3.20%, 3.33% for CTL and LO respectively) and a tendency (P<0.06) for increased fat yield (1277, 1328 g/d for CTL and LO, respectively). Feeding HI decreased (P<0.01) dry matter intake (23.5, 23.2 kg/d for CT and HI, respectively) and fat yield (1277, 1218 g/d for CT and HI, respectively; P<0.01). Milk fat yield decreased (P<0.01) by 110 g/d, which is indicative of the 1.9 kg/d decrease (P<0.01) in FCM yield for HI compared to LO. Additionally, HI cows consumed 0.2 kg/d less DM than LO (P<0.01). Plant botanicals improved animal performance at the LO feeding rate, but had negative effects at the HI rate. The negative effect of HI appeared related to intake. These results suggest feeding recommendations be based at 28 g/d to supply 250 mg/d of active botanical components.

Key Words: Botanicals, Dairy cattle, Lactation

T246 Evaluation of lactating dairy cattle performance when fed plant botanicals in a commercial field setting. K. J. Daniels*, J. L. Dunn, P. H. Doane, and M. J. Cecava, *ADM Animal Nutrition Research, Decatur, IN.*

Our objective was to evaluate the effects of specific plant botanicals on performance of lactating dairy cows in commercial settings under different management and forage conditions. Holstein cows (n = 173) were allotted to treatment in a completely randomized design on four herds in Pennsylvania and were fed standard lactation diets for 30 days before treatments were applied. Cows were housed in tie stalls

and fed individually. The standard lactation diet served as the control (CTL), while the treatment diet (TRT) had an additional 56 g/cow/d of a specific blend of botanicals (RumeNext D™; ADM Alliance Nutrition, Inc., Quincy, IL). The TRT was fed for 60 days. Individual parameters for intake and production produced grouped means from repeated measures. Milk yield improved by 1.2 kg/d (P<0.5) for TRT. There were trends (P<0.13) for decreased milk fat and protein content when TRT was fed. However, milk fat (P<0.30) and protein (P<0.10) yield tended to increase because of increased milk yield. On a farm-specific basis, Farm C had a decrease (P<0.05) in milk fat content, but there tended to be increases (P<0.15) in total milk and milk protein yields for TRT. There were positive responses (P<0.10) to TRT for milk, fat-corrected milk and fat yield at Farm D, as well as a tendency (P<0.11) for increased protein yield. Both Farms A and B recorded numeric performance benefits for TRT. Results indicate that there may be farm-specific interactions with plant botanicals including management, basal diet, or production level. Plant botanicals may benefit performance of lactating cattle through a potential increase in milk and fat yield.

Key Words: Botanicals, Dairy cattle, Lactation

T247 Effect of carvacrol on ruminal fermentation *in vitro*. V. Noirot*¹ and C. Bayourthe², ¹*Génuol, Albi, France*, ²*ENSAT, Castanet-Tolosan, France.*

The aim of this study was to investigate the effects of 0, 10, 100 and 1000 mg/L (CTR, C-10, C-100 and C-1000 respectively) of carvacrol (CAR) on *in vitro* ruminal fermentation of a substrate consisting of dactyle-fescue hay, corn silage and soybean meal. Ruminal fluid was collected from two dairy cows, mixed with phosphate buffer (1:1), and incubated (120 ml) anaerobically at 39°C for 4 and 16h with or without CAR, using 5 g (DM basis) of substrate. After each fermentation period, pH was determined in culture fluid. Samples were collected for the determination of N-NH₃ and volatile fatty acids (VFA) in the liquid phase and DM, CP, and NDF contents were analysed in the solid phase. CH₄ and CO₂ were calculated from VFA according to theoretical stoichiometric equations. Data were analysed using GLM of Systat®; differences between treatments were declared at P< 0.05 using the pairwise multiple comparison test of Tukey. Whatever the time, C-1000 resulted in higher acetate and lower propionate and valerate proportions, lower total VFA concentration, lower gas production, and lower drop in pH, compared with others treatments. C-1000 increased N-NH₃ concentration after 4 h (112.0 vs 49.4 mg/L for CTR)-probably due to less bacterial consumption according to the other data-, and decreased NDF degradation after 16h by 57.4% compared to CTR. Minor VFA concentration and CP degradation were unaffected by CAR, after 4 and 16h of incubation respectively. Compared to CTR, C-10 and C-100 did not significantly affect acetate and valerate proportions, and NDF degradation after 16h. After 4h, excluding for C-10, propionate proportion was decreased, and all doses increased the isobutyrate proportion when compared to CTR. After 16h of incubation, non different pattern was observed with C-10 and C-100: C-10 and C-100 decreased significantly compared to CTR total VFA, CH₄ and CO₂ production by 5.7, 7.8 and 8.0% respectively. These results showed that high dose of CAR resulted in a general inhibition of rumen microbial fermentation and suggested that lower doses can be used to reduce CH₄ production.

Key Words: Carvacrol, *In vitro*, Rumen

T248 Effect of plant extract supplementation on rumen fermentation and metabolism in young Holstein bulls receiving a high-concentrate diet. A. Anglada¹, M. Devant^{*1}, and A. Bach^{1,2}, ¹IRTA, Barcelona, Spain, ²ICREA, Barcelona, Spain.

Ninety male Holstein bulls were used in a complete randomized design to study the effect of a blend of cynarin, ginseng and fenugreek (Biostar, Phytosynthese, France) supplementation on performance, rumen fermentation, and metabolism of Holstein bulls fed high-concentrate diets. Three treatments : control (CTR), supplementation of 32 mg/kg DM of were tested sodium monensin (MON, positive control), and supplementation of 2.8 g/kg DM of Biostar (BIO) over a 109-d period. Animals were weighed (303 ± 3.6 kg of initial BW) and randomly distributed by BW in 6 pens. Concentrate and straw were both offered *ad libitum*. Animal BW, and group concentrate and straw consumptions were recorded every 3 wks. Rumenocentesis was performed to all bulls starting at 63 d of study at 0900 during 3 consecutive days to determine rumen pH, ammonia N, and VFA concentrations. Blood samples from all bulls were taken starting at 7, 35, and 71 d of study at 0900 during 3 consecutive days to determine cortisol, glucose, insulin, and leptin. Final BW at 109 d of study of MON ($463 \text{ kg} \pm 4.1$) and BIO ($466 \text{ kg} \pm 4.1$) bulls was greater ($P < 0.05$) than CTR bulls ($452 \text{ kg} \pm 4.1$). Neither monensin nor Biostar supplementation affected feed consumption, and feed efficiency. Rumen pH was lower ($P < 0.001$) in MON and BIO treatments than in CTR. Rumen molar proportion of propionic acid increased ($P < 0.05$) in MON and BIO treatment bulls compared to CTR bulls. Bulls supplemented with Biostar had greater ($P < 0.05$) insulin and glucose plasma levels than MON or CTR bulls. Monensin or Biostar supplementation increased ($P < 0.001$) cortisol levels in bulls at 7 and 71 d of study compared to CTR treatment. Serum leptin concentration increased ($P < 0.01$) from 35 to 71 d of study; however, in MON bulls the increase was not as pronounced as in BIO and CTR bulls. In bulls fed a high-concentrate diet Biostar supplementation had similar effects on rumen fermentation to monensin supplementation.

Key Words: Rumen fermentation, Plant extracts, Leptin

T249 Evaluation of tannins on ammonia release of soybean meal protein under in vitro ruminal conditions. H. Carneiro^{*1}, T. A. Corrêa², and J. C. F. Lima², ¹Empresa Brasileira de Pesquisa Agropecuária, Juiz de Fora, MG, Brazil, ²Universidade Federal de Juiz de Fora, Juiz de Fora, MG, Brazil.

The objective of this experiment was to examine the effects of two types of tannins quebracho (TQ) (*Schinopsis* spp) and sorghum bicolor (TS) on in vitro degradation of soybean meal. The extent of binding to soybean protein commercial tannin from TQ and TS was evaluated incubating them under in vitro ruminal conditions for 48h. The protein binding activity was estimated measuring changes in ammonia concentration when the tannin was incubated with soybean meal at a proportion of 8% of the dry weight. Soybean meals (0.5g) were weighted in 100 mL plastic tubes and 0.01, 0.02 and 0.04g (2, 4, 8%) of one the tannin sources dissolved in McDougall buffer (5mL) was added. Triplicate tubes were used for each tannin level and for the control (no tannin). Tubes were placed in water bath at 39°C for 12hs to allow tannin and protein to react. Tilley and Terry procedure was used to determine degradation by rumen bacteria and degradation by rumen bacteria plus pepsin. ANOVA analysis was performed and differences among means were tested using Tukey's test. As compared to soybean meal alone (control equal 87% degradation), ammonia concentration decreased by 35% for TC from TQ and 31% for TC from TQ. Ammonia concentration decreased and also in vitro DM

degradation with addition of tannins to soybean meal. Crude Protein increased in the residual degradation. Reduction of ammonia per unit of tannin added was higher for TQ than TS ($p < 0.05$). Linear regression equation was calculated using ammonia concentration, rumen bacteria DM degradation and rumen bacteria plus pepsin DM degradation as dependent variable. Coefficients for linear relation were higher for commercial tannin R^2 98% than sorghum R^2 78%. The results showed that TQ were more efficient in protecting soybean meal from in vitro degradation by rumen bacteria with the lowest negative effect on in vitro rumen bacteria plus pepsin degradation as compared to TS. Although in vitro results can not be extrapolated to the whole animal, it suggest that CT from TQ could have a beneficial effect in vitro by increasing rumen escape protein but microbial ruminal protein formation could be depressed.

Key Words: Condensed tannin, Sorghum, Ammonia

T250 Effects of nitroethane on methane production and fermentation balance in fed steers. H. Gutiérrez-Bañuelos^{*1}, L. J. Slay¹, G. E. Carstens¹, N. Ramlachan², S. Horrocks², T. R. Callaway², T. S. Edrington², R. C. Anderson², and D. J. Nisbet², ¹Texas A&M University, College Station, ²USDA/ARS, Food & Feed Safety Research Unit, College Station, TX.

Objectives of this study were to examine the effects of a methane-inhibitor (nitroethane; NE) on methane (CH₄) emissions, and ruminal CH₄-producing activity in Holstein steers (403 ± 26 kg BW). Steers were fed a 50% concentrate diet and orally administered NE twice daily at 0 (0X), 80 (1X) or 160 (2X) mg NE/kg BW d⁻¹ for 14 d. Methane emissions were measured for 22 h/d on d 0, 6 and 13 of the study, using the sulfur hexafluoride tracer gas technique. Ruminal and fecal contents were collected on d -1, 1, 2, 7 and 14 of treatment for measurement of VFA and CH₄-producing activity. Compared to control steers (14.6; 1.24 kg/d), DMI and ADG were higher ($P < 0.01$) in 1X-treated steers (15.0; 1.49 kg/d), but lower ($P < 0.01$) in 2X treated steers (13.1; 0.86 kg/d). Methane emissions (L/d) decreased ($P < 0.07$) as NE dose increased (283, 270 and 246 ± 11 for 0X, 1X and 2X steers, respectively). Methane emissions per unit gross energy intake (% GEI) were also lower ($P < 0.03$) in 1X- ($3.76 \pm 0.14\%$) compared to control steers ($4.22 \pm 0.14\%$). However, lower DMI of 2X-treated steers resulted in similar CH₄ emissions between 2X- ($4.15 \pm 0.14\%$) and control steers. Methane emissions were not affected by day of study or day x treatment. Ruminal CH₄ producing activity ($8.5, 7.9$ and 4.7 ± 0.5 $\mu\text{mol/g h}^{-1}$) and calculated ruminal CH₄ based on fermentation balance ($23.1, 23.1$ and 19.1 ± 1.3 mol CH₄/100 mol VFA) were lower ($P < 0.01$) in 2X- compared to 0X- and 1X-treated steers. Fecal CH₄ producing activity was lower in 1X- and 2X-treated steers compared to 0X-steers ($3.9, 1.4$ and 1.4 ± 0.4 $\mu\text{mol/g h}^{-1}$). Day of study affected ruminal CH₄ activity, but day x treatment was not significant. Results from both in vivo and in vitro measurements of CH₄ production suggest that NE inhibits methanogenesis in steers for up to 14 d.

Key Words: Methane, Nitroethane, Rumen

T251 Effects of hop acids. I. In vitro ruminal fermentation. M. A. Schmidt and M. L. Nelson^{*}, Washington State University, Pullman.

Two randomized complete block *in vitro* experiments were conducted to 1) determine if hop (*Humulus lupulus* L.) beta acids altered ruminal fermentation in vitro and, 2) determine if five other hop acids altered ruminal fermentation similar to monensin. Experiment 1 had treatments

of 0, 1.25, 2.50, or 3.75 ppm beta acids and either barley or alfalfa substrate. Experiment 2 had treatments of control, 2 ppm alpha acids, 2 ppm beta acids, 2 ppm hexahydro-iso-alpha acid, 2 ppm iso-alpha acid, 2 ppm rho-iso-alpha acid, 2 ppm tetrahydro-iso-alpha acid, 6 ppm monensin and either alfalfa, barley, or corn substrate. Addition of beta acids in Exp.1 decreased ($P < 0.01$) gas production, pH, DM disappearance, microbial purines and increased ($P < 0.01$) lactate production when barley was the substrate. When alfalfa was the substrate, addition of beta acids decreased ($P < 0.01$) DM disappearance, pH, NDF disappearance, total gas production and rate of gas production. Beta acids decreased ($P < 0.01$) total VFA production with both barley and alfalfa substrates. However, with beta acids addition to barley, the molar proportions of acetate and propionate increased ($P < 0.01$), whereas, butyrate decreased ($P < 0.01$). In contrast, beta acids addition to alfalfa decreased ($P < 0.01$) the molar proportions of acetate and butyrate and increased ($P < 0.01$) propionate. Protozoal numbers and microbial purines decreased ($P < 0.01$) for barley, but only microbial purines decreased for alfalfa. In Exp. 2, beta acids showed the most favorable response of the hop acids with decreased ($P < 0.01$) gas production, increased propionate but not acetate. Significant decreases ($P < 0.01$) in DM and starch disappearance were observed, suggesting the rate of fermentation decreased. Monensin increased ($P < 0.01$) propionate and decreased ($P < 0.01$) protozoal numbers and bacterial purines compared to the control. Beta acids at approximately 2 ppm appeared to have beneficial effects on *in vitro* ruminal fermentation.

Key Words: Hop acids, *In vitro*, Fermentation

T252 Effects of hop acids. II. Beta acids on ruminal methane emission, protozoal population, fermentation, and CoM concentration in cannulated finishing steers. M. A. Schmidt, M. L. Nelson*, J. J. Michal, and H. H. Westberg, *Washington State University, Pullman.*

The objective of this study was to determine if beta acids (lupulones) from hops (*Humulus lupulus* L.) had an impact on *in vivo* ruminal fermentation. Four ruminally cannulated steers were randomly assigned to a 4 × 4 Latin Square design. The steers were fed a 90% corn, 10% alfalfa haylage diet with treatments added to the supplement. The treatments included 0, 0, 16.5, or 33 g beta acid/1000 kg diet. Two control treatments (0 g beta acid/1000 kg diet) were included to allow testing for carryover. Intake of DM and GE and methane emission decreased ($P < 0.10$) quadratically. Ruminal pH and lactic acid concentration increased ($P < 0.01$) linearly with beta acids addition. The molar proportions of acetate and propionate were quadratically affected ($P < 0.05$) to a maximum with addition of beta acids. However, the ratio of molar proportions of acetate and propionate was not affected by beta acids addition. There was a linear decrease ($P < 0.10$) in the rate of *in situ* DM disappearance but the extent of disappearance

was quadratically affected ($P < 0.05$) with beta acids addition. There was no effect on ruminal volume; however, ruminal mass increased ($P < 0.05$) quadratically when beta acids were fed. Beta acids had no effect on DM, NDF, ADF, starch, or nitrogen digestibility. Coenzyme M concentration in the fluid and particulate fractions increased ($P < 0.10$ and $P < 0.05$, respectively) with beta acids addition. Total protozoa and *Entodinium* spp. quadratically increased ($P < 0.0001$) with addition of beta acids. There was no change in microbial purines when beta acids were added. Therefore, addition of beta acids to the diet resulted in more efficient ruminal fermentation and starch digestion.

Key Words: Corn hop, Beta acids, Methane

T253 Use of sodium bicarbonate and an exogenous fibrolytic enzymatic compound on diets for Holstein steers. O. D. Montañez Valdez^{*1}, J. R. Bárcena Gama², S. S. González Muñoz², M. E. Ortega Cerrilla², M. A. Cobos Peralta², L. Landois Palencia², E. O. García Flores³, J. H. Avellaneda Ceballos⁴, and I. E. Morales Zambrano¹, ¹Centro Universitario del Sur. Universidad de Guadalajara, Ciudad Guzmán, Jalisco, México, ²Colegio de Postgraduados, Montecillos, Texcoco, Estado de México, ³Centro Universitario de la Costa Sur. Universidad de Guadalajara, Autlán, Jalisco, México, ⁴Universidad Técnica Estatal de Quevedo, Quevedo, Los Ríos, Ecuador.

The objective of this study was to evaluate the effect of sodium bicarbonate (SB) and the buffering capacity (BC) of the diets on the *in situ* digestibility of DM, ADF and NDF and ruminal fermentation. Five Holstein steers fitted with rumen cannula (BW 450±15 kg) were randomly assigned to a 5 × 5 latin square and they were housed in individual pens. Each period was 15 d, 10 for adaptation to diets and 5 to collect samples. Diet was 70% concentrate (47% ground sorghum, 8 % soybean meal, 7% molasses cane, 6. 8% corn gluten meal and 1.2 % mineral premix) and 30% forage (15% alfalfa hay and 15% corn silage) with different concentrations of SB and one exogenous fibrolytic enzymatic (Fibrozyme[®]; EFE) used to evaluate changes in fiber digestion. The treatments were: T1) control; T2) 0% SB + 3 g EFE; T3) 1.5% SB + 3 g EFE; T4) 3% SB + 3 g EFE; T5) 4.5% SB + 3 g EFE. There were no differences ($P \geq 0.05$) among treatments on the *in situ* digestibility of DM, NDF, ADF, VFA, and protozoa concentration. The N-NH₃ was different between treatments ($P \leq 0.05$) on 2, 4 and 6 h postfeeding, with a higher concentration in T3 (21.23 mg/dL) and lower in T2 (17.20 mg/dL) compared with T1 (19.17 mg/dL). The cellulolytic bacteria were higher in T3 and lower in T2. There was no effect of BC, SB and EFE on high concentrate diets on the *in situ* digestibility of fiber, VFA or ruminal pH, but improved the N-NH₃ and cellulolytic bacteria concentration.

Key Words: Buffering capacity, Enzyme, Digestibility

Swine Species

T254 Protein source affects feed palatability in piglets. D. Solà-Oriol¹, E. Roura^{*2}, and D. Torrallardona¹, ¹IRTA-Centre de Mas Bové, Reus, Spain, ²Lucta SA, Barcelona, Spain.

The choice of a protein source for piglet diets is mainly driven by their nutritive value. However, the palatability of these proteins may also

play an important role in feed intake and weight gain. The palatability of different protein sources in piglet diets was studied using a double choice preference test (two trials of 36 pens; 4 animals/pen) in which a reference basal diet (REF) with 20% of a soy protein product low in anti-nutritional factors (56% CP) was used. Each pen was offered free access to two different diets in two feeders: either the REF diet or

the diet containing the protein source to be tested. The protein sources were included in the diets at 5, 10 and 20% of inclusion by replacing the soy protein product from the REF diet and these were presented in mash form. In each trial a double control test (REF vs. REF) was included. The inclusion levels of 5, 10 and 20% were tested in three consecutive 4 d periods, respectively. Each protein source preference (relative to the reference diet) was calculated as the percentage contribution of the test diet to total feed intake. The preference values were analyzed taking into account the effects of protein source, level of inclusion and their interaction. At 5% of inclusion, the preferences (% of total feed intake) observed were: digestible porcine peptides (DPP), 76^a; fishmeal (FM), 72^a; REF, 45^b; wheat gluten (WG), 40^b; soybean meal concentrate (SBM), 18^c and potato protein (PP), 9^c. At 10% of inclusion the preferences were: FM, 72^a; DPP, 61^{ab}; REF, 47^b; WG, 39^b; SBM, 15^c and PP, 9^c. Finally, at 20% of inclusion the preferences were: FM: 66^a, REF: 50^b, SBM: 33^c, DPP: 32^c, WG: 32^c and PP: 3^d. Values with different superscripts were significantly different ($P < 0.05$); pooled SEM=6.3. In conclusion, protein source and inclusion level affect the palatability of diets for piglets. Amongst the products tested, fishmeal consistently had the highest palatability values across the three inclusion levels and potato protein had the lowest.

Key Words: Piglet palatability, Diet preference, Protein sources

T255 Estimation of the ideal ratio of threonine:lysine in diets for growing pigs weighing 30-60 kg. I. Moreira^{*1}, D. Paiano¹, P. L. O. Carvalho¹, A. R. Poveda Parra¹, A. R. B. Quadros², and L. S. Perdigão¹, ¹Universidade Estadual de Maringá, Maringá, Paraná, Brazil, ²Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil.

This study was carried out to evaluate the effects of threonine:lysine ratio (Thr:Lys) for growing pigs. Forty crossbred pigs (20 barrows and 20 gilts) with initial an weight of 30.1±1.8 kg were used. Pigs were housed in individual pens (4m²) and had ad libitum access to one nipple waterer and a one-hole feeder. Pigs were allotted to one of five dietary treatments in a randomized complete block design with eight replicate pens per treatment. A corn-soybean meal diet was formulated according to the ideal protein concept, to meet NRC – 1998 requirements (3.4 Mcal DE/kg; 14.7% CP; 0.81% true digestible lysine; 0.55% Ca and 0.39% P). Additional synthetic amino acids were supplied as necessary to meet intended Thr:Lys ratios (0.574; 0.624; 0.672; 0.722; 0.772). Data were analyzed by polynomial regression using Thr:Lys as an independent variable. Thr:Lys had no effect on feed intake, daily weight gain, feed:gain ratio and PUN. However, backfat thickness decreased linearly with increasing Thr:Lys. These data indicate that the ideal ratio of Thr:Lys for growing pigs (30–60 kg BW) is as high as 0.772.

Key Words: Amino acid, Backfat thickness, Ideal protein

T256 Estimation of the ideal ratio of threonine:lysine in diets for finishing pigs weighing 60-90 kg. I. Moreira^{*}, D. Paiano, A. C. Furlan, P. L. O. Carvalho, C. Scherer, and N. Silvestrini, *Universidade Estadual de Maringá, Maringá, Paraná, Brazil.*

An experiment was conducted to evaluate the effects of threonine:lysine ratio (Thr:Lys) for finishing pigs. Forty crossbred pigs (20 barrows and 20 gilts) with an initial weight of 60.7±4.7 kg were used. Pigs

were housed in individual pens (4m²) and had ad libitum access to one nipple waterer and a one-hole feeder. Pigs were allotted to one of five dietary treatments in a randomized complete block design with eight replicate pens per treatment. A corn-soybean meal diet was formulated according to the ideal protein concept, to meet NRC–1998 requirements (3.4 Mcal DE/kg; 12.5% CP; 0.68% true digestible lysine; 0.49% Ca and 0.33% P). Additional synthetic amino acids were supplied as necessary to meet intended Thr:Lys ratios (0.574; 0.624; 0.672; 0.722; 0.772). Data were analyzed by polynomial regression having Thr:Lys as the independent variable. There were no effects of Thr:Lys rations on feed intake, daily weight gain, feed:gain ratio, PUN and carcass traits. Liver weight increased linearly with increasing Thr:Lys. The results suggest that for better lean meat accretion, finishing (60–90 kg BW) pigs should be fed on diets with 0.722 Thr:Lys ratio.

Key Words: Amino acid, Carcass traits, Ideal protein

T257 Nucleotide supplementation enhances piglet performance. S. Tibble^{*1}, P. Köppel², and T. van Kempen³, ¹SCA Iberica, Spain, ²Chemoforma Ltd., Switzerland, ³Provimi RTC, Belgium.

Nucleotides play several key roles in metabolism. They are the building blocks of RNA and DNA, intermediates in and regulators of energy metabolism, and co-factors for enzymes. The objective of this research was to determine if supplemental nucleotides enhanced performance of nursery piglets. Piglets (n=1280) weaned at 21 d of age were blocked into weight categories of 5, 6, and 7 kg and housed 12 per pen. Pens were assigned using a RCB design to diets containing 0 (control), 0.05%, 0.1%, 0.2%, and 0.4% nucleotides (Ascogen from Chemoforma). Piglets were fed high quality high zinc diets manufactured by SCA Iberica. Data were analyzed using analysis of variance, and treatment means were used to model the dose response using quadratic regression. ADG and G/F was significantly improved in all periods at 0.20% nucleotides. ADFI was only significantly improved in period 1 (Table). The results of the dose-response analysis showed that nucleotide supplementation improved ADG by 18.7, 6.3, and 6.3% at an optimum dose of 0.23, 0.21, and 0.21%, in period 1, 2, and 3, respectively. In line with the results of the ANOVA, the feed intake response was less consistent, with an increase in feed intake in period 1 by 7.7% at a dose of 0.23%. G/F was improved by 10.4, 10.6, and 10.4 at doses of 0.25, 0.25, and 0.21% nucleotides in periods 1, 2, and 3, respectively. Overall, these data demonstrate that the optimum dose for nucleotides in order to optimize daily gain and gain/feed is 0.20 to 0.25%. The response for feed intake was variable and less strong.

Table 1.

Dose, %	ADG, g/d			FI, g/d			G/F		
	d0-11	d11-26	d26-68	d0-11	d11-26	d26-68	d0-11	d11-26	d26-28
0	127	363	543	137	438	961	0.92	0.83	0.56
0.05	138	371	559	142	437	954	0.98	0.85	0.59
0.10	143	378	567	146	427	940	0.98	0.89	0.60
0.20	151	386	577	147	424	934	1.02	0.91	0.62
0.40	140	367	550	142	418	961	0.99	0.88	0.57
P	0.00	0.00	0.00	0.00	0.20	0.15	0.24	0.00	0.00

Key Words: Piglet, Nucleotides

T258 Palatability of diets with different oil and fat sources in piglets. D. Solà-Oriol¹, E. Roura^{*2}, and D. Torrallardona¹, ¹IRTA-Centre de Mas Bové, Reus, Spain, ²Lucta SA, Barcelona, Spain.

Oils and fats are used in piglet diets mainly as a source of energy. However, they may also affect palatability and play an important role in feed intake and weight gain. The palatability of different sources of fat and oil in piglet diets was studied in two trials of 36 pens (4 animals/pen) using a double choice preference test in which a reference basal diet (REF) with sunflower oil was used. Each pen was offered free access to two different diets in two feeders: either the REF diet or the diet containing the fat or oil source to be tested (TEST). The oil and fat sources tested were included in the TEST diets at 1.5, 3 and 10% of inclusion by replacing the same amount of sunflower oil from the REF diet and these were presented in mash form. In each trial a double control test (REF vs. REF) was included. The TEST diets were studied in three consecutive 4d periods, from the lowest to the highest level of inclusion. Each fat or oil preference (relative to the reference diet) was calculated as the percentage contribution of the TEST diet to total feed intake. The preference values were analyzed taking into account the effects of fat or oil source, level of inclusion and their interaction. REF diet included 3, 3 and 10 % sunflower oil in the first, second and third periods, respectively. At 1.5% of inclusion, the preferences (% of total feed intake) were: fish oil: 54, REF: 54, palm oil: 53, soybean oil: 52, coconut oil: 45, linseed oil: 40 and lard: 40. At 3% of inclusion, the preferences were: palm oil: 69^a, fish oil: 56^{ab}, REF: 56^{ab}, coconut oil: 53^b, soybean oil: 49^b, lard: 46^b and linseed oil: 26^c. Finally, at 10% of inclusion the preferences were: coconut oil: 57^a, REF: 53^a, fish oil: 51^a, lard: 50^{ab}, palm oil: 43^{ab}, soybean oil: 38^b and linseed oil: 34^b. Values with different superscripts are significantly different ($P < 0.05$); pooled SEM=5.5. In conclusion oil or fat source affects the palatability of diets for piglets and linseed oil had the lowest palatability, particularly at 3 and 10% inclusion.

Key Words: Piglet palatability, Diet preference, Oil and fat sources

T259 Effect of inclusion of sweet potato (*Ipomoea batatas* L) meal on weight gain and dressing percentage of finishing pigs. S. Pietrosevoli^{*}, O. Moron, A. Paez, C. Chirinos, and A. Marrugo, *La Universidad del Zulia, Maracaibo, Zulia, Venezuela.*

The objective of this study was to assess the effect of including sweet potato meal (foliage [F] and root [R]) on the weight gain and dressing percentage of growing pigs. Eighteen female and castrated males (1:1) Duroc × Landrace pigs (62 ± 3.9 kg), were balanced across 3 treatments in a completely randomized design: **T1**, 100 % commercial concentrate (CC); **T2**, 60 % CC, 30 % F and 10 % R; **T3**, 50 % CC, 40 % F and 10 % R. Pigs had *ad libitum* access to feed and body weight was monitored weekly until they reached a final weight of 90 ± 5 kg. Pigs of **T1** reached final weight 2 weeks earlier than those of **T2** and **T3**. Daily weight gain, hot carcass weight, and dressing percentage differed ($P \leq 0.01$), whereas no difference was observed for the other variables. Including sweet potato meal into diets of finishing pigs negatively affected daily weight gain, hot carcass weight and dressing percentage.

Table I. Performance of finishing pigs feed with sweet potatoes meal.

	TREATMENTS		
	T1	T2	T3
Initial weight, kg	64.27 ± 1.96	61.63 ± 1.70	60.10 ± 1.52
Final weight, kg	93.60 ± 1.82	86.0 ± 4.01	85.20 ± 2.14
Daily gain, kg	0.84 ± 0.04a	0.55 ± 0.04b	0.51 ± 0.04b
Hot Carcass weight, kg	67.0 ± 2.4a	59.8 ± 1.9b	58.4 ± 1.9b
Dressing percentage, %	53.9 ± 5.1a	67.5 ± 4.2b	66.8 ± 4.2b

a,b: Within a row differ ($p < 0, 05$)

Key Words: *Ipomoea batatas*, Pig, Growth

T260 Effects of in-feed anti-salmonella egg yolk antibodies on growth performance and health status in weaned pigs challenged with *Salmonella* Typhimurium. S. Rattanabattimong^{*}, A. Mathew, A. Saxton, S. Chattin, E. Jarboe, and R. Clift, *University of Tennessee, Knoxville.*

An experiment was conducted to determine effects of anti-salmonella egg yolk antibodies (ASEYA) on the growth performance, rectal temperatures and immunological indicators prior to and following *Salmonella enterica* Typhimurium challenge. In two replicate trials, weaned pigs (n=132) were randomly assigned to six dietary treatments, including a control diet without additives or similar diets containing apramycin followed by carbadox, or oxytetracycline, or egg yolk powder containing ASEYA, or egg yolk powder lacking ASEYA, or spray dried plasma protein. Pigs were challenged with *S. Typhimurium* seven days following initiation of dietary treatments. Blood samples were collected, weights were recorded, and rectal temperatures were measured prior to initiation of dietary treatments (day 0), just before challenge (day 7), and on days 8, 12, 14, 21, and 28 of the experiment. Blood was analyzed for white blood cell (WBC) counts and serum was analyzed for anti-salmonella antibody and interleukin-1β (IL-1β) concentrations. Weight gains did not differ between treatment groups over the course of the study. Rectal temperatures also did not differ between treatment groups; however, pigs in all groups had higher rectal temperatures 24 h after challenge ($P < 0.001$) and had decreasing rectal temperatures beginning on day 12. Concentrations of anti-salmonella antibodies and IL-1β in serum did not differ between treatment groups. Anti-salmonella antibody concentrations increased in all groups beginning on day 14 and continued to increase through day 28 ($P < 0.001$). Pigs fed diets containing antibiotics had lower WBC counts compared to other treatment groups ($P < 0.05$). This study indicates that in-feed addition of anti-salmonella egg yolk antibodies may not be effective in improving the performance or health status of pigs challenged with salmonella.

Key Words: Egg yolk antibodies, Salmonella, Swine

T261 Differential effects of three herbal feed additives on growth and gut microbiota of weanling piglets. T. Dorian^{*}, G. Sara, and S. Simone, *University of Milan, Milan, Italy.*

As the use of antibiotic growth promoters has been banned in Europe, research has focused on an effective replacement. One of the possible strategies towards this objective is the use of bioactive compounds from plants. The aim of the present study was to evaluate the differential effects of three plant extracts on growth and intestinal microbiota of

weanling piglets. Animals were divided into five groups of 28 piglets each and treated from 21 to 41 days of age as follows: CN (negative control, no additives); AB (positive control, 2 g/kg feed of apramycin and 1 g/kg feed of colystin); CO (2 g/kg of LM51228); GY (2 g/kg of LM53411); LO (2 g/kg of LM 54236). Individual weight was determined on d21, d29, d41, and d71 and feed intake was estimated at the end of the treatment period (d41). Fecal samples were collected on d29 and d41 and total bacterial count, *Escherichia coli*, *Enterococcus* spp., total coliforms, anaerobic bacteria, and *Lactobacillus* spp. were cultured in selective media. The average weight gain in the treatment period (21 to 41d) was greater in treated groups compared to the CN group: LO 2.76 kg (P<0.1), CO 3.39 kg (P<0.05), GY 3.52

kg (P<0.01), CN 2.58 kg (SE=0.23 kg). Average feed intake was also higher in these groups compared to CN, indicating that the tested substances did not negatively affect palatability of feed. Microbiological evaluations on fecal samples showed a lower value for *E. coli* in LO (P<0.01) and CO groups (P<0.05) and a lower value of *Enterococcus* spp. in both LO and CO groups (P<0.01) compared to the CN group. In conclusion the tested plant extracts can contribute to improve growth performance and control intestinal microbiota, having a potential as new feed additives for weanling piglets.

The support of Indena S.p.A. is gratefully acknowledged.

Key Words: Plant extract, Feed additives, Weanling piglet

Tuesday, July 11, 2006

SYMPOSIA AND ORAL SESSIONS

Bioethics: Teaching Animal Ethics Within Today's Animal Science Curriculum

245 Teaching bioethics in the animal sciences: Challenges and strategies. C. C. Croney*¹ and D. J. R. Cherney², ¹*Oregon State University, Corvallis*, ²*Cornell University, Ithaca, NY*.

As critics and the consuming public increasingly scrutinize the efforts of Animal Scientists, the need to incorporate ethics education into the traditional Animal Sciences curriculum is growing. Efforts to meet this goal have been both promising and problematic. Many animal scientists, engaged in debate about ethical animal use and treatment often respond inappropriately—with off-hand self-justification, rationalizing and dogmatism. Such responses may be a reflection of the limitations of Animal Sciences students and faculty in regards to their academic training and expertise in animal bioethics. Most of our faculty lack formal education in moral philosophy, so it can be difficult to avoid adopting and teaching an overly simplistic problem-solving approach to complex ethical questions. Some faculty are now adapting pedagogical tools used by social scientists to develop useful in-house strategies to overcome the challenges of teaching bioethics in Animal Sciences. Role-playing, moral reasoning and analyses of carefully constructed case studies are only a few of the tools that can be implemented to facilitate these efforts.

Key Words: Bioethics, Teaching, Curriculum development

246 Incorporating ethics into the undergraduate curriculum. D. J. R. Cherney*¹ and C. C. Croney², ¹*Cornell University, Ithaca, NY*, ²*Oregon State University, Corvallis*.

Ethical issues such as animal welfare, rural community issues, environmental concerns, and genetic engineering have garnered front page headlines in recent years. If animal production systems are to be part of the future, animal scientists must join with society to solve these ethical issues. Traditional animal science curricula did not include methods to deal with these issues, but getting ethics into our curricula is imperative. For many of our undergraduate students, who by nurture or nature tend to think empirically, discussion of ethics is difficult. Many have gone through their entire college career without having to argue a position or express an opinion; and are uncomfortable with the idea of having to do so. It can be a challenge to fit ethics smoothly into our curriculums and to draw our students into meaningful discussions involving ethics. Couple this with some faculty who believe that their work is value-free and amoral, and that they are not responsible for the consequences resulting from their work, and the task can be daunting. Fortunately, many animal science departments are now moving towards incorporating ethical issue classes into the curriculum and there are more resources for those willing to take on the challenge.

Key Words: Bioethics, Education

247 A successful model for teaching ethics to animal science students. J. Tannenbaum*, *University of California, Davis*.

At the University of California at Davis, undergraduates who major in animal science and animal biotechnology are required to complete the author's upper division course in animal ethics. The course reflects a general approach that the author will argue can guarantee a successful and useful educational experience. The course is team-taught by an animal scientist and an ethicist. This enables the course to present and reinforce the fundamental principle that consideration of ethical issues relating to animal science requires an interweaving of empirical knowledge and information with ethical concepts and theory. The course begins with treatment of leading ethical theories in animal ethics. In this part of the course, students are required to read primary philosophical and religious texts that have influenced contemporary ethical attitudes towards animals. The next segment of the course considers topics in animal science essential to the consideration of issues in animal ethics, including animal sentience, animal pain, animal welfare, and environmental enrichment. The final section of the course combines ethical theory and empirical knowledge by focusing on four areas of special interest in animal science: animal agriculture, the use of animals in biomedical research, companion animals, and wild animals and the environment. These four areas are covered by the course leaders, as well as by animal scientists and veterinarians who demonstrate how scientists and those who care for animals in various contexts face ethical issues in their daily work. The course stresses critical thinking and writing skills. Students consider cases and problems relevant to the lectures in weekly discussion sections. They are required to do a substantial amount of writing in which they present and defend ethical positions relevant to important issues in animal science. This presentation will make specific suggestions about how to construct a successful course in animal ethics that animal science students will enjoy and can be required to take. The presentation will also suggest how existing courses might be improved.

Key Words: Ethics courses, Animal ethics, Teaching ethics

248 Animal welfare, bio-ethics and animal sciences. E. A. Pajor*, *Purdue University, West Lafayette, IN*.

Animal science students require a better understanding of how ethics plays a role in research, teaching, and extension activities. Teaching animal welfare within traditional animal science departments provides such an opportunity. Animal welfare is a unique subject area that combines objective scientific measures and ethics. Recent developments in animal agriculture are requiring that animal science departments develop a formal understanding of animal ethics and social values. One such development is the implementation of animal welfare standards

and audits. Another development is the fundamental change in the economic structure of how food is sold, the change from a push to a pull economy. Animal welfare and associated issues provide a valuable

framework for ethical discussion and the possibility of teaching collaborations with social scientists.

Key Words: Animal welfare, Ethics, Teaching

Breeding and Genetics: Dairy Breeds

249 Crossbreds of Normande/Holstein, Montbeliarde/Holstein, and Scandinavian Red/Holstein compared to pure Holsteins for reproduction and survival. B. J. Heins, L. B. Hansen*, and A. J. Seykora, *University of Minnesota, St. Paul.*

Normande/Holstein, Montbeliarde/Holstein, and Scandinavian Red/Holstein crossbreds were compared to pure Holsteins for reproduction and survival. Cows were in 7 commercial dairies in California. Daughters of Normande, Montbeliarde, and Scandinavian Red sires were from imported semen. Holsteins were required to have a recorded sire with an NAAB code to assure they were sired by A.I. sires. For days open, cows were required to be at least 250 days in milk and those with greater than 250 days open were truncated to 250 days. Least squares means for days to first breeding were 69 for Holsteins, 62 for Normande/Holstein, 65 for Montbeliarde/Holstein, and 66 for Scandinavian Red/Holstein crossbreds, and differences were significantly different than pure Holsteins for Normande/Holstein and Montbeliarde/Holstein crossbreds. First service conception rates were 22% for Holsteins, 35% for Normande/Holstein, 31% for Montbeliarde/Holstein, and 30% for Scandinavian Red/Holstein crossbreds and, again, differences from Holstein were significant for the Normande/Holstein and Montbeliarde/Holstein crossbreds. Least squares means for days open were 150 for pure Holsteins, 123 for Normande/Holstein, 131 for Montbeliarde/Holstein, and 129 for Scandinavian Red/Holstein crossbreds, and all three crossbred groups had significantly fewer days open than pure Holsteins. Crossbreds surpassed pure Holsteins for survival for any reason to 30-d, 150-d, and 305-d postpartum during first lactation and for percentage with a second lactation.

Key Words: Crossbreeding, Heterosis, Reproduction

250 Crossbreds of Jersey/Holstein compared to pure Holsteins for body weight, dry matter intake, feed efficiency, and body condition score. B. J. Heins, L. B. Hansen, A. J. Seykora*, A. R. Hazel, J. G. Linn, M. L. Raeth-Knight, and W. P. Hansen, *University of Minnesota, St. Paul.*

Jersey/Holstein crossbreds (n = 24) were compared to pure Holsteins (n = 19) for body weight (BW), dry matter intake (DMI), feed efficiency, and body condition score (BCS) during first lactation. Cows were housed in the University of Minnesota research facility at the St. Paul campus and calved from September 2004 to January 2005. Jersey/Holstein crossbreds and pure Holsteins were sired by 6 Jersey and 6 Holstein AI bulls selected for Net Merit. Pure Holsteins were taller (141.1 vs 134.2 cm) and had larger heart girths (187.5 vs 180.6 cm) than Jersey/Holstein crossbreds at calving. Cows were individually fed a TMR twice daily, and feed was mixed with a drum mixer. Feed weighbacks were collected once daily and cows were weighed bi-weekly. Milk production was recorded daily and milk composition was from monthly DHI. Best Prediction was used to calculate actual

production (fat plus protein) for each cow for the first 150 d of first lactation. Fat plus protein production was 308 kg for Jersey/Holstein crossbreds and 309 kg for Holsteins. Ratio of fat plus protein production (kg) divided by DMI (kg) for the first 150 d of lactation was 0.11 for both Jersey/Holstein crossbreds and Holsteins. Body weights and body condition scores were recorded once every two weeks from 1 to 26 weeks postpartum. Independent variables were breed, random effect of cow within breed, week postpartum within breed, month of calving, and age at calving (linear, mo). Statistical analysis was performed for the first two weeks and 1 to 26 weeks. Holstein cows had significantly higher BW and significantly lower BCS than Jersey/Holstein crossbreds. There were no differences in DMI between Jersey/Holstein crossbreds and pure Holsteins.

Table 1.

Breed	1 st two weeks	1 to 26 weeks	BCS
	BW (kg)	DMI (kg/d)	
Holstein	516.0	11.6	2.97
	508.0	19.1	2.80
Crossbred	472.7	11.5	3.14
	471.7	19.0	2.92

Key Words: Crossbreeding, Feed efficiency, Body condition score

251 Crossbreds of Jersey/Holstein compared to pure Holsteins for production, calving difficulty, stillbirths, and fertility. B. J. Heins, L. B. Hansen, A. J. Seykora, A. R. Hazel*, J. G. Linn, D. G. Johnson, and W. P. Hansen, *University of Minnesota, St. Paul.*

Jersey/Holstein crossbreds (n = 77) were compared to pure Holsteins (n = 72) for 305-d milk, fat, and protein production, calving difficulty, stillbirths, days to first breeding, first service conception rate, and days open during first lactation. Cows were housed at two University of Minnesota research facilities and calved from September 2003 to May 2005. Jersey/Holstein crossbreds were bred to Montbeliarde sires, and Holstein cows were bred to Holstein sires. Best Prediction was used to calculate actual production (milk, fat, and protein) for 305-d lactations. Adjustment was made for age at calving and herd-year and records less than 305 d were projected to 305 d. Jersey/Holstein crossbreds (258 kg) and pure Holsteins (259 kg) were not significantly different for fat production, but pure Holsteins had significantly higher milk (7266 vs 6693 kg) and protein (229 vs 214 kg) production than Jersey/Holstein crossbreds. For fat plus protein production, the Jersey/Holstein crossbreds (471 kg) and pure Holsteins (488 kg) were not significantly different. Calving difficulty scores were 1, 2, 3 (no difficulty) and 4, 5 (calving difficulty), and stillbirths were 1 (alive) and 0 (dead) within 24 hr of birth. Age at calving, herd-year, sex of calf, and breed were

included in the statistical model. Calving difficulty and stillbirth rates did not differ significantly for the Jersey/Holstein crossbreds versus pure Holsteins. Jersey/Holstein crossbreds (78 d) had significantly fewer days to first breeding than pure Holsteins (88 d). Least squares means for days open were 139 for Jersey/Holstein crossbreds and 155 for pure Holsteins.

Key Words: Crossbreeding, Heterosis, Production

252 Crossbreds of Normande/Holstein, Montbeliarde/Holstein, and Scandinavian Red/Holstein compared to pure Holsteins for 305-d production. B. J. Heins*, L. B. Hansen, and A. J. Seykora, *University of Minnesota, St. Paul.*

Normande/Holstein crossbreds (n = 245), Montbeliarde/Holstein crossbreds (n = 494), and Scandinavian Red/Holstein crossbreds (n = 328) were compared to pure Holsteins (n = 380) for 305-d milk, fat, and protein production during first lactation. Cows were housed in seven commercial dairies in California and calved from June 2002 to January 2005. All Holstein sires and Holstein maternal grandsires of all cows were required to have a code assigned by the National Association of Animal Breeders to assure they were sired by AI bulls. Daughters of Normande, Montbeliarde, and Scandinavian Red sires were from imported semen. Scandinavian Red was a mixture of Swedish Red and Norwegian Red. Best Prediction was used to calculate actual production (milk, fat, and protein) for 305-d lactations. Adjustment was made for age at calving and milking frequency, and records less than 305 d were projected to 305 d. Herd-year-season (4-month seasons within the seven herds) and the genetic level of Holstein maternal grandsire (linear) were included in the model for statistical analysis. Pure Holsteins had significantly higher milk (9757 kg), fat (346 kg), and protein (305 kg) than all crossbreds except Scandinavian Red/Holstein crossbreds (340 kg) were not significantly different than pure Holsteins for fat production. Fat plus protein production was used to gauge the overall productivity of pure Holsteins versus crossbreds. The Scandinavian Red/Holstein (637 kg) crossbreds were not significantly different from the pure Holstein (651 kg) for fat plus protein production; however, the Normande/Holstein (596 kg) and the Montbeliarde/Holstein crossbreds (627 kg) had significantly lower fat plus protein production than pure Holsteins.

Key Words: Crossbreeding, Heterosis, Production

253 Economic efficiency and genetic improvement of alternative breeding schemes for Taiwan dairy cattle population. C. L. Chang*¹ and I. L. Mao², ¹*Hsin-chu Branch, COA-LRI, Hsin-chu, Taiwan, ROC*, ²*Michigan State University, East Lansing.*

Seven practical alternative breeding schemes were designed and the economic efficiency and genetic improvement would be compared with that of Current Breeding Scheme (CBS) to determine an optimum schemes for Taiwan dairy cattle population. CBS included 20% of cows were bred by natural service (NS) bulls, 20% were bred by untested selected AI bulls, and 60% were bred by imported semen from progeny test proven AI bulls. Proposed alternative breeding schemes included the use of bulls from progeny test for AI services (PT/AI), the use of bulls with high pedigree merit but untested for AI and natural services (untLB/AI/NS), the use of a MOET nucleus population to produce AI and NS bulls (MOET/AI/NS), the use of imported semen from the top 40% (FS40) or top 20% (FS20) U.S. proven bulls to breed local cows, the use of embryos to produce untested AI bulls (untFEB), or to produce AI bulls by paternal half-sib performance

(STFEB). Deterministic models were used to estimate the genetic gain and economic efficiency for each of the consecutive 25 years considering the genetic difference between the U.S. and the target population and the effect of genotype by environment interaction. The breeding schemes were ranked in descending order by genetic gain as STFEB, untFEB, MOET/AI/NS, FS20, FS40, untLB/AI/NS, and PT/AI. All breeding schemes surpassed the genetic gain by the current breeding scheme (CBS), except PT/AI, by 35%, 29%, 23%, 17%, 12%, and 5%, respectively. Yet the ranking of the designed breeding schemes based on their economic efficiency was different from that based on their rates of genetic progress. The use of imported embryos to produce AI bulls tested by half-sib performance (STFEB) was the optimum scheme in terms of economic efficiency and the rate of genetic progress.

Key Words: Economic profit, Genetic gain, Alternative breeding schemes

254 Genetic parameters of monthly test day milk yields in Iranian buffaloes. H. Farhangfar*¹ and J. Rahmaniya², ¹*Birjand University, Birjand, Iran*, ²*Zabol University, Zabol, Iran.*

A total of 7315 monthly test day milk yields at first lactation from 1123 Iranian buffaloes distributed in 381 herds and which calved from 1993 to 2005 were used to estimate genetic parameters. A covariance function which consisted of orthogonal legendre polynomials of 5th order was applied to model monthly test day milk yields of individual animals at two genetic (1423 levels) and permanent environment effects (1123 levels). In the model, environmental fixed effects of herd, year and month of recording, milktimes, as well as age of animals at the time of recording were included. The results obtained at the present research showed that heritability of monthly test day milk yields initially decreased from the beginning of lactation towards the middle of the lactation and after that it increased towards the end of the lactation. The heritability estimates ranged from 0.17 (at month 5) to 0.78 (at month 10). Genetic correlations between adjacent monthly test days were mostly greater than 0.7 and decreased as the interval between test days increased. Permanent environmental correlations among test day milk yields were positive and showed the same pattern observed for the genetic correlations.

Key Words: Genetic parameters, Monthly test day milk yield, Iranian buffaloes

255 Revised estimates of lifetime net merit for dairy breeds and breed crosses. P. M. VanRaden and M. E. Tooker*, *Animal Improvement Programs Laboratory, USDA, Beltsville, MD.*

Dairy breeds and breed crosses were compared using updated net merit (NM), cheese merit (CM), and fluid merit (FM) formulas that include calving ease and daughter pregnancy rate (DPR). National data for milk, fat, protein, productive life, somatic cell score, and DPR were each evaluated using an all-breed animal model. New estimates of breed differences were compared to phenotypic breed differences and to previous estimates from studies that only included herds containing crossbred cows. Estimates of general heterosis from previous studies were used in the current research and not re-estimated. New estimates of breed effects were generally intermediate between the previous estimates and the phenotypic breed differences; all three estimates were similar. For calving ease, percentages of difficult births in first parity (%DBH) were estimated to be 7.9% for over 3.5 million Holstein (HO), 0.8% for 22,318 Jersey (JE), 4.7% for 5,909 Brown Swiss (BS),

3.3% for 1,418 Guernsey, 4.4% for 520 Ayrshire and 7.8% for 205 Milking Shorthorn. First generation crosses of JE x HO exceeded HO by \$22 for NM and by \$123 for CM, and BS x HO crosses exceeded HO by \$32 for NM and by \$102 for CM. All comparisons were at the genetic base of zero for each breed, and no crossbreds exceeded HO for FM. For later generations, backcrosses to HO are preferred for NM, whereas for CM, three-breed crosses may provide profit equal to HO backcrosses. Economic values were from 2003 and included relative emphasis of 33% on protein, 22% on fat, 11% on productive life, 9% against somatic cell score, 7% on daughter pregnancy rate, 7% on udder composite, 4% on feet and leg composite, 4% on calving ease, and 3% against body size composite. Economic values may need revision again during 2006 to account for a new definition of productive life, a new evaluation of calf livability, higher prices for butterfat relative to protein, and higher replacement heifer costs. Routine updates of economic values and breed differences can help producers to manage crossbreeding programs.

Key Words: Genetic evaluations, Net merit, Crossbreeding

256 A survey of Australian dairyfarmers to establish farmer attitudes to crossbreeding. M. F. Pyman* and K. L. Macmillan, *University of Melbourne, Werribee, Victoria, Australia.*

A survey in 2004 documented the experiences and attitudes of Australian dairyfarmers to crossbreeding, complimenting the data gathered in Victorian dairy herds comparing the performance of crossbred cows with their straightbred herd mates in terms of health, production and reproduction. The information was recorded to establish whether farmers believed there were advantages to be gained from crossbreeding in terms of sustainability, profitability, ease of management and flexibility of the breeding process. Three focus group meetings were conducted to discuss the advantages and disadvantages of Jersey Holstein crossbreds versus straightbred Holstein cows, the reasons for selecting a particular breed type, how and where breeding information was sought and what other economic data might be required to demonstrate the advantage of one breed over another. The focus group material was used to develop a 10 minute telephone questionnaire in which 201 random computer assisted telephone interviews were conducted. Response rate was high (83%) with most respondents (91%) having had some personal experience with Jersey Holstein crossbred cows even though less than 4% had crossbred cows as their principle breed type. The major perceived advantages of Holsteins were high production (78%), size (33%), sale value (31%) and good temperament (25%). Crossbreds were seen to have the advantage of high components (73%), smaller size (39%), hybrid vigour (23%) and better fertility (18%). Although high proportions of farmers noted the individual benefits that accrued from milking crossbreds, most indicated they would not be prepared to alter the composition of their herd to improve profitability, herd conception rates or herd management. Their attitudes related to the uncertainty of a breeding program after the first cross, a perceived stigma associated with small, uneven crossbred cows and the superior economic value of a purebred herd.

Key Words: Crossbreeding, Herd management, Herd composition

257 A comparative study of the reproductive performance of Holstein and Jersey Holstein first cross cows in 15 Australian dairy herds. M. F. Pyman*, G. A. Anderson, and K. L. Macmillan, *University of Melbourne, Werribee, Victoria, Australia.*

The reproductive performance of first cross (F1) Jersey Holstein crossbred cows was compared to Holstein cows in 15 dairy herds as part of a larger study of crossbreeding in the Australian dairy industry. The objective of the industry funded study is to assess the profitability and sustainability of crossbreeding for seasonally calving dairy farms. Data were collected over a single lactation in 2003/2004 from 5,086 cows including 3,053 Holsteins and 821 F1 Jersey Holstein cows, ranging in age from 2 years to 16 years. The first service conception rate to artificial insemination however was based on 2,661 Holsteins and 728 F1 crossbred cows. Each herd was pasture-based and seasonally calving and located in Victoria, the major dairying state in Australia. Seasonality in Australia implies that herds should have an average calving interval close to 365 days with peak calving coinciding with peak grass growth and availability of pasture in Spring and Autumn. Farm profitability is therefore closely linked to the reproductive performance of the herd as reflected in the compactness of the calving pattern. Significant differences were found in the first service conception rate to AI (CR1; 55% vs 45%; $P < 0.001$), pregnancy rate after 42 days of breeding (PR6W; 63% vs 52%; $P < 0.001$), pregnancy rate after 14 weeks of breeding (PR14W; 80% vs 72%; $P < 0.001$) and the not pregnant rate at the end of 21 weeks of breeding (NIC; 18% vs 25%; $P < 0.001$) for the Jersey Holstein crossbreds compared to the Holsteins after the least squares means for these parameters were adjusted for herd, age and the interval from calving to the start of mating. The results suggest that crossbreeding can improve the reproductive performance of the herd where a twelve month calving interval is desired, particularly in temperate climates with grazing cows on pasture-based diets.

Key Words: Seasonal calving, Crossbreeding, Reproductive performance

258 Weights and hip heights for Holstein, Jersey and their reciprocal crosses in the Virginia Tech crossbreeding project. K. M. Olson*, B. G. Cassell, D. R. Winston, and J. A. D. R. N. Appahamy, *Virginia Polytechnic Institute and State University, Blacksburg.*

Heifers from the crosses of the Holstein and Jersey breeds were first born starting in June 2003 at Virginia Tech. Four Holstein and four Jersey bulls were used as foundation sires with matings to purebred dams. Weight and hip height data through late 2005 included 112 heifers with each having records for at least two months. Weights and hip heights were adjusted to a constant age (CA) at each month (birth to 23 months). A mixed model using repeated records was used to analyze weights and hip heights separately. Effects in the model included year-season, breed group with sire listed first [HH (n=39), HJ (n=30), JH (n=23), JJ (n=20)], dam parity (1, 2, 3 and later), breed by parity interaction, twin status and breed by CA interaction. Significant effects for monthly weights included breed group, breed by CA at weight, year-season and dam parity. Significant effects for hip heights were breed group, breed by CA at height and year-season. Least square means (LSM) for 3 months, 12 months and 18 months for weights and hip heights are presented in table 1. Visual inspection of breed group means by age suggests a positive heterosis for weight (untested).

Table 1. LSM for body weights and hip heights

	Body Weight (kg)			Hip Height (cm)		
	3	12	18	3	12	18
Month						
Breed						
HH ^a	103	318	475	98	129	139
HJ	93	304	420	93	123	132
JH	93	302	424	95	125	134
JJ	79	258	323	82	116	124

^aSire breed first followed by dam breed; H=Holstein; J=Jersey

Key Words: Crossbreeding, Body weight, Hip height

259 Genetic evaluation of milking speed for Brown Swiss dairy cattle. G. R. Wiggans^{*1}, L. L. M. Thornton¹, and R. R. Neitzel², ¹*Animal Improvement Programs Laboratory, Agricultural Research Service, Beltsville, MD,* ²*Brown Swiss Association, Beloit, WI.*

Genetic parameters and breeding values (EBV) were estimated for milking speed in Brown Swiss cattle. Owner recorded milking speed scores on a 1 to 8 scale (low to high) were collected by the Brown Swiss Association as part of its linear type appraisal program starting

in 2004. Data were 6,483 records on 6,017 cows in 352 herds. A total of 13,192 ancestors and seven unknown parent groups, each including four years of birth, also were included. The model included fixed effects for herd appraisal date, parity-stage of lactation, and random effects for permanent environment, animal and error. Four 90-day stages of lactation were defined. An Average Information REML variance estimation procedure produced heritability of 0.22 and repeatability of 0.41. The residual variance was 1.13. There was little trend in EBV of cows born 1999 through 2002. The 109 bulls with 10 or more daughters had a range in EBV of 2.7. Speed increased with stage of lactation for first parity cows by 0.37. There was not a clear trend in second parity, and in third and later parities, there was a drop of 0.20 from the first to the third 90-day period, then an increase of 0.10 in the last period. For the 109 bulls with 10 or more daughters, significant correlations between evaluations for milking speed and other traits were 0.22 for milk, 0.53 for productive life and -0.37 for somatic cell score. The association of faster milking speed with lower somatic cell score was not expected. The milking speed information can provide useful EBV given the moderate heritability. Similar data is being collected for Holsteins, so this evaluation system could be extended to that breed.

Key Words: Milking speed, Brown Swiss, Variance components

Companion Animals: Companion Animal Research: Contributions and Conflicts

260 Marrying science to society — hurdles for the use of companion animals in research. G. Golab^{*}, *American Veterinary Medical Association, Schaumburg, IL.*

Scientists and veterinarians are most comfortable when decisions about when and how to use animals in research involve a careful balance between the expected benefits of the knowledge gained and the potential costs to the animals and other stakeholders involved. This logical analysis is consistent with the methodical approach that scientists most often take when studying any complex problem. Not surprisingly, frustration results when carefully considered advice about what constitutes appropriate use and care appears to go unheeded. But why does such advice go unheeded? Because, rightly or wrongly, decisions about animal use always have been and are likely to continue to be decisions of public policy. Public policy has as much or more to do with attitudes, ethics, morals, perception and cultural norms as it has to do with scientific truth. The impact that science and scientists have on public policy depends on the degree of public trust that can be achieved. Establishing trust and dialog becomes even more critical when the species used are those with which large numbers of the public have special relationships in their own homes (i.e., companion animals). This presentation will focus on the factors influencing public understanding and trust of science and scientists. Scientific literacy and public engagement will be discussed as strategies to maximize the influence of science on animal welfare decision-making.

Key Words: Animal welfare, Public trust, Companion animal research

261 Conserving endangered wild felids – the invaluable domestic cat connection. W. F. Swanson^{*}, *Cincinnati Zoo's Center for Conservation and Research of Endangered Wildlife, Cincinnati, OH.*

Most of the world's 36 wild cat species are facing escalating threats to their future survival, primarily due to habitat loss and persistent poaching. America's most popular companion animal, the domestic cat, is playing a key role in ongoing efforts to conserve these endangered felid populations. Laboratory research with domestic cats has provided us with a broader understanding of general felid physiology, including reproduction, disease and stress susceptibility, and nutrition, which has contributed to improved exhibitry, diets and reproductive management of nondomestic felids. For example, basic studies with domestic cats have permitted the validation of urinary and fecal hormone analysis for assessment of reproductive cyclicity, seasonality, pregnancy and adrenocortical activity in nondomestic cats. Findings from fecal hormone monitoring have led to modifications in exhibitry and husbandry that serve to enhance captive propagation while minimizing captive stress. Similarly, systematic studies of in vivo embryogenesis and embryo metabolism in naturally-bred domestic cats have provided a normative database of early pregnancy that forms the basis for improving culture of in vitro-generated embryos and creation of offspring after embryo transfer in endangered felids. Applied studies in domestic cats also have investigated immune responses to exogenous gonadotropins and the cross-species fertilization of domestic cat oocytes in efforts to optimize the success of assisted reproductive procedures in nondomestic cats. Other ongoing studies are assessing the suitability of diets, formulated based on domestic cat requirements, for meeting the nutritional needs of nondomestic cats and conducting comparative assessments of the nutritional status of free-living animals consuming natural prey. In conclusion, the domestic cat continues to represent an invaluable research model and ally in our efforts to maintain, manage and conserve their nondomestic relatives – the wild felids. (NIH grant RR 15388)

Key Words: Conservation, Reproduction, Nutrition

262 Working Dog Challenges: The interplay between genetics, environment and training. P. Mundell*, *Canine Companions for Independence, Santa Rosa, CA.*

While dogs do not fall within the traditional agricultural focus of animal science, their ever growing role in modern life offers unique challenges and opportunities for the discipline. The rapid increase in economic importance of the pet industry in recent decades has obvious and well-understood significance. A more recent phenomenon, and one that is perhaps not as well appreciated, is the proliferation of both the number of dogs that are trained and placed into working roles and the types of tasks that these dogs are being asked to perform. In addition to the functions of livestock herding and guarding, finding game, and the other purposes for which dog breeds were originally developed, dogs are currently working with blind, deaf and physically disabled people, serving as narcotic and explosive detectors, patrolling with the police and military and detecting the presence of certain medical disorders such as cancer and diabetes. The many programs worldwide that employ dogs in these and other capacities face a wide variety of challenges to meet the demand for suitable and well-trained animals. After presenting an overview of some of the ways in which dogs are currently employed, the types of challenges common to working dog programs are explored, as are the approaches being adopted to address these challenges.

Key Words: Working dogs

263 Companion Animal Science: State of the discipline. G. Aldrich*¹, N. A. Irlbeck², and R. L. Kelley³, ¹*Pet Food & Ingredient Technology, Inc, Topeka, KS*, ²*Colorado State University, Fort Collins*, ³*The Iams Company, Lewisburg, OH.*

The U.S. pet industry has seen steady growth with sales of companion animal products of \$35.9 billion, \$14 billion from food alone, and

more than 140 million dogs, cats, and other pets. From an economic perspective, this segment is larger than the revenues of the more traditional animal science segments like sheep, goats, and horses combined. The demographics at the academic level have also changed from rural, male students interested in food animals to a majority of suburban, female students interested in small (companion) animals with aspirations for veterinary medicine. In response, some animal science departments have developed companion animal coursework. Companion animal research has made substantial advancements in the past decade. On the broader social level, research has begun to demonstrate the direct value of companion animals on human health by such things as stress reduction, human socialization, and even cancer detection. At the animal level, completion of the canine genome map, dedicated pet imaging centers, improved diagnostic tools, joint replacement, better therapeutic nutrition, species specific cell lines and molecular kits have all become a reality. While this truly marks great strides within the discipline, it is not without challenges. Each year there are over 330,000 dog bite incidents, with a loss of life for more than 300 people between 1979 and 1996. Each year more than 4.3 million pets are relinquished to animal shelters with most euthanized (63%). The scientific community within the discipline stands at a crossroads. Since there is very little direct public funding, most scientific advancements have occurred within closed industrial communities (food and pharmaceuticals), veterinary schools, breed associations, and service dog programs. Examples of collaboration are available, but not prevalent, and far too much research goes unpublished. To fill the gaps and remain relevant, Companion Animal Sciences must demonstrate the value of the discipline to the economy, its importance to society and public health, and demonstrate to prospective students that careers in companion animal science are worthy of pursuit.

Key Words: Companion Animals, Academia, Industry

Extension Education: Profitability of Dairy Farming in a Global Economy

264 Financial records for dairy farms from across the USA. W. T. Cunningham*, *Genske, Mulder & Company, LLP, Rancho Cucamongo, CA.*

Benchmarking within dairy production financial records is an important management tool. Information within and between states, regions, genetics, and herd size can be used to improve dairy profitability. Income and expense information will be provided for dairies that average over 1500 head milking that are located in the following states and geographic regions of the United States: Arizona, California (Southern, Central, and Northern), Idaho, Midwest, New Mexico, Texas (Central and Panhandle), and Washington. Information and analysis will also be provided separately for certain 'top 25%' performers and for Jersey cow operations. Key financial areas that will be discussed include sources of income, feed expenses, herd maintenance and replacement costs, and various other operating expenses such as financing, labor and veterinary. Limited production data will also be disclosed, with discussion of the correlation of production and profitability. The data presented is from the client records of Genske, Mulder & Co., and is from financial statements, prepared in accordance with Generally Accepted Accounting Principles, from approximately 250 dairies.

Key Words: Dairy production, Financial management

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265 Determinants of regional profitability on dairy farms. J. Miller*^{1,2}, ¹*USDA Economic Research Service, Washington, DC*, ²*Retired, Harrisonburg, VA.*

Relative profitability of dairy farms across regions depends on a number of natural and market factors, as well as the managerial ability of dairy farmers. Some of these factors are truly regional in nature, such as climate, forage production and markets, taxes, local fluid markets, and environmental sensitivity. Other factors are not really regional, although large regional differences may exist. These factors include farm size, dairy infrastructure, availability of human capital for dairy production, and a dairy friendly business climate. In all of these factors, local differences may be greater than regional differences.

Key Words: Dairy, Profitability, Region

266 Northeast Dairy Profitability. D. Rogers*, *First Pioneer Farm Credit, Enfield, CT.*

The Northeast Farm Credit ACA's publish an annual report on the Dairy Industry. For short, it is called the Book Book or Dairy Farm Summary. In 2004, 549 Dairy Farm financial records were compiled

on an accrual basis. Highlights include: 5 year trends showing the Dairy Profitability Cycles, farms split into profit quartiles to see what the top 25% do to make so much money, also are broken down into different size groups that show the impact of various herd sizes and costs are shown on a per cow and per cwt. basis. In this 30 minute presentation, we will cover the key factors that contribute to successful farms. Herd size, productivity, efficiency, cost control and internal herd growth (IHG). The average dairy farm return on assets (ROA) over the past 5 years has ranged from 1.9% to 7.5%. This is not very high for the risk involved. It is not financially wise to just be average. Dairy farmers today must step up their management intensity if they want to make progress. My one liner is "To have a quality of life, you have to run your farm as a business". The Northeast summary covers 9 of the 12 states that Hoards defines as the Northeast region. There are about 18,000 commercial dairy farms with New York, Pennsylvania and Vermont having the major dairy concentration. Almost all of the farms grow their own forages with a trend of smaller ones utilizing intensive grazing. The farms in our summary average 230 cows. The Region averages 80 cows per farm.

Key Words: Profitability, Dairy, Business

267 Profitability of pasture-based versus confinement dairy farming. G. Benson* and S. Washburn, *North Carolina State University, Raleigh.*

Purpose: To review and integrate existing information on the relative profitability and longer term viability of pasture-based dairy farming.

Evidence from several studies shows that profit margins for pasture-based farms are higher than for confinement farms. Most data are from north central and northeastern states. A recent study using 2000-2003 data showed an advantage in annual net farm income from operations for pasture-based farms of \$243 per cow in Wisconsin and \$210 per cow in New York. Compared to the confinement farms, the advantage to pasture-based farms is 64% and 92% higher, respectively. Data for other regions is limited but is supportive of the competitiveness of pasture-based dairy farms. Reliance on pasture and pasture management practices can vary widely and are seldom well defined in these studies. Data show wide variation in profitability among farms of a similar type, whether confinement or pasture based. Dairy farm numbers are declining, particularly small farms, and reported average sizes of pasture-based farms are small, although herds of > 300 cows exist. In the short run, the observed financial advantage enhances survival relative to similarly sized confinement farms. However, the income potential for any small dairy farm is limited and the trend in profit per cow is down, which is an obstacle for the long-run viability of some pasture-based farms. The distance milking cows can walk to pastures, acreage and farm layout affect herd expansion opportunities on a specific site. Some pasture-based dairies have options to add income by supplying a growing market for specialty products produced by methods valued by consumers. These include homestead cheese, farm bottled milk, pasture-raised, and certified organic. The transition to organic likely is simpler for pasture-based dairies because the pasture requirements are already in place and reported herd health problems are fewer. Well managed pasture-based dairies create fewer environmental impacts and are more likely to be socially acceptable, thereby reducing external threats to farm viability.

Key Words: Pasture-based dairy, Profitability

Food Safety: Ruminant and Nonruminant Foodborne Pathogens

268 Development of a cost-effective method to enumerate *Escherichia coli* O157 in cattle feces. J. T. Fox*, D. G. Renter, M. W. Sanderson, and T. G. Nagaraja, *Kansas State University, Manhattan.*

Our objective was to evaluate the application of the most-probable number (MPN) enumeration technique to quantify *E. coli* O157 in cattle feces. Cattle (n = 10) were inoculated orally with a mixture of three strains of *E. coli* O157 (1.4×10^{10} per animal) that were made resistant to nalidixic acid. Feces were collected twice a week for three weeks (60 samples) beginning 3 d post inoculation. A known amount of feces (2.0 ± 0.5 g) was diluted in 18 mL of gram-negative broth (1:10 dilution) containing cefixime, cefsulodin and vancomycin (GNccv). Serial 10-fold dilutions (200 μ L in 1.8 mL GNccv) of 1:10 dilution were then made, in triplicate, in a 96 well (2.5 mL capacity) dilution block to yield dilutions of 10^2 to 10^6 . Diluted samples were direct plated onto sorbitol-MacConkey agar containing cefixime and potassium tellurite (SMACct) plus nalidixic acid to establish a gold standard for the concentration of *E. coli* O157 in the sample. Following 6 h enrichment at 37°C, a loopfull of each dilution was streaked onto SMACct. Also, 1 mL of 10^1 , 10^2 , 10^4 and 10^6 dilutions were subjected to immunomagnetic separation (IMS) and plated on SMACct. On the next day if needed 1 mL of 10^3 or 10^5 was subjected to IMS and plated on SMACct. Diluted samples in each well that yielded sorbitol negative colonies (direct streak or plating after IMS) which were positive for indole production and latex agglutination were considered as positive for *E. coli* O157. Concentration of *E. coli* O157 in the original sample

was determined by MPN procedure. Mean concentration of *E. coli* O157 in samples, as determined by the gold standard method was 16,635 cfu/g. Both direct streak MPN ($r = 0.81$) and IMS MPN ($r = 0.52$) values correlated ($P < 0.01$) with the gold standard. Because IMS is expensive and labor intensive, the direct streak procedure of the diluted and enriched sample offers a simple and cost-effective method to enumerate *E. coli* O157 shed in the feces of cattle.

Key Words: *E. coli* O157, Enumeration, Cattle feces

269 Effect of vaccinating against type III secreted proteins of *E. coli* O157:H7 on its pre- and post-harvest occurrence on cattle hides. R. E. Peterson*, D. R. Smith, R. A. Moxley, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln.*

A trial was conducted to test the effect of vaccination against type III secreted proteins of *E. coli* O157:H7 (EC) on the probability to detect EC on hides of vaccinated and nonvaccinated cattle and on hides pre- and post-harvest. Steers (n=336) were stratified by weight and assigned randomly to one of two vaccination treatments. Vaccination treatments included vaccinated or non-vaccinated pens of steers (n=42 pens; 21 vaccinated and 21 not vaccinated). Two doses of vaccine (2 mL dose) were given to vaccinated steers. Placebo was given to nonvaccinated steers. Eighty-four days post treatment a hide sample was collected from each steer at the feedlot the day they were sent to harvest (pre-harvest) and from each steer at the packing plant (post-harvest). Steers were loaded onto clean trucks at the feedlot, held in lairage,

and harvested within the same treatment group. EC was isolated and identified using standard methods involving selective enrichment, immunomagnetic separation, and PCR confirmation. The outcome variables were recovery of EC from hides of vaccinated and nonvaccinated cattle and pre- and post-harvest. Outcomes were tested by modeling the probability of detecting EC from hides using the logit link function in a multivariable generalized estimation equation. EC was recovered from 56 of 621 hide-culture observations (9%). Vaccination reduced the probability for hides of feedlot cattle to test positive for EC (OR = 0.53, $P = 0.04$). There was no pre-harvest, post-harvest interaction ($P = 0.80$), indicating vaccination was equally protective at the feedlot and at the processing facility. Overall, vaccination reduced the probability of hide-contamination by 44%. Further, the probability of detecting EC on hides post-harvest was 4.7 times greater than that of detecting EC on hides pre-harvest at the feedlot of origin (OR = 5.5, $P < 0.0001$).

Key Words: Cattle, *Escherichia coli*, Vaccination

270 Influence of exogenous triiodothyronine (T_3) on fecal shedding of *E. coli* O157 in cattle. T. S. Edrington^{*1}, T. R. Callaway¹, D. M. Hallford², R. C. Anderson¹, and D. J. Nisbet¹, ¹USDA-ARS-FFSRU, College Station, TX, ²New Mexico State University, Las Cruces.

Fecal prevalence of *E. coli* O157 in ruminants is highest in the summer months and decreases to low or undetectable levels in the winter. We hypothesize that the seasonal variation of this pathogen is a result of physiological responses within the host animal to changing day-length. The thyroid is one gland known to respond to changing day-length. Two experiments were conducted to determine if a hyperthyroid status would initiate fecal shedding of *E. coli* O157 in cattle during the winter when shedding is virtually non-existent (Winter experiment) or influence cattle actively shedding *E. coli* O157 (Summer experiment). Yearling cattle were group-penned under dry-lot conditions, adjusted to a high concentrate ration, and randomly assigned to treatment: Control (1 mL corn oil injected s.c. daily) or T_3 (1.5 mg T_3 suspended in corn oil injected s.c. daily). Cattle were individually processed daily for collection of fecal and blood samples. Treatment with exogenous T_3 produced a significant change in serum thyroid hormone concentrations indicative of a hyperthyroid status in both experiments. No differences ($P > 0.10$) were observed in fecal shedding of *E. coli* O157 in the winter experiment. In the summer experiment, fecal shedding of *E. coli* O157 was decreased ($P = 0.05$) by administration of T_3 during the treatment period (d 1 to 10), tended to be lower ($P = 0.08$) during the following 7-d period of no treatment and was lower ($P = 0.01$) when examined across the entire experimental period. Results of this research indicate that the thyroid or its hormones may be involved in the seasonal shedding patterns of *E. coli* O157 in cattle.

Key Words: *E. coli* O157, Thyroid, Cattle

271 Isoamyl acetate application as a method to reduce pathogens and methane production in cattle prior to harvest. T. R. Callaway^{*}, A. M. B. Prazak, T. S. Edrington, R. C. Anderson, and D. J. Nisbet, USDA/ARS, Food and Feed Safety Research Unit, College Station, TX.

Cattle can carry foodborne pathogenic bacteria, especially *E. coli* O157:H7, in their gastrointestinal tracts. These pathogens are spread to consumers through contaminated meat products, water, fruits or

vegetables. The microbial population of the ruminant is inefficient and also produces methane which can waste up to 12% of the GE of the diet of the animal. Methods to improve food safety do not currently carry an economic advantage to implementation; but if a method to reduce pathogens simultaneously reduces the inefficiencies of fermentation then the economics of food safety can be improved. Isoamyl acetate (IA; banana oil) is a naturally occurring aliphatic carboxylic ester widely used as a flavoring agent in foods that has been reported to have bacteriostatic activity. In the present study we added IA at various concentrations (from 0 to 50 mM) to pure cultures of *E. coli* O157:H7 (initial concentration of 10^6 cfu/mL) and found that approximately 30 mM IA demonstrated significant ($P < 0.05$) antibacterial activity. Mixed rumen contents from grass-fed Holstein cows were used for the in vitro mixed culture studies. Rumen fluid (containing 1 g/L glucose and xylose) was inoculated with 10^4 cfu/mL *E. coli* O157:H7 and added to separate anaerobic tubes (n=16). IA was added to achieve final concentrations from 0 to 50 mM in each tube. Tubes were incubated at 39°C for 24 h. Samples were serially diluted (10-fold increments) and plated to determine populations of inoculated *E. coli* O157:H7. *E. coli* O157:H7 populations were reduced ($P < 0.05$) in tubes containing >30 mM IA. Parallel tubes (n=16) were incubated to determine the effects of IA on the ruminal fermentation. Total gas volume, CH₄, and total VFA concentrations were reduced ($P < 0.05$) in tubes containing >30 mM IA. Results suggest that IA could be used as a surface or hide disinfectant with more efficacy than as a feed additive because the impact on the overall fermentation efficiency appears to be probably detrimental.

Key Words: Intervention, Pathogen, *E. coli*

272 Microbial characteristics of ground beef produced from beef trimmings treated with potassium lactate, sodium metasilicate, peroxyacetic acid or acidified sodium chlorite. S. A. Quilo^{*}, F. W. Pohlman, A. H. Brown, P. G. Crandall, P. N. Dias-Morse, R. T. Baublits, and C. Bokina, University of Arkansas, Fayetteville.

Beef trimmings (90/10) were inoculated with a mixture (7 log cfu/mL each) of *Escherichia coli* (EC) and *Salmonella typhimurium* (ST) and left untreated or treated under vacuum in a tumbler with 3% potassium lactate (KL), 4% sodium metasilicate (NMS), 0.1% acidified sodium chlorite (ASC) or 0.2% peroxyacetic acid (PAA) prior to grinding. Trimmings were ground, weighed, packaged and sampled at 0, 1, 2, 3 and 7 days of simulated retail display for EC, ST, coliforms (CO), and aerobic plate counts (APC). All treatments reduced ($P < 0.05$) EC approximately 1 log or more on day 0 of display and maintained the same reduction pattern through day 7 of display. All treatments reduced ($P < 0.05$) CO counts 0.86 log or more throughout display. The ASC was the most effective by day 7 of display with a CO reduction of 2.26 logs, which demonstrates a residual reduction that was effective across days. Regardless of day, the APC counts were lower ($P < 0.05$) for all antimicrobial treatments, with a reduction of approximately 1 log for the KL, NMS and PAA treatments and a 2.5 log reduction for ASC on day 7. All the treatments demonstrated ST reductions ($P < 0.05$) during day 0, 3, and 7 of display including a 2.92 log reduction at day 7 of display for the PAA treatment. These results suggest that the use of these antimicrobial agents on beef trimmings reduced bacterial counts of ground beef under retail display, and ASC and PAA demonstrated the highest microbial reduction on day 7 of display.

Key Words: Ground beef, Antimicrobials, Bacteria

273 Effects of feeding wet corn distiller's grains with solubles and monensin and tylosin on the prevalence and antibiotic susceptibilities of fecal commensal and foodborne bacteria in feedlot cattle. M. Jacob*, J. T. Fox, S. Narayanan, J. S. Drouillard, and T. G. Nagaraja, *Kansas State University, Manhattan.*

Our objective was to evaluate prevalence and antibiotic susceptibilities of fecal commensal and foodborne bacterial pathogens in feedlot cattle fed steam-flaked corn or a combination of steam-flaked corn and wet corn distiller's grains with solubles (WDGS), with or without monensin and tylosin. Cattle (n = 370) were allotted to 54 pens with 6 to 7 animals in each pen and 9 pens per treatment. Treatments were arranged in a 2 × 3 factorial arrangement with factor 1 being 0 or 25% WCDGS and factor 2 being the inclusion of no antibiotics, monensin only (300 mg/d), or monensin (300 mg/d) and tylosin (90 mg/d). Fecal samples were collected on d 122 and 136 and pooled within pen for isolations of commensal bacteria (generic *Escherichia coli* and *Enterococcus* species) and foodborne pathogens (*E. coli* O157 and *Salmonella* serotypes). Antimicrobial susceptibilities of isolates were determined for twenty antimicrobial compounds by broth microdilution method. Prevalence of *Salmonella* ($P = 0.62$) or *E. coli* O157 ($P = 0.15$) were not different among diets. *Enterococcus* species were more likely to be resistant to macrolides (erythromycin and tylosin) if fed diets with monensin or monensin and tylosin than diets with no antibiotics ($P < 0.01$). Generic *E. coli* from cattle fed monensin and tylosin were less likely to express resistance to oxytetracycline than those isolated from cattle fed diets with no antibiotics ($P < 0.01$). *Enterococcus* species were less likely to be resistant to flavomycin in pens fed WDGS than in pens without WDGS ($P < 0.01$). Feeding distiller's grains, monensin, or tylosin to feedlot cattle had no measurable effect on prevalence of major food-borne pathogens, but these factors may indeed impact susceptibility of bacteria to common antimicrobials.

Key Words: Distiller's grains, Feed additives, Foodborne bacteria

274 Prevalence of *Salmonella typhimurium* in swine at slaughter. M. H. Rostagno^{*1}, H. S. Hurd², and J. D. McKean², ¹USDA, ARS, Livestock Behavior Research Unit, West Lafayette, IN, ²Iowa State University, Ames.

Salmonella is recognized as an important foodborne pathogen with multiple potential sources, including pork. Although *Salmonella* constitutes a very heterogeneous group of bacteria, including more than 2,400 serotypes, only a limited number of serotypes are responsible for most outbreaks. Despite the importance of *Salmonella typhimurium* as the most common cause of foodborne infection, limited serotype-specific information is available to date, particularly in swine. Therefore, the objective of this cross-sectional study was to analyze data available from multiple studies conducted by our research team estimating the prevalence of *Salmonella typhimurium* in swine at slaughter. A total of 1,110 pigs from 3 large capacity abattoirs located in the Midwestern U.S. were individually sampled at slaughter. Individually paired samples (cecal contents and mesenteric lymph nodes) were collected in multiple occasions in all 3 abattoirs, transported to the laboratory, and processed for the isolation and identification of *Salmonella*. The *Salmonella* prevalence, based on any of the samples collected (i.e., pigs positive in at least one of the samples), was: 57.1% in abattoir A, 48.3% in abattoir B, 70.2% in abattoir C, and 62.6% overall. Various serotypes were isolated in all abattoirs. The prevalence rates of *Salmonella typhimurium* were 18.8% in abattoir A, 5.8% in abattoir B, 38.7% in abattoir C, and 27.3%

overall. This study confirms that *Salmonella* prevalence in swine at slaughter is frequently high requiring attention due to the associated risk of contamination of the abattoir environment, and consequently, of pork products. This study also shows that the prevalence of *Salmonella typhimurium* varies considerably between abattoirs.

Key Words: *Salmonella*, Swine, Food safety

275 Resting pigs on transport trailers: A potential intervention to reduce *Salmonella* prevalence at slaughter. M. H. Rostagno^{*1}, H. S. Hurd², and J. D. McKean², ¹USDA, ARS, Livestock Behavior Research Unit, West Lafayette, IN, ²Iowa State University, Ames.

Prior to slaughter, pigs are usually held for at least two hours to recover from the stress of transport, improve meat quality, and maintain a constant supply for the slaughter line. However, recent research has shown that much pre-harvest *Salmonella* infection occurs immediately before slaughter during this rest period in the contaminated abattoir holding pens. Intervention strategies to reduce the occurrence of *Salmonella* infections during the pre-slaughter holding are necessary, in order to reduce the number of pigs carrying the bacteria into the slaughter line, increasing the risk for pork and pork products contamination. The objective of this study was to evaluate a potential intervention strategy to reduce the prevalence of *Salmonella*-positive pigs at slaughter, which consisted in resting (or holding) pigs prior to slaughter on their transport vehicle, instead of in the abattoir holding pen. A total of 120 animals were included in the experiment, divided in 4 replicates (n=30 pigs per replicate). Upon arrival at the abattoir, 15 randomly chosen pigs were unloaded, and moved to a holding pen, whereas the remaining 15 pigs stayed in the transport trailer. After approximately 1.5 h of resting, both groups were slaughtered, and samples collected. Samples collected included; distal ileum portion (10 cm), cecal content (10 g), and ileocecal lymph node. Results showed higher *Salmonella* recovery rates ($P < 0.05$) from pigs held in the abattoir pens (40.7% vs 13.3%). This study demonstrates that, except for unloading logistics, the possibility of resting pigs on the transport vehicle has the potential to decrease *Salmonella* levels entering the abattoir. Moreover, this study shows the importance of avoiding the exposure of pigs to the contaminated lairage environment.

Key Words: *Salmonella*, Swine, Food safety

276 Project supported by the European Union to find alternatives to antibiotic growth promoters. G. Schatzmayr^{*1}, R. Beltran², and K. C. Mountzouris³, ¹BIOMIN GmbH, Herzogenburg, Austria, ²BIOMIN USA Inc., San Antonio, TX, ³Agricultural University of Athens, Athens, Greece.

Due to the ban of antibiotic growth promoters (AGP's) the European Commission is supporting multinational research projects on finding alternatives to AGP's. One of the projects aimed at the development of a defined multi-species competitive exclusion product for poultry. By applying various growth media about 500 bacterial strains were isolated from different parts of the gastrointestinal tract of chicken. These strains were further subjected to different tests like an inhibition assay to determine their potential to counteract pathogenic bacteria like *Salmonella*, *E. coli*, *Clostridium perfringens* and *Campylobacter*. Further selection criteria were adhesion capability to mucosal cell lines, pH-reduction, formation of different organic acids and immunological activity. Based on these results a product consisting of 5 isolates belonging to the genera *Enterococcus*, *Pediococcus*, *Lactobacillus* and *Bifidobacterium* was designed. This product (Biomim[®]PoultryStar

[BPS]) was tested in a feeding trial with three hundred 1 d old broilers. These were allocated to 3 experimental treatments for 6 wk. Experimental treatments were: C (corn-soybean basal diet), PFW (basal diet containing BPS) and A (basal diet containing 2.5 mg avilamycin/kg). Overall BW in treatment A (2314 g) was higher ($P \leq 0.05$) than in treatment C (2216 g), but did not differ from treatment PFW (2276 g). The cecal microflora (log cfu/g wet cecal content) of probiotic treatment PFW had higher ($P \leq 0.05$) concentrations of bacteria belonging to *Bifidobacterium spp.*, *Lactobacillus spp.* and Gram positive cocci respectively, compared to treatments C and

A. Treatments PFW had numerically higher VFA concentrations in intestinal contents and also higher ($P \leq 0.05$) specific activities of α -galactosidase and β -galactosidase. The results showed that when the probiotic product was administered a growth promoting effect similar to the antibiotic avilamycin could be obtained. In addition Biomin®PoultryStar modulated the composition and the activities of the cecal microflora, resulting in a significant probiotic effect.

Key Words: Pathogens, Natural growth promotion, Probiotics

Forages and Pastures: Silages

277 Mastication and rumination effects on digestion and passage. M. R. Murphy* and K. E. Cowles, *University of Illinois, Urbana.*

Ruminants spend many hours per day chewing, including time spent eating and ruminating. Comminution of feed and digesta particles affects the kinetics of both digestion and passage. These, in turn, determine nutrient availability to the animal and its productive efficiency. Although large particles (i.e., those retained on a screen with 1.18-mm pores) often comprise 80 to 90% of alfalfa or corn silage dry matter, they account for only 5 to 10% of fecal dry matter. Large particles can be a minority of those in the reticulorumen at any given time; therefore, size is not the only criterion determining passage to the lower gut. Interactions of chewing during eating and rumination with other factors (diet composition and consumption, animal physiology, and microbial fermentation in the reticulorumen and lower gut) are important, although complex. Synergism apparently exists between animal and microbial effects; for example, mastication enhances microbial fermentation, which may increase the effectiveness of comminution during rumination. Copious salivation during mastication also affects rumen fermentation, fluid dynamics, and digesta passage. A quantitative understanding of factors involved in comminution, and the kinetics of their interactions, may allow digestion and passage to be manipulated for optimal production.

Key Words: Particle size, Comminution, Ruminant

278 Effect of forage particle length and sorting of dietary ingredients by lactating dairy cows on performance and health. L. Armentano*, *University of Wisconsin, Madison.*

Forage particle length and proportion of forage determine the mean particle length (MPL) and physical effectiveness of diets. Adequate physically effective fiber (PEF) is required to minimize displaced abomasum, milk fat depression and other negative production and health responses. Impact of low PEF may be reduced by reducing the fermentability of dietary carbohydrate, but some requirement for PEF remains. Excessive forage length negatively impacts stability of silage, diet mixing, and feed intake. Most cows sort somewhat against the longest particles in the diet so the diet consumed has a shorter MPL and less neutral detergent fiber (NDF) than the diet offered. Not only are long fibers sorted more than intermediate fibers, but long fibers are sorted more when diets contain more long fiber. Both these factors contribute to wider chemical and physical differences between the diet offered and consumed for diets rich in long particles, although increasing the proportion of long fibers in the diet offered will increase the MPL of the diet consumed. Drier diets are more susceptible to sorting, but adding liquids to diets complicates measuring MPL.

Increased NDF content in alfalfa did not increase sorting; however increased NDF in long particles will amplify the effect of sorting to reduce dietary NDF. Cow variation is large relative to the effect of diet on mean measures of sorting, and this complicates estimating risk associated with diet, especially for sporadic negative health events. Cows housed in groups can sort more on average than individually fed cows, but extreme sorting by a few cows may be difficult to measure in loose housing. MPL is obviously strongly correlated with the percentage of larger particles and it is not clear that either is a better predictor of PEF. It takes more added mass of moderate length fibers to increase MPL compared to if longer particles are added, however the former will provide a consumed diet closer in physical and chemical makeup to the diet offered.

Key Words: Sorting, Particle length, Physically effective fiber

279 Effect of brown midrib mutation and stage of development at harvest on chemical composition and in situ disappearance of millet forage. F Hassanat*, A. F. Mustafa, and P. Seguin, *McGill University, Ste. Anne De Bellevue, Quebec-Canada.*

A study was conducted to evaluate the effects genotype and stage of development at harvest on chemical composition and in situ disappearance of forage millet in a 2x2 factorial design. Regular (RM) and Brown midrib (BM) millet were harvested at vegetative (VS) or heading (HS) stage, and separated to leaves, stems, or whole plant. Concentrations of ADF and ADL were higher ($P < 0.05$) for RM (39.8% and 3.5%) than BM (36.4% and 1.7% respectively) and were higher ($P < 0.05$) at HS compared with VS. Level of CP was higher ($P < 0.05$) for BM at VS and HS than for RM. Millet harvested at VS contained more ($P < 0.05$) soluble CP and NPN and less ($P < 0.05$) NDICP and ADICP than those harvested at HS. Differences in chemical composition of leaves and stems of RM and BM at VS and HS followed the same trend as the whole plants. Cell wall of BM leaves and stems contained more ($P < 0.05$) xylose (31.4%vs. 15.9% for leaves, 29.2%vs. 24.4% for stems), but less glucose (49.9%vs. 56.7% for leaves, 45.2%vs. 53.1%, for stems) than that of RM. Arabinose concentration was higher ($P < 0.05$) for leaves of BM compared with RM (9.6%vs. 5.5%), but was similar in the stems of both millet types. Arabinose and xylose levels increased ($P < 0.05$) with advanced development, while glucose decreased in leaves of the two millet types, and in the stems of RM only. In situ DM and NDF disappearance of whole plant was higher ($P < 0.05$) for BM (72.6% and 60.2%) compared with RM (64.9% and 53.8% respectively). In situ disappearance of all cell wall sugars in BM leaves was higher ($P < 0.05$) than RM leaves. Stems of BM had higher glucose disappearance (47.5% vs. 38.5%) but less xylose disappearance (46.8%vs. 55.6% respectively, $P < 0.05$) compared with

RM. In situ disappearance of most cell wall sugars was reduced ($P < 0.05$) with advanced development. High NDF disappearance in BM could be related to increase in all cell wall sugars disappearance in leaves, and some in the stems. It could be concluded that the improved in situ disappearance of BM is attributed to reduction in ADL concentration and to alternation in cell wall structure.

Key Words: Millet, Brown midrib, Cell wall

280 Performance of dairy cows fed soybean silage. E. Vargas*, A. F. Mustafa, and P. Seguin, *McGill University, Ste-Anne-De-Bellevue, Quebec, Canada.*

The objective of this study was to determine the feeding value of forage soybean silage to dairy cows relative to a fourth cut alfalfa silage. Two isonitrogenous diets were formulated with 50:50 forage:concentrate ratio. Alfalfa silage (AS) or soybean silage (SS) comprised 72% of the forage in each diet, with corn silage comprising the remaining 28%. Twenty Holsteins cows in early lactation (DIM 68 d \pm 113 d) were used in a Switchback design where each group of cows received both treatments and one treatment twice. The study consisted of three 21-d periods with the first 7 d for diet adaptation and the last 14 d for data collection. Relative to AS, SS contained 15% and 28% more NDF and ADF, respectively. Both silages had a similar CP level (average $21\% \pm 3.39\%$). Dry matter intake and milk yield were lower ($P < 0.05$) for cows fed SS than those fed AS. Dry matter intake and milk yield for SS treatment was 20.3 and 34.9 kg, respectively. The corresponding values for AS treatment were 25.4 and 38 kg, respectively. Milk protein, lactose and total solid concentrations were not affected by dietary treatments (average 3.0, 4.7, and 12.6%, respectively). However, cows fed SS produced milk with higher ($P < 0.05$) milk fat (3.7 vs 3.6%) and milk urea concentrations (15.6 vs 14.3%) compared with cows fed AS. It was concluded that forage SS used in this study had a lower feeding value for lactating dairy cows when compared with AS.

Key Words: Soybean silage, Alfalfa silage, Dairy cows

281 Effects of propionic acid-based additive (Solution Foin) on short-term ensiling characteristics of corn. T. Levital*, A. F. Mustafa, and P. Seguin, *McGill University, Montreal, QC, Canada.*

Silage is an important source of forage for ruminant animals. Forage shortage may force producers to feed unfermented ensiled forages, which are more susceptible to aerobic deterioration. Propionic acid-(PA) based additives can be added to ensiled forages to inhibit yeast and mould growth, and improve the aerobic stability of silages. The objectives of this study were to determine the effects of a PA-based silage additive (Solution Foin=SF) on short-term ensiling characteristics of corn silage, and on dairy cattle production. Chopped whole corn forage was left untreated or treated with SF (contains about 70% PA and 30% NH_4^+). The additive was added to forage prior to ensiling at a rate of 0.5% (wet basis). Treated and untreated forages were placed in six plastic silo bags (three each). Silo bags were opened one day after ensiling and daily samples were collected for 30 d to evaluate ensiling characteristics. Effects of feeding treated or untreated forage on animal performance were determined in a complete randomized design, using 30 lactating cows (DIM=178 \pm 55) fed TMR (50% forage and 50% concentrate) with the forage portion consisting of untreated or treated forage. Yeast and mold populations in the ensiled forages were reduced by SF ($P < 0.05$) between d 5 and 15 post-ensiling. For example, yeast counts on d 10 were 4.35 and 7.85 \log_{10} cfu/g for treated and untreated forages respectively ($P < 0.005$; SE=0.17). Mould counts on d 10 were

0.0 and 2.51 \log_{10} cfu/g for treated and untreated forages respectively ($P < 0.02$; SE=0.24). Aerobic stability of ensiled forage was also improved ($P < 0.05$) between d 0 to d 15; For instance, on d 5 treated forage was stable for 127.3 hrs compared with 20.7 h for the untreated one ($P < 0.0005$; SE=1.69). The additive had minor effects on pH, temperature, lactic acid and water soluble carbohydrate concentration of ensiled forages. Dairy cows fed treated forage had similar DMI and milk yield to cows fed the untreated forage. It was concluded that SF can be used to improve the short-term stability of unfermented ensiled forages, likely by reducing yeast and mold populations.

Key Words: Solution Foin (SF), Silage additive, Corn silage

282 Genetic determinism and QTL mapping of plant parameters involved in the efficient and sustainable utilisation of forage maize in animal nutrition. L. A. Lethbridge¹, J. K. Margerison*¹, C. S. Brennan¹, M. Chrenkova², and L. Hentenyi², ¹*Massey University, Institute of Food, Nutrition and Human Health, Palmerston North, New Zealand,* ²*RIAP, Slovakia.*

The objective was to measure forage maize (FM) composition (DM, CP, NDF, ADF, ADL, starch, water soluble carbohydrates (WSC), ash) and degradability (dg) for qualitative trait loci (QTL) mapping. Near isogenic lines (NILs) of FM (n=350) were produced from 3 parent varieties and grown in randomised block design in 3 EU countries. UK FM was harvested in mid October (27% DM). Data from parental varieties (ANT, NKB) with 8 NILs (A to H) (in g/kg DM unless stated otherwise) were analysed (ANOVA) and compared (Tukey's test). DM: A 281.1, B 284.8, C 250.2, D 299.5, E 292.9, F 288.5, NKB 270.9, ANT 294.5, G 295.8, H 284.6 (sed 2.11, $P < 0.001$). NDF: A 483.3, B 485.7, C 490.7, D 455.7, E 455.3, F 398.3, NKB 489.7, ANT 410.3, G 471.3, H 452.3 (sed 31.73). ADF: A 289.7, B 271.33, C 320.0, D 253.3, E 238.3, F 307.3, NKB 275.7, ANT 241.7, G 255.0, H 311.3 (sed 16.56, $P < 0.05$). ADL: A 20.0, B 19.3, C 46.7, D 26.7, E 32.0, F 38.7, NKB 44.3, ANT 13.3, G 32.3, H 33.3 (sed 16.06). Ash: A 42.9, B 39.3, C 53.1, D 31.4, E 39.4, F 37.6 NKB 43.0, ANT 39.9, G 37.9, H 115.9 (sed 5.15, $P < 0.001$). CP: A 73.5, B 63.0, C 72.1, D 67.7, E 57.7, F 57.5, NKB 59.2, ANT 63.5, G 55.3, H 59.2 (sed 1.22, $P < 0.001$). Starch: A 159.5, B 247.7, C 98.3, D 201.8, E 507.0, F 324.0, NKB 122.0, ANT 434.9, G 464.9, H 148.7 (sed 88.69, $P < 0.001$). WSC (mg/ml DM): A 5.00, B 13.3, C 15.0, D 10.0, E 9.8, F 5.0, NKB 2.9, ANT 8.1, G 4.1, H 17.8 (1.30, $P < 0.001$). FM dg: quickly (a), slowly (b) and total dg rates, starch development, structure and relationship with protein varied significantly between NILs, pectin and amylopectin did not. Starch levels increased as DM increased, while NDF, ADF, ADL, CP and ash decreased. Genotype affected starch, ash and crude protein levels, starch and fibre degradability, starch structure and relationship with protein ($P < 0.001$), but did not affect pectin and amylopectin. Distinct QTL were involved in FM composition, degradability and starch characteristics. QTL mapping can be used in genetic selection and breeding of FM to increase forage utilization efficiency and sustainability.

Key Words: Forage maize, Efficiency/sustainability, QTL mapping

283 Effect of multi enzyme cocktails on the digestion and fermentation of bahiagrass hay. N. A. Krueger* and A. T. Adesogan, *University of Florida, Gainesville.*

This study aimed to determine the effects of different combinations of ferulic acid esterase (E), cellulase (C), and xylanase (X) on the digestion of bahiagrass hay. A 12-wk regrowth of bahiagrass (*Paspalum*

notatum) hay was ground (1mm) and treated with nothing (Control), with a commercial esterase preparation (Depol (D) 740) containing all three enzymes, or with enzyme cocktails containing either 2% X, 2% C and 0% E (220) or 2% X, 2% C, 1% E (221) (DM basis). The 220 and 221 enzymes were more effective at improving the DM disappearance of the hay used in this study than various enzyme combinations in preliminary studies. Enzymes were dissolved in 1 ml of citrate-phosphate buffer (pH 6.0) and applied to 0.5 g of hay in triplicate in each of two runs. Samples were fermented in buffered, rumen fluid using a wireless automated gas production system for 24 or 96 h, and residues were analyzed for DM and volatile fatty acid concentrations. The kinetics of 24 h fermentation was determined by fitting a regression model to the data. A completely randomized design was used to analyze the data from 24 and 96 h incubations separately. Enzyme treatment did not increase ($P>0.05$) fermentation rate or 24 h DMD, but enzyme 221 increased ($P<0.05$) 96 h DMD. All enzymes decreased ($P<0.05$) the lag phase and enzyme 221 gave the shortest lag phase (4.92 h). Only enzyme 221 increased ($P<0.01$) the 24 h total gas production. After 24 hours of incubation, all enzymes had decreased ($P<0.001$) acetate concentration and increased ($P<0.04$) propionate and butyrate concentrations. Enzymes 221 and D740 decreased ($P<0.0001$) the acetate to propionate ratio and enzyme 221 was more effective than enzyme D740 in this respect. This study indicates that enzyme cocktails containing X, C, and E improved rumen fermentation. The 221 enzyme cocktail was the most effective treatment as it also increased 96 h DMD (2.36%), decreased the lag phase (57.5%) and increased the extent of gas production (13.4%) after 24 h of incubation.

Key Words: Ferulic acid esterase, Cellulase, Xylanase

284 Meta-analysis on the effect of main dietary forage on N excretion from dairy cows. V. R. Moreira¹ and C. Leonardi^{*2}, ¹Louisiana State University AgCenter Southeast Research Station, Franklinton, ²Louisiana State University, Baton Rouge.

The objective of this meta-analysis was to evaluate the effect of primary forage source and nitrogen intake (NI) on N split between urine (UN) and feces (FN) in dairy cows. A dataset containing 187 treatment means obtained from 42 published N balance studies was assembled. Primary forage source was defined as 1) sole source of forage in the diet; 2) forage accounting for 60% or more of the dietary forage when 2 forages were fed; 3) forage accounting for 50% or more of the dietary forage when the diet contained 3 forages or more. A small number of observations that did not fit the criteria described above were not included in the analysis. Forages were categorized as alfalfa (A, hay or silage), corn silage (C), and grass (G, hay or silage). The effect of NI (kg/d) on the amount of excreted N was modeled utilizing the mixed procedure of SAS. Data were weighted by the inverse of the squared standard error of the independent variable divided by its own average. Linear, polynomial, exponential and power models were fitted for both UN and FN. The models chosen were linear for FN and power for UN. Each model included a fixed intercept and slope for NI, forage and its interaction with NI and a random intercept and slope clustered by study. The covariance among random intercept and slope was not

different from 0 ($P > 0.30$) for both dependent variables; therefore only slope and intercept variance components were estimated. The FN excreted (kg/d) did not differ across forages ($P > 0.16$). The FN equation was: $FN = 0.077(\pm 0.007) + 0.176(\pm 0.016) \times NI$. The amount of UN excreted (kg/d) differed across forages ($P < 0.05$). The UN equation for A was: $UN = 0.39 \times NI^{1.30(\pm 0.26)}$; for C was: $UN = 0.50 \times NI^{1.70(\pm 0.14)}$; and for G was: $UN = 0.70 \times NI^{1.96(\pm 0.11)}$. Urinary N surpassed FN when NI reached between 0.450 and 0.550 kg/d. Increasing the amount of NI above 0.550 kg/d is more likely to increase UN excretion on grass- than corn- than alfalfa-based diets, and thus increase the risk for N loss as ammonia.

Key Words: Forage, N-split, Dairy cows

285 Forage production and water use efficiency of 30 species used in the Australian dairy industry. J. S. Neal^{*1}, W. S. Fulkerson¹, and K. Greenwood², ¹The University of Sydney, Camden, New South Wales, Australia, ²Department of Primary Industries Victoria, Kyabrum, Victoria, Australia.

The Australia dairy industry is the largest agricultural user of irrigation water. The recent drought and government policy to increase environmental flows in rivers have highlighted the importance of maximizing forage production from available water. Forage production accounts for up to 35% of variability in farm profit. The dominant forage used in Australia is perennial ryegrass (*Lolium perenne*); however its poor persistence has led dairy farmers to question its suitability and look for alternative species. In this context, thirty forage species suitable for dairy cows were evaluated to assess dry matter production (DM), water use efficiency (WUE) and forage quality. Besides an optimal irrigation treatment, to maximize DM, two other irrigation treatments were imposed to investigate how different species responded to increasing water stress. Irrigation was initiated once the optimum treatment had used 30mm of water from the soil profile. At this time the optimum treatment was refilled to field capacity (100%), the two water stress treatments received 66% and 33%, of the water applied to the optimum treatment. The WUE was calculated from the rainfall, water used from irrigation and changes in the soil moisture profile. Each species was harvested at the optimal stage of growth and was fertilized to replace nutrients removed. Annual DM ranged from 8 to 31t DM/ha, with maize (*Zea mays*) having the highest yield. The perennial grasses, tall fescue (*Festuca arundinacea*), perennial ryegrass, prairie grass (*Bromus willdenowii*) and kikuyu (*Pennisetum clandestinum*) had the next highest yields in the range of 27 to 28t DM/ha. WUE of the forages varied significantly from 12 to 59 kg DM/ha/mm, and depended on the season. In winter the WUE of perennial ryegrass was the highest at 37 kg DM/ha/mm, but it was one of the lowest in summer of only 20kg DM/ha/mm. Maize had the highest WUE during the summer of 59kg DM/ha/mm. The response to moisture stress differed significantly between species, the loss in yield in summer ranged from a low of 33% for lucerne (*Medicago sativa*) to a high of 82% for white clover (*Trifolium repens*).

Key Words: Forage, Pasture, Water use efficiency

Growth and Development: IGF and IGF Binding Proteins

286 Insulin-like growth factor-I, a link between nutrient intake and growth. D. Clemmons*, *University of North Carolina, Chapel Hill.*

Insulin-like growth factor-I (IGF-I) is a small polypeptide hormone that is synthesized in multiple tissues. IGF synthesis is controlled principally by nutrient intake and by pituitary GH secretion. In periods of adequate intake, GH is the predominant stimulant of IGF-I synthesis however in periods of caloric or protein restriction organisms become refractory to GH and the effect of nutritional deficiency predominates. This change in IGF-I synthesis functions to regulate protein metabolism in tissues. IGF-I is a predominant stimulant of both skeletal muscle, growth and differentiation and it inhibits apoptosis. In multiple tissues IGF functions to maintain tissue hypertrophy in response to either exercise induced stress or changes in nutrient intake. In adult organisms IGF-I stimulates hyperplasia only in cell types that are susceptible to stimulation but it stimulates hypertrophy in almost all cell types. IGF-I stimulated growth is a mixture of the two processes. Under normal conditions certain cell types such as vascular smooth muscle respond to IGF-I with increases in cell size and protein content however during some periods of stress these cell types such as smooth muscle cells, endothelial cells, osteoblasts, chondrocytes are capable of partially dedifferentiating and responding to IGF-I with a hyperplastic response. In contrast skeletal muscle always responds with a hypertrophic response except for myoblasts that proliferate in response to IGF-I. IGF-I is a potent antiapoptotic factor for both skeletal muscle and neural tissue. The IGF-I synthesis and blood concentrations decline in all aging organisms but the significance of this decline for changes in tissue mass and protein synthesis that occur with aging has not been definitively determined. IGF-I is an important systemic growth factor that is responsible for the growth of multiple tissues. In adult organisms this growth occurs as a result of hypertrophy although certain specialized cell types can undergo a hypoplastic response. IGF-I protein balance, and tissue responsiveness, will continue to be an important goal of future studies.

Key Words: Muscle hypertrophy, Somatic growth, Protein metabolism

287 Effects of short day photoperiod on mammary growth of dry cows: Altered prolactin and IGF signaling. G. E. Dahl*¹, E. H. Wall², and T. B. McFadden², ¹*University of Illinois, Urbana*, ²*University of Vermont, Burlington.*

Manipulation of photoperiod has dramatic physiological and production effects on mature dairy cows. During lactation, exposure to long day photoperiod (LDPP) increases milk yield and circulating IGF-I and prolactin (PRL). In contrast, dry cows housed under a short day photoperiod (SDPP) produce more milk in the subsequent lactation than cows exposed to LDPP or natural photoperiod. Relative to LDPP, exposure to SDPP depresses PRL secretion but expression of PRL-receptor (PRL-R) mRNA increases in mammary and hepatic tissue and in lymphocytes. Under SDPP, PRL signaling emerges as a possible mechanism to drive more extensive mammary cell differentiation and growth relative to LDPP. Using sequential mammary biopsies, we determined temporal changes in mammary cell proliferation and in expression of genes of the IGF and PRL signaling pathways during the dry period and transition into lactation. For both SDPP and LDPP, cell proliferation rate increased significantly as the dry period advanced, then decreased significantly in early lactation. However, timing of the proliferative response differed between treatments, increasing earlier in SDPP cows than in LDPP cows during the dry period. Overall, expression of IGF-II was significantly greater, whereas that of IGFBP-5 was lower, in SDPP versus LDPP cows. IGFBP-5 mRNA increased significantly during lactation in both groups. Expression of IGF-I did not differ over time or between treatments however, the lower IGFBP-5 expression in SDPP cows coupled with increased IGF-II expression may enhance mammary cell growth and survival. Key among the potential modulators of PRL signaling is the suppressors of cytokine signaling (SOCS) family, the best characterized of which are SOCS-1, -2, -3, and cytokine-inducible SH2-containing protein (CIS). Mammary expression of SOCS-1, -2, -3, and CIS were low during the dry period, but increased in lactation. During the dry period, SOCS expression of cows on SDPP was generally reduced, which may enhance PRL induced proliferation and subsequent milk production.

Key Words: Dry cow, Mammary growth, Prolactin signaling

Nonruminant Nutrition: New Frontiers in Amino Acid Research in Nonruminant Nutrition

288 Branched chain amino acid metabolism and nutrition in monogastric animals. S. M. Hutson*¹, P. She², T. M. Reid¹, M. Janket¹, S. K. Bronson², A. Sweatt¹, and C. J. Lynch², ¹*Wake Forest University School of Medicine, Winston-Salem, NC*, ²*Penn State College of Medicine, Hershey.*

Studies in our laboratory have shown that several features of indispensable branched chain amino acid (BCAA) metabolism in animals sets them apart from other indispensable amino acids. The initial 2 steps of BCAA catabolism are common to all 3 BCAAs; reversible transamination followed by irreversible oxidative decarboxylation of the branched chain α -keto acid transamination products. Due to the shared steps, dietary intake of individual BCAAs impacts the catabolism of all three. Rather than being restricted to liver, BCAA catabolic enzymes are distributed widely in body tissues. With the exception of the nervous system, all reactions occur in the mitochondria.

The tissue specific expression and intracellular compartmentalization of the branched chain aminotransferase isozymes (BCATm and BCATc) impact intra- and inter-organ exchange of BCAA metabolites, nitrogen cycling, and net nitrogen transfer. Transamination of the BCAAs makes them important nitrogen donors for synthesis of alanine and glutamine, as well as giving them a key role in the transfer of nitrogen between skeletal muscle and liver. In brain, BCAAs are important in neurotransmitter glutamate synthesis, and the localization of the BCAT isozymes separately in neurons and glia promotes intercellular shuttling of nitrogen. Dysregulation of the BCAA catabolic pathways that leads to excess BCAAs and their metabolites has been shown to result in severe neural dysfunction. Finally, leucine serves as a nutrient signal that regulates protein synthesis and cell growth pathways affected by mTOR and insulin secretion. Indeed the BCATm knockout mouse (blocked body BCAA catabolism) exhibits increased energy

expenditure, lower fat deposition, lower plasma glucose, and increased insulin sensitivity. The results indicate that BCAAs play an important role in macronutrient partitioning and suggest that leucine (and/or BCAAs) is the signal(s) that allows protein to communicate with other macronutrients. Together these features make the regulation of BCAA intake important in maintaining metabolic homeostasis, while avoiding the toxic effects of BCAA excess. (NIH NS038641, DK34738, DK053843 and DK062880)

Key Words: Leucine, Alanine, Nutrient signal

289 Nutrition of the arginine-family amino acids in nonruminant animals. G. Wu^{*1,3}, S. W. Kim^{2,1}, D. A. Knabe¹, and Y. L. Yin³, ¹Texas A&M University, College Station, ²Texas Tech University, Lubbock, ³The Chinese Academy of Sciences, Changsha, Hunan, P.R. China.

The arginine-family amino acids include glutamine, glutamate, aspartate, proline, ornithine, citrulline, and arginine. They can be inter-converted in mammals through inter-organ metabolism and cell-specific pathways, although the rates of their conversion vary greatly with precursors, species, developmental stages, and disease. Growing interests in these amino acids in nonruminant nutrition mainly arise from the emerging knowledge about: 1) their high concentrations in fetal and postnatal animals; 2) remarkable species-differences in their tissue-specific catabolism and synthesis; 3) their roles in regulating the metabolic processes essential for animal growth and development (e.g., fat metabolism, protein turnover, glucose homeostasis, nucleotide synthesis, and immune response) via the production of unique metabolites and signaling pathways; 4) their dietary supplementation as a practical, effective means to maintain tissue integrity, improve pregnancy outcomes, enhance animal growth, and optimize health; and 5) their role in reducing dietary protein content to minimize nitrogen excretion and environmental pollution. Recent examples for the beneficial application of the arginine-family amino acids to swine nutrition are: 1) preventing intestinal atrophy and improving growth performance in weanling pigs through dietary supplementation with glutamine; and 2) increasing growth performance in milk-fed piglets and finishing pigs as well as enhancing fetal survival and growth in gestating sows through dietary supplementation with arginine. Future holds great promise for the use of the arginine-family amino acids in increasing the efficiency of animal agriculture. Supported by grants from USDA/NRI, TAES, Texas Tech University, The Chinese Academy of Sciences, and China NSF.

Key Words: Arginine, Nutrition, Nonruminants

290 Biological roles of tryptophan and its metabolism in pigs. N Le Floc'h* and B Sève, *UMR INRA-Agrocampus SENAH, Saint Gilles, France.*

Tryptophan (TRP) is an essential amino acid which content does not exceed 1.1% of whole-body protein. Apart from its incorporation into body proteins, TRP is known to play important biological roles, most of them being associated to metabolic pathways involved in its catabolism. Tryptophan deficiency was shown to depress the appetite parallel to slower gastric emptying and reduced insulin secretion in young pigs. However, independent of the latter effects, tolerance to glucose was reduced. This role of TRP in sensitivity to insulin appeared to depend on vitamin B6 supply. Otherwise, tryptophan transport and availability in the brain is one of the limiting steps for synthesis of serotonin which is involved in the appetite for protein. Serotonin is

also involved in sleep, mood and stress response. It was recently shown that pigs receiving a large excess of TRP exhibit lower cortisol and catecholamine response to social stress. However, from a quantitative point of view, the proportion of tryptophan used for the production of serotonin is very low: less than 10% of tryptophan that is degraded would be into serotonin. Most of TRP degradation occurs through the kynurenine pathway. Two enzymes are involved in the first step of this pathway: TDO located in the liver degrades excess TRP; we focus our talk on the second enzyme, IDO expressed by immune cells and tissues targets by inflammation. Increased TRP catabolism through the IDO pathway occurs during inflammatory states and immune stress leading to reduced TRP availability when this amino acid is not provided at a sufficient amount by the diet. We showed that pigs fed with a low TRP diet were more sensitive to an inflammatory stress. We will discuss what can be the roles of TRP catabolism through IDO pathway in the regulation of T cells proliferation and the production of antioxidant molecules.

Key Words: Tryptophan, Serotonin, Inflammation

291 Methionine: Nutrition and metabolism. J. T. Brosnan*, *Memorial University of Newfoundland, St. John's, NF, Canada.*

Methionine, a dietary indispensable amino acid, is one of two sulfur-containing amino acids commonly found in proteins. A hydrophobic amino acid, it plays a critical role in protein structure. Oxidative damage to methionine residues in proteins may play a role in aging. The first step in methionine's metabolism gives rise to S-Adenosylmethionine (SAM) which plays a number of diverse metabolic roles, including methylation and polyamine synthesis. About 70 methyltransferases have been identified; bioinformatic analysis of a number of genomes suggest that as many as 1% of all genes may code for methyltransferases. Quantitatively major methylation reactions include the synthesis of creatine and phosphatidylcholine. Other critical reactions involve methylation of DNA, RNA and proteins. This transmethylation pathway produces homocysteine which may be oxidized, via conversion to cysteine, by the transsulfuration pathway, or may be reconverted to methionine (thus, conserving this indispensable amino acid) by the process of remethylation. Homocysteine removal by these reactions is impaired by folic acid, pyridoxal or Vitamin B12 deficiency as well as by some common genetic polymorphisms. Increased plasma homocysteine is associated with an increased incidence of cardiovascular disease, Alzheimer's disease and fractures.

Key Words: Methyltransferase, Homocysteine, S-adenosylmethionine

292 Effects of L-arginine supplementation on lactation performance of first parity sows. R. D. Mateo*¹, G. Wu^{1,2}, J. A. Carroll³, I. Shinzato⁴, H. K. Moon⁵, and S. W. Kim^{1,2}, ¹Texas Tech University, Lubbock, ²Texas A&M University, College Station, ³USDA-ARS-LIRU, Lubbock, TX, ⁴Ajinomoto, Tokyo, Japan, ⁵RDA, Suwon, Korea.

This study was conducted to determine the effects of L-arginine (ARG) supplementation (1.0%) on lactation performance using 27 first parity sows with litter size greater than 9. An isonitrogenous diet (1.7% L-alanine, ALA) served as the control. Sows were allotted to four dietary treatments which consisted of gestation and lactation diets: ALA-ALA, ALA-ARG, ARG-ALA, and ARG-ARG (gestation-lactation). All gestation diets contained 3.1 Mcal/kg and 12.1% CP and all lactation diets contained 3.2 Mcal/kg and 18.6 % CP. Litter size was equalized by cross fostering within the treatment groups before 24 h postpartum.

Experimental diets were fed 2 kg/d during gestation and ad libitum during lactation. Individual feed intake of sows was recorded daily during lactation. Body weight and backfat thickness of sows as well as body weights of individual piglets were measured weekly until weaning at 21-d of lactation. The number of days return-to-estrus was recorded. Backfat thickness of sows measured at the P2 position did not differ ($P=0.679$) nor did average daily feed intake ($P=0.524$) among the treatments during the 21-d lactation period. All treatment groups had similar days return-to-estrus ($P=0.778$). Initial body weight of piglets did not differ among treatments after cross fostering ($P=0.541$). Piglets of sows fed 1 % L-arginine from gestation to lactation (ARG-ARG) were heavier (2.35 vs. 2.68 kg, $P=0.026$) at 7 d of lactation and had a greater weight gain (0.971 vs. 1.253 kg, $P=0.037$) from d 0 to d 7 of lactation compared to piglets of sows fed the isonitrogenous diet from gestation to lactation (ALA-ALA). However, there were no differences in weight gains from d 7 to 21 among the treatments. Arginine supplementation in sow diets may improve the growth of neonate during early lactation period.

Key Words: Arginine, Sows, Lactation

293 Skeletal muscle protein synthesis in neonatal pigs is stimulated by α -ketoisocaproic acid, but not by norleucine. J. Escobar*, J. W. Frank, A. Suryawan, H. V. Nguyen, and T. A. Davis, *Baylor College of Medicine, Houston, TX.*

In neonatal pigs, skeletal muscle protein synthesis is stimulated when plasma leucine is increased within the physiological postprandial range. We previously have shown that valine and isoleucine were not able to stimulate protein synthesis when their plasma concentrations were elevated within the physiological postprandial range. The objective of the present study was to determine the effect of an elevation in plasma levels of α -ketoisocaproic acid (KIC, the α -keto acid of leucine) and norleucine (an aliphatic leucine analogue that does not charge leucyl tRNA) on skeletal muscle protein synthesis and the activation of translation initiation factors. Piglets (5 d of age) were food-deprived overnight and infused intra-arterially with saline or 400 $\mu\text{mol}\cdot\text{kg}^{-1}\cdot\text{h}^{-1}$ of leucine, KIC or norleucine for 60 min. At the end of the infusion period, protein synthesis and the activation of translation initiation factors were determined in longissimus dorsi muscle and liver. Plasma concentration of leucine was reduced ($P < 0.02$) by norleucine and increased ($P < 0.01$) by KIC compared to saline controls. Infusion of leucine and KIC increased the phosphorylation of eukaryotic initiation factor (eIF) 4E binding protein-1 (4E-BP1, $P < 0.01$), decreased ($P < 0.04$) the inactive 4E BP1•eIF4E complex, and numerically increased

the active eIF4G•eIF4E complex in muscle. Both leucine and KIC increased ($P < 0.03$) muscle protein synthesis. Norleucine had no effect on muscle translation initiation factor activation or protein synthesis. In the liver, the activation of translation initiation factors and protein synthesis were not affected by any treatment. Our results indicate that the ability of leucine to act as a nutrient signal to stimulate skeletal muscle protein synthesis is likely specific for leucine or its metabolites. (NIH AR 44474 and USDA 58-6250-6-001)

Key Words: Leucine, Norleucine, α -Ketoisocaproic acid

294 A flooding dose of valine can be used to measure protein synthesis in growing pigs. A. J. Libao-Mercado*^{1,3}, M. Rademacher², and C. F. M. de Lange¹, ¹University of Guelph, Guelph, Ontario, Canada, ²Degussa AG, Hanau, Germany, ³Cargill Animal Nutrition Phils., Bulacan, Philippines.

A key concern with flooding dose technique for measuring protein synthesis (PS) is that a large dose of amino acid (AA) can change the animals' hormonal and nutritional status, which can influence PS. Among stable isotope tracers, 1-¹³C-valine is the preferred amino acid for measuring PS in gut tissue and mucins. A study was conducted to determine the impact of a flooding dose of valine on the metabolic status of pigs. Six barrows (12 kg BW) were randomly assigned, following a two-treatment cross-over design, to 12-minute intravenous infusions of either 150 mM valine (1.5 mmol/kg BW) or saline (control). Blood samples were taken at 10 min prior to infusion, at the end of infusion, at 10 min intervals for 1 hr, and at 90 and 120 min post infusion. Plasma concentration of insulin, glucose, AA, urea nitrogen and packed cell volume (PCV) were measured. Data were analyzed as repeated measures using Proc Mixed Procedure of SAS. Infusion of valine increased plasma valine levels (4178 vs. 532 $\mu\text{mol/L}$; $P < 0.0001$) but had no influence on PCV (26.4 vs. 27.2%), glucose (5.8 vs. 5.9 mmol/L), urea nitrogen (8.5 vs. 7.8 mg/dL) and insulin (8.2 vs. 8.4 $\mu\text{U/mL}$; $P > 0.10$). It also had no impact on plasma levels of most AA, particularly leucine (240 vs. 231 $\mu\text{mol/L}$) and isoleucine (308 vs. 332 $\mu\text{mol/L}$; $P > 0.10$). There was however a slight increase in threonine (225 vs. 263 $\mu\text{mol/L}$; $P < 0.05$) and a tendency towards reduced glycine (1387 vs. 1312 $\mu\text{mol/L}$; $P < 0.10$). There were also numerical increases in alanine (1186 vs. 1310 $\mu\text{mol/L}$) and glutamine (788 vs. 846 $\mu\text{mol/L}$) levels ($P > 0.10$). The results indicate that a flooding dose of valine does not cause a substantial change in the metabolic status of growing pigs, and is therefore suitable for measuring PS rates in tissues with high protein turnover rates.

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295 Comparison of swine manure composition using multiple manure sampling methods. D. M. Sholly*, R. B. Hinson, K. L. Saddoris, M. C. Walsh, D. T. Kelly, B. T. Richert, A. L. Sutton, and J. S. Radcliffe, *Purdue University, West Lafayette.*

Sixteen manure pits (30 pigs/pit) were sampled monthly during a wean-finish trial (22 wks) to compare the effects of sampling method on estimates of manure DM and ash. Eight pits were emptied monthly

in a pull plug/recharge (PP) system, and 8 were kept as a deep pit (DP) system. Manure pits were sampled using: 1) mechanical core sampler (Coswala); 2) vacuum core sampler (vacuum); 3) cup sampler; and 4) agitated slurrystore sample (control, CTL). For core sampling, manure was obtained from 12 locations/pit and pooled. Cup samples were taken from 6 locations/pit and pooled. All data were analyzed using the GLM procedure of SAS. Within the PP system (40 obs/method), manure DM was 14.8% higher ($P < 0.05$) for vacuum samples compared

to CTL samples, while DM was 30.3 and 44.5% lower ($P < 0.05$) for Coswala and cup samples, respectively, compared to CTL samples. Manure ash content was 12.5% higher ($P < 0.10$) for vacuum samples and 19.8% lower ($P < 0.05$) for cup samples compared to CTL samples. Ash content of Coswala samples was 10.4% less than CTL samples, although statistically similar. Within the DP system (wk 22, 8 obs/method), manure DM was 28.6% lower ($P < 0.10$) for cup samples compared to CTL samples. Manure DM was 7.7% higher for vacuum samples and 16.7% lower for Coswala samples compared to CTL samples, but neither were statistically different from the CTL. Numerically, DP system manure ash followed the same pattern, but no significant differences ($P > 0.10$) were observed among sampling methods. From wk 8-22, manure DM from Coswala and cup samples increased from 53 to 79% and 47 to 71%, respectively, relative to vacuum samples in the DP system. Relative estimates of manure ash followed a similar pattern, although initial estimates were closer (67%) to vacuum samples. Outcomes of this trial demonstrate that manure sampling method can significantly influence manure composition, potentially impacting land application.

Key Words: Pigs, Manure, Sampling method

296 Comparison of daily milk weight data with the multiple trait prediction model. M. Quist^{*1}, D. Kelton¹, S. LeBlanc¹, K. Hand², D. Lazenby², and F. Miglior^{3,4}, ¹University of Guelph, Ontario Veterinary College, Guelph, Ontario, Canada, ²CanWest Dairy Herd Improvement Corporation, Guelph, Ontario, Canada, ³Agriculture and Agri-Food Canada - Dairy and Swine Research and Development Centre, Lennoxville, Quebec, Canada, ⁴Canadian Dairy Network, Guelph, Ontario, Canada.

The objective of this study was to compare the MTP 305-day lactation yield with the non-traditional 305-day daily milk yield data (from on-farm automated meters and software) to examine the accuracy of the MTP at different stages of lactation. Many automated milking parlour systems have the ability to record and store individual milk weights for each cow at each milking. The availability of these data as inputs to regional and national milk recording programs needs to be evaluated. Traditionally, 24-hour milk and component yields are calculated using milk weights and samples collected 8-10 times per year by Dairy Herd Improvement (DHI) organizations. The Multiple Trait Prediction (MTP) model uses these data to predict 305-day lactation yields. The information generated by these models is used in genetic evaluation programs and for on-farm selection and management of dairy cattle. Daily milk weights were collected from milking cows on 5 farms using parlour milking systems with automatic animal identification. A total of 139 cows with complete 305-day lactation yields were included in the analysis. All herds were enrolled on a regular DHI program. In this preliminary analysis, 908 DHI test-days were entered into the MTP model and lactation yields were predicted. Test-days were grouped into 1st, 2nd and 3rd + lactations and within each lactation group, days in milk (DIM) were categorized in 3 stages (5-60, 61-120 and 120-305+ DIM) for a total of 9 classes. Agreement analysis was used to compare the daily milk weights 305-day lactation yield to the MTP 305-lactation yield predictions, using inputs from various test-days throughout the lactations. Results suggest that the MTP model using monthly test day inputs predicted late lactation yields across all parity groups more accurately than early lactation yields.

Key Words: Daily milk weights, MTP model, Lactation yields

297 Simulation of variation in methane emissions from enteric fermentation in dairy cattle in the Netherlands. J. Dijkstra^{*1}, A. Bannink², K. W. van der Hoek³, and W. Smink⁴, ¹Wageningen University, Wageningen, The Netherlands, ²Wageningen University and Research Centre, Lelystad, The Netherlands, ³RIVM, Bilthoven, The Netherlands, ⁴Feed Innovation Services, Wageningen, The Netherlands.

Accurate estimation of methane emissions has a profound effect on mitigation options available to meet commitments under the Kyoto protocol. The objective of this study was to simulate the methane emissions from dairy cattle in the Netherlands during 1990-2003 using a mechanistic model of fermentation and digestion of nutrients and methanogenesis in the gastro-intestinal tract [Mills, J.A.N., J. Dijkstra, A. Bannink, S.B. Cammell, E. Kebreab and J. France. 2001. A mechanistic model of whole-tract digestion and methanogenesis in the lactating dairy cow. *J. Anim. Sci.* 79:1584-1597] and updated VFA stoichiometric coefficients that relate type of VFA formed to rumen pH and to type of substrate fermented. Diet and milk production data of Dutch dairy cattle were available from the Workgroup Uniform Manure and Mineral Figures and the Dutch Marketing Board Dairy Products. DMI increased from an average 14.7 kg/d (1990) to 17.6 kg/d (2003). In these years, the dietary proportion of grass decreased, and that of grass silage and corn silage increased considerably. Fat and protein corrected milk (FPCM) production increased from 17.5 kg/d (1990) to 22.7 kg/d (2003). The simulated methane production was 107.7 (1990) and 124.6 (2003) kg/year, or 16.8 and 15.0 g methane/kg of FPCM. The methane conversion factor decreased from 6.1 to 5.9% of GE intake in 1990 and 2003, respectively. This decline was the combined result of an elevated DMI and a change towards less fiber and more starch in the diet. Unlike the IPCC Tier 2 method which assumes a fixed 6% of GE intake loss as methane, the mechanistic model accounts for the effects of dietary manipulations on methane emissions required for full assessment of mitigation options. The simulation results will be included in the Dutch 2006 National Inventory Report of greenhouse gas emissions.

Key Words: Dairy cattle, Mechanistic model, Methane

298 Relationship between size of vegetated buffers and transport of fecal coliform bacteria from pasturelands treated with dairy cow manure. T. J. Sullivan¹, J. A. Moore², T. W. Downing^{*2}, D. Thomas², E. Mallory³, K. U. Snyder¹, M. Wustenberg⁴, and S. Mackey¹, ¹E+S Environmental, Corvallis, OR, ²Oregon State University, Corvallis, ³Oregon Streamside Service, Tillamook, OR, ⁴Kilchis Dairy Herd Service, Bay City, OR.

Field spreading of dairy manure can contaminate streams and estuaries with fecal coliform bacteria (FCB), posing health hazards and impairing beneficial uses such as recreation and shellfish harvesting. The installation of vegetated buffers between application areas and streams is a common BMP. It is important that we determine buffer widths that will simultaneously protect water quality and require the smallest buffer width necessary. Buffer size requirements have typically been established by political process and it has been unclear what degree of treatment could be expected. Here we show that installation of a vegetated buffer on loamy soils dramatically reduced the bacterial contamination of runoff water from manure-treated pasturelands. However, the size of the vegetated buffer was not an important determinant of the extent to which bacteria were removed from runoff. Results from 17 experimental treatment cells during 9 rainstorms indicated that only 10% of the runoff samples collected from treatment

cells having vegetated buffers exhibited FCB concentrations > 200 colony forming units (cfu)/100 ml, and the median concentration for all cells containing vegetated buffers was only 6 cfu/100 ml. The presence of a vegetated buffer of any size, from 1 m to 25 m, generally reduced the median FCB concentration in runoff by more than 99%. This result was largely due to the observed high rate of infiltration of precipitation, even during large storms (up to 20 cm). It appears that FCB contamination of runoff from manure-treated pasturelands may be disproportionately associated with specific field or management conditions, such as the presence of soils that exhibit low water infiltration and generate larger volumes of runoff. Buffer size regulations that do not consider such differences may not be efficient or effective in reducing bacterial contamination of runoff.

Key Words: Vegetative buffers, Fecal coliform bacteria

299 Effects of dietary crude protein on ammonia emissions from dairy heifers. W. A. Jackson*, E. J. DePeters, J. G. Fadel, and F. M. Mitloehner, *University of California, Davis*.

Dairy operations are considered an important source of atmospheric ammonia (NH₃) emissions impairing ambient air quality. The study objective was to evaluate the effects of dietary crude protein on NH₃ volatilization from urine and feces of Holstein heifers housed in enclosed corrals. The hypothesis was that nitrogen (N) fed in excess of the heifer's dietary requirements is excreted in urine and feces, resulting in increased gaseous NH₃ emissions. Heifer diets were formulated to bracket the NRC N requirements. Twenty-four short-bred heifers averaging 495 kg were randomly assigned to four groups. Every group was housed in one of four greenhouse-like enclosures that were used to allow for comprehensive measurements of gaseous emissions. At the onset of each treatment period animal groups were assigned to their rations, following a 4x4 Graeco-Latin square design. Diets were formulated to contain 12%, 14%, 16%, or 18% CP. Diets differed only in almond hull, barley, and soybean meal content to achieve the desired CP level. All diets contained 50% oat hay and 12% alfalfa hay. Heifers were fed ad libitum once daily for a 16 d period. On d 16, NH₃ emissions were measured three times (2 h sampling intervals) using an EPA approved sampling train method. Random floor grab samples were taken from nine locations on the corral floor of each enclosure to assess pH, surface temperature, and total N. On d 17, heifers were weighed and blood samples collected to determine blood urea N. Urine and fecal samples were collected for total N analysis. Ammonia emission flux decreased incrementally from 18% CP (highest) to 12% CP (lowest). Urine urea N and blood urea N concentrations followed the same trend as the ammonia flux. Dry matter intake was similar across treatments. Present results show that high dietary CP concentrations lead to increased ammonia emissions. Further studies will identify CP levels needed to achieve optimal animal performance while minimizing environmental impacts.

Key Words: Dairy ammonia emissions, Crude protein

300 Nitrogen, phosphorus, and potassium balance and potential for reducing phosphorus imports in Idaho dairy farms. A. N. Hristov*, W. Hazen, R. Etter, and J. W. Ellsworth, *University of Idaho, Moscow*.

Eight commercial dairies from southcentral Idaho were surveyed to estimate the whole-farm balance of nitrogen (N), phosphorus (P), and potassium (K) and to investigate the possibility of reducing P excretion through dietary manipulation. Nitrogen, P, and K imports and exports were monitored in a 12-mo period and samples from the diets, feeds,

feces, urine, and manure were collected at regular farm visits. Soils from manure-amended fields were sampled in the spring and fall. In all cases, the largest import of N, P, and K to the dairy was with purchased feeds (on average 90, 95, and 92% of all N, P, and K imports). Major nutrient export items were milk and manure and forages in the case of a dairy with a large land base (DairyF). Whole-farm N surplus varied from 91 to 604 t/year. The efficiency of use of imported N varied from 25 to 64%, with DairyF having the greatest efficiency. Phosphorus and K surpluses were also significant (average of 29 and 182 t/year, respectively). During the study period, DairyF was a net exporter of K. The average efficiency of use of imported P and K was 66 and 58%, respectively. Soil P levels in the 30-cm layer were high and above state threshold standards, most likely reflecting accumulation of P on the farm and over application of manure. Soil nitrate-N concentrations were also high, but K concentrations were within the accepted range. The average P content of the lactating cow diets was 0.49% and was reduced ($P = 0.007$) to 0.38% in the second year of the study, which resulted in numerical decrease (by 16%; $P = 0.167$) in average fecal P concentrations. The estimated reduction in imported P due to the reduced dietary P levels was from 5.7 to 61.4 t/year/dairy. This study indicated that in addition to exports with milk and manure, export of nutrients with forages produced on the farm is a major factor in achieving whole-farm N, P, and K balance.

Key Words: Nutrient management, Whole-farm balance, Dairy cow

301 Daily manure production from a lactating cow facility. M. Hollmann*¹, K. F. Knowlton¹, C. M. Parsons¹, M. D. Hanigan¹, and T. N. Rensch², ¹*Virginia Polytechnic Institute and State University, Blacksburg*, ²*Integrity Nutrient Control Systems, Inc., Chambersburg, PA*.

Manure and its nutrient concentrations are important in meeting environmental regulations. This project determined the daily production of manure at the Virginia Tech Dairy in 2005. The herd consisted of 140 Jerseys, Holsteins, and crossbreds, with a mean bodyweight of 560 kg, and averaged 30.1 kg/d milk with 3.16% true protein. The intake of N and P was estimated from the formulated TMR, allowing for a 3% feed refusal. Approximately 103 kg/d of sawdust were used as bedding. The alleys in the freestall barn were flushed every 6 h with recycled wastewater and the slurry was collected. On 17 dates the volumes and constituents of the flushwater and the flushed manure were determined during a 6 h flush cycle. One sampling showed outlying results and was eliminated from the analysis. Net daily accumulations of solids and nutrients from the manure were calculated as the differences between masses in flushed slurry and flushwater. These results were compared with ASAE Standards for "Manure Production and Characteristics" with the Students t-test. Total (TS) and volatile solids (VS) per cow were 6.4 and 5.3 kg/d with bedding, and 5.7 and 4.6 kg/d without bedding. Production of TS and VS without bedding differed from the standards, but VS as a percentage of TS (84%) did not. Daily chemical oxygen demand was similar to the ASAE prediction of 6.2 kg/cow. Total Kjeldahl N (289 g/d), ammonia-N (144 g/d; n=12), and P (77 g/d) accumulations per cow were higher than predicted. Recovery in slurry of the P in feed and bedding minus P in milk was 93%. Recovery of N averaged 59%. Assuming a constant N loss from manure, N loss was 4.3%/h. Assuming that 60% of the manure N was in urine, the urinary N volatilization rate was 15.5%/h. These results showed less than predicted production of TS and VS in the manure of lactating dairy cows and provide a practical estimate of N volatilization and P recovery.

Key Words: Dairy farm mass balance, Manure production, Nitrogen volatilization

Ruminant Nutrition: Forage & Fiber

302 Meta analysis of ruminant digestive responses of cattle to dietary NDF. D. Sauvant*¹ and D. Mertens², ¹*Institut National Agronomique Paris Grignon, Paris, France*, ²*US Dairy Forage Research Center, Madison, WI*.

Ruminal responses to dietary NDF are useful for improving feeding systems. A database was compiled from 176 published experiments (n = 448 treatments) where dietary NDF or concentrate content varied. Dietary NDF averaged 38.5 ± 13.3% of dry matter (DM from 13 to 80%). Data were analysed using GLM to separate among and within experiment variance. Equations are in the table. Ruminal pH (6.23 ± 0.33) was related curvilinearly to NDF. Duration of time with ruminal pH below 6 (TpH6 = 395 ± 360 min/d) decreased as NDF increased. Acetate/propionate ratio (A/P = 3.26 ± 0.92) increased curvilinearly with NDF. Apparently (DOMa = 39.7 ± 10.8 %DM) and truly (DOMr = 53.0 ± 10.5 %DM) digested OM in the rumen were inversely related to NDF. Microbial crude protein synthesis (MCP = 8.1 ± 2.7 %DM) was depressed as NDF increased, however microbial growth efficiency was not altered by dietary NDF. Fractional outflow rates of particles (kp = 4.32 ± 1.67 %/h) and liquid (kl = 10.06 ± 3.13 %/h) were affected by dietary NDF. Rumen liquid (RL = 5.30 ± 2.57 g/100g DMI) and rumen liquid outflow rate (ROUTL = 12.15 ± 4.15 g/100g DMI) were increased by dietary NDF. Similar results were observed when rumen liquid was expressed on a live weight basis. Most digestive responses were altered by dietary NDF, and the proposed equations can be used to evaluate rumen mechanistic models and improve feeding systems.

Table 1.

Variable	Cste	NDF	NDF2	n	nexp	rmse
PH	5.36	+0.029	-0.00017	249	98	0.13
TpH6	909	-13.6	-	70	30	181
A/P	0.82	+0.086	-0.00054	235	97	0.42
DOMa	48.7	-0.22	-	154	62	4.9
DOMr	58.7	-0.13	-	123	49	4.2
MCP	8.70	-	-0.0003	124	49	0.81
kp	4.67	+0.029	-0.0005	126	51	0.46
kl	6.5	+0.153	-0.0015	141	55	0.91
RL	3.96	-	+0.00074	142	60	0.66
ROUTL	2.27	+0.32	-0.0017	142	60	0.59
RLW[g/100gLW]	9.50	+0.062	-	135	58	1.08

Key Words: NDF, Ruminal pH, Ruminal digestion

303 Meta analysis of multiple responses of dairy goat to diet concentrate content. D. Sauvant*^{1,2} and S. Giger-Reverdin², ¹*Institut National Agronomique Paris Grignon, Paris, France*, ²*Institut National de la Recherche Agronomique, Paris, France*.

Dairy goat multiple responses to dietary concentrate are useful to develop feeding systems. A data base was built from 62 experiments (147 treatments) where the concentrate level (%CO = 43.2 ± standard deviation 21.1 % dry matter-DM), or the dietary NDF content, varied. %CO was considered as the explicative variable. The following parameters were collected: dry matter intake % of live weight (DMI = 4.05 ± 0.77 % LW), chewing time (CT = 673 ± 164 min/d), measured diet organic matter digestibility (OMD = 68.3 ± 7.5 %), diet energy density (ED = 1.51 ± 0.21 Mcal/kgDM), raw milk yield (RMY =

2.76 ± 1.12 kg/d), milk contents in fat (MFC = 3.58 ± 0.78 %) and protein (MPC = 3.10 ± 0.46 %), energy balance (EB = 0.18 ± 0.58 Milk Mcal/d). Data were analysed with the GLM procedure to separate across and within experiment variations which were captured by a curvilinear combination of %CO and %CO₂. Increase in %CO affected DMI with a maximum value for %CO near 57% (DMI = 3.40 + 0.029 %CO - 0.00025 %CO₂, n = 126, nexp = 52, rmse = 0.35). When NDF content was measured, it was closely linked to %CO (NDF = 55.0 - 0.245 %CO, n = 53, nexp = 19, rmse = 3.4). Chewing time was inversely related with %CO (CT = 1035 - 6.31 %CO, n = 21, nexp = 7, rmse = 56). OMD was positively and closely linked with %CO (OMD = 63.2 + 0.185 %CO, n = 34, nexp = 13, rmse = 2.7). The dietary ED was linearly enhanced by %CO increase (ED = 1.26 + 0.0064 %CO, n = 91, nexp = 37, rmse = 0.07). RMY was positively and curvilinearly linked with %CO, with a maximum beyond the range of %CO data (RMY = 1.80 + 0.032 %CO - 0.00020 %CO₂, n = 145, nexp = 61, rmse = 0.23). MFC was inversely related to %CO (MFC = 3.66 - 0.000063 %CO₂, n = 115, nexp = 48, rmse = 0.20), in contrast, MPC was not influenced. Energy balance was positively and curvilinearly related with %CO (EB = - 0.14 + 0.00016 %CO₂, n = 89, nexp = 36, rmse = 0.20). Significant equations allowed to describe fairly accurately marginal responses to dietary concentrate in dairy goat, they can be used to build formulation programs including strategy of concentrate supply.

Key Words: Dairy goat, Responses to concentrate supply, Meta-analysis

304 Investigating *Silphium perfoliatum* (cup plant) silage for growing cattle. M. H. Ramos*, J. W. Lehmkuhler, S. C. Arp, and K. A. Albrecht, *University of Wisconsin, Madison*.

Three experiments were conducted to examine the response of substituting cup plant silage for corn silage. In Exp. 1 thirty-six weaned steers (avg initial wt = 244 kg +/- 16) were blocked by source and assigned to nine pens. Treatments were randomly assigned to pens within blocks. Basal diets were corn silage (CS), 33% cup plant+67% corn silage (1/3 cup) or 67% cup plant+33% corn silage (2/3 cup) DM basis. All diets received the same suppl. Diets were offered for 110d. ADG was significantly different (P<0.05) among treatments averaging 1.38, 1.20 and 0.77 kg/d, respectively for CS, 1/3 cup and 2/3 cup. DMI was not different (P>0.05) between CS and 1/3 cup (6.43 kg/d vs 6.38 kg/d) while 2/3 cup had the lowest (P<0.01) intake of the three treatments (5.33 kg/d). G:F was different (P<0.05) for treatments with CS>1/3 cup>2/3 cup. Exp. 2 used twenty-four yearling steers (avg initial wt = 353 kg +/- 22) and twelve yearling heifers (avg initial wt = 362 kg +/- 11) for 62 d from late August through late October of 2005. The same diets as Exp. 1 were tested. Animals were blocked by sex and allotted to nine pens with treatment randomly assigned to pens within blocks. ADG did not differ (P>0.05) between CS and 1/3 cup (1.40 kg/d vs 1.13 kg/d) while 2/3 cup (0.98 kg/d) was significantly (P<0.05) lower than CS. DMI was not different (P>0.05) among diets. G:F was different (P<0.05) with CS>2/3 cup while 1/3 cup was similar to both (P>0.05). A digestibility trial using a 3x3 Latin Square design with an extra observation was conducted using the same feed offered during Exp. 2. Animals were fed ad libitum 2 times a day. During the 5d adaptation period steers were bolused with 5g of TiO₂ at 12h intervals. During the 3d collection period fecal samples were collected at 6h intervals. DMI was greatest (P<0.05) for CS at 5.90 kg/d while 1/3 cup was not different (P>0.05) than 2/3 cup (5.34 kg/d vs 5.08 kg/d,

respectively). Corn silage had higher ($P<0.05$) DM, OM and NDF digestibility than 1/3 cup and 2/3 cup. NDF intake was not different ($P>0.05$) between treatments. We conclude that corn silage substituted by cup plant at low level allows for respectable performance.

Key Words: Beef cattle, Silage, *Silphium perfoliate*/cup plant

305 Particle size distribution in rumen contents and faeces from cows fed grass silages in different physical form or barley straw supplemented with grass pellets. P. Norgaard* and L. F. Kornfelt, *The Royal Veterinary & Agricultural University, Copenhagen, Denmark.*

The purpose of the experiment was to study effects of forage quality and physical form on particle size distribution in rumen contents and faeces. A 4 x 4 Latin square experiment was conducted with 4 rumen cannulated, non lactating Jersey cows fed 80% of ad libitum intake of unchopped grass silage (U), chopped grass silage (CS), barley straw (H) or 0.6 kg barley straw (L). Straw diets were supplemented with 3 kg grass pellets. NDF in DM were 34, 71 and 29% for grass pellets, barley straw and grass silages, respectively. Faeces and rumen contents sampled before and after the morning meal were washed in nylon bags (0.01 mm) and freeze-dried before sieving through 4.7, 2.8, 1 and 0.5 mm pore sizes into n fractions. The length (PL), width (PW) and area (PA) of particles in sub samples from each sieving fraction were measured by Image analysis. The arithmetic mean PL (APL_n) and PW (APW_n) were estimated by weighting with PA. The overall APL and APW values were estimated by weighting with the mass proportions in the individual fractions (m_n). The PL and PW distributions were estimated by gamma functions, and the overall most frequent PL (MoPL) and PW (MoPW) were estimated from a composite density distribution function by weighting with m_n . Data were analyzed by PROC MIXED in SAS v. 8.1 with treatment, period, T and T*treatment as fixed effects and cow as random. The rumen APL, APW and proportions of washed rumen particles retained in the bottom bowl and in the sieves with 4.7, 2.8 and 0.5 mm pore size were affected ($P<0.05$) by time of sampling (T) and treatments. There was an interaction ($P<0.02$) between treatments and T on rumen MoPL and APL. The MoPL and MoPW values of faeces particles were 0.28, 0.26, 0.41 and 0.44 mm, and 0.05, 0.04, 0.07 and 0.08 mm, respectively, for the CS, US, L and H treatments ($P<0.01$). In conclusions, the mode dimensions of faeces particles appear to be affected by forage quality.

Key Words: Particle length, Image analysis

306 Effect of yeast culture on efficiency of nutrient utilization for milk production and impact on fiber digestibility and fecal particle size. J. Harrison¹, R. White*¹, D. Mertens², I. Yoon³, W. Sanchez³, and L. Nicholson³, ¹Washington State University, Puyallup, ²USDFRC, Madison, WI, ³Diamond V Mills, Cedar Rapids, IA.

Objectives of this study were to evaluate the effect of Diamond V XP Yeast Culture on milk production, fiber digestibility and fecal particle size. Two groups of 111 cows each (average DIM of 179 and 191 at initiation of trial) were utilized in a two-period (40 d and 49 d) switchback design. The BW and milk production data were analyzed using the GLM procedures of SAS. Cows received basal diets containing SBM, steam rolled corn, potatoes, canola meal, whole cottonseed, corn silage, alfalfa hay and vitamin-mineral mix once/d

and milked 3X. Treatment group received 140 g/d premix (ground corn, mill run and soybean meal) containing 56 g yeast culture. Control group received 140 g/d premix without yeast culture. The addition of yeast culture resulted in a trend for increased 3.5% FCM (43.0 vs 42.4 kg/d; $P<0.19$), and increases in milk fat percentage (3.69 vs 3.61%; $P<0.02$), milk fat production (1.53 vs 1.49 kg/d; $P<0.08$), and body weight (BW) gain (1.31 kg vs 0.35 kg/d; $P<0.001$). A numerical increase in dry matter intake (0.45 kg/d) was observed with yeast culture. Yeast culture did not affect milk protein percentage, MUN and estimated microbial protein production. Milk potential from BW gain was calculated based on energy value of body tissue and that of 3.5% FCM. This calculation resulted in an estimated 3.2 kg/d more 3.5% FCM for cows receiving yeast culture. Digestibility of NDF was numerically greater for cows receiving yeast culture (37.8 % vs 34.6%) resulting in a numerically higher percentage of smaller particles in the feces. Results suggest that addition of yeast culture can improve production of milk fat and 3.5 % FCM; and, may increase total tract NDF digestibility, and decrease fecal NDF particle size.

Key Words: Dairy nutrition, Yeast culture, Fecal particle size

307 Effects of chop lengths of alfalfa and oat silage on feed intake, milk production, rumen pH, and feeding behavior of dairy cows fed total mixed rations. S. K. Bhandari*, J. C. Plaizier, K. H. Ominski, and K. M. Wittenberg, *University of Manitoba, Winnipeg, MB, Canada.*

Effects of chop length of alfalfa silage and oat silage on dry matter intake, rumen conditions, and milk production were investigated in 16 mid-lactation Holstein, four of which were rumen fistulated. Forages were chopped short (6 mm) or long (19 mm) using a New Holland Forage Harvester, model 790. A four by four replicated Latin square design with experimental periods of two adaptation weeks and one sampling week was used. Feeding behavior was monitored in 8 cows using video taping and a 5 min scan sampling technique. Cows were fed total mixed rations containing (DM basis) 42% barley grain based energy supplement, 10% protein supplement, and 24% long chop alfalfa silage (AL) or short chop alfalfa silage (AS) and 24% long chop oats silage (OL) or short chop oat silage (OS). Hence, the four diets were ALOL, ALOS, ASOL, and ASOS. Reducing the chop length reduced the proportion of the alfalfa silage and the oat silage retained by the 8 and 19 mm screens of the Penn State particle Separator (pe) from 83.5 to 75.3% of DM and from 81.8 to 74.8% of DM, respectively. This shows that all forages were coarse, and that theoretical chop length might not predict particle size distribution. The chop length reduction decreased the pH of alfalfa silage and oats silage from 6.0 to 4.9 and from 5.4 to 4.6, respectively. Statistical analysis was conducted with SAS Mixed procedure. The effects of alfalfa chop length and oats chop length were considered fixed. The effects of cow and period were considered random. Reducing the chop length of both silages reduced the pe of the diets from 71.4 to 64.6%DM (Table). Reducing oat silage chop length increased DMI, but did not alter rumen pH, feeding behavior, and milk production. Reducing alfalfa chop did not affect DMI, rumen pH, feeding behaviour, and milk production. In this study reducing chop length improved silage quality, but this did not result in increased milk production or put cows at risk for subacute ruminal acidosis.

Table 1.

	Diet ¹				SE	Effect ¹		P value
	ALOL	ALOS	ASOL	ASOS		AC	OC	
pe, %DM	71.4	68.9	69.3	64.6	4.5	0.30	0.21	
peNDF _{PS} , % DM	24.5	23.4	23.7	21.6	1.64	0.28	0.19	
peNDF _{NDF} , % DM	28.1	27.5	26.3	24.3	2.10	0.11	0.41	
DMI, kg/d	19.0	21.3	19.7	21.0	0.45	0.61	<0.01	
Avg. rumen pH	6.21	6.22	6.27	6.27	0.07	0.30	0.94	
Time < pH 5.6, hr/d	197	128	121	129	59.6	0.41	0.50	
Milk yield, kg/d	35.0	36.3	36.7	36.2	0.81	0.65	0.33	
Milk fat yield, kg/d	1.02	1.08	1.11	1.10	0.03	0.58	0.08	
Milk protein yield, kg/d	1.08	1.13	1.15	1.15	0.02	0.47	0.10	
Eating, h/d	6.0	6.4	5.9	5.9	0.23	0.09	0.28	
Ruminating, h/d	9.5	9.4	9.4	9.9	0.29	0.37	0.28	
Idle, h/d	8.5	8.2	8.7	8.2	0.37	0.68	0.13	

¹AC = alfalfa chop effect, OC = oats chop effect

Key Words: Forage chop length, Milk production, Feeding behavior

308 Effects of enhanced in vitro fiber digestibility of barley silage on dry matter intake and milk yield of dairy cows. L. Chow^{*1}, M. Oba¹, V. Baron², and R. Corbett³, ¹University of Alberta, Edmonton, AB, Canada, ²Agriculture, Agri-Food Canada, Lacombe, AB, Canada, ³Alberta Agriculture Food and Rural Development, Edmonton, AB, Canada.

The effect of enhanced in vitro NDF digestibility (IVFD) of barley silage on DMI and milk production was evaluated using thirty primiparous and multiparous cows (182.7 ± 71.7 days in milk; mean ± SD) in a crossover design with 19-d periods. Six of the multiparous cows were ruminally cannulated prior to the experiment. Two fields of barley were planted on either May 5, 2005 (BM) or June 7, 2005 (BJ), and both were harvested at the late-dough stage and ensiled. Concentrations of NDF and starch of fresh samples were 50.4% and 26.3% for BM, and 52.6% and 24.6% for BJ, respectively. The 30-h IVFD was greater for BJ by 8.8 units compared with BM (60.5 vs. 51.7%). It was hypothesized that barley silage with enhanced IVFD would reduce the physical fill of the rumen allowing for greater DMI and milk production. Experimental diets containing either BM or BJ at 59% of dietary DM were formulated for 37.1% and 39.5% dietary NDF concentrations for BM and BJ treatments, respectively. Both diets were formulated for 17% CP, and fed as a total mixed ration. The DMI (20.4 vs. 19.9 kg/d) and milk yield (27.2 vs. 27.1 kg/d) was similar for both BM and BJ treatments, respectively. Mean ruminal pH was numerically lower for cows fed BJ compared with BM (5.97 vs. 6.07), but was not statistically significant (P = 0.16). Body weight gain was greater for cows fed BJ compared with BM (864 vs. 504 g/d). A significant interaction between parity and treatment effects was observed for BCS; BJ increased BCS gain compared with BM only for multiparous cows (0.13 vs. -0.02; P < 0.05). Lack of responses in DMI and milk production to enhanced IVFD of barley silage might be attributed to relatively lower milk production or later stage of lactation for cows used in this experiment; physical fill may not limit maximum DMI and milk yield. Then, expected additional energy intake from enhanced NDF digestion for cows fed BJ might be partitioned to the body weight gain.

Key Words: In vitro fiber digestibility, Barley silage, Physical fill

309 Voluntary feed intake affects response to dietary forage content. J. A. Voelker Linton^{*} and M. S. Allen, Michigan State University, East Lansing.

The effect of appetite on the relative importance of physical fill and metabolic satiety in regulating feed intake was tested using 14 ruminally and duodenally cannulated Holstein cows in a crossover design experiment with a 14 d pretrial period and two 15 d experimental periods. During the pretrial period, 3.5% fat-corrected milk yield (FCMY) was 15 to 60 kg/d (mean = 40 kg/d), and pretrial voluntary DMI (pVDMI) was 20.6 to 30.5 kg/d (mean = 25.0 kg/d). Treatments were a low-forage diet (LF), containing 20% of dry matter as forage neutral detergent fiber (NDF) and 24% as total dietary NDF, and a high-forage diet (HF), containing 27% forage NDF and 31% total dietary NDF. The ability of linear and quadratic factors of pVDMI to predict the difference in responses of individual cows to treatments (Y_{LF} - Y_{HF}) was tested by analysis of variance, with treatment sequence as a covariate. In contrast to a previous experiment, differences in DMI and FCMY responses to LF and HF did not depend on pVDMI (P > 0.50). This might be because of combined physical fill and metabolic satiety effects of LF, especially in cows with greatest pVDMI. Ruminal DM and NDF pools do not indicate that a physical threshold was reached, but NDF digestion and(or) passage might have been inhibited on LF among high-intake cows. As pVDMI increased, NDF turnover time increased more greatly on LF than on HF (r = 0.79, P = 0.05). Among high-pVDMI cows, NDF turnover time was actually greater on LF than on HF. With increasing pVDMI, digestion rate of pdNDF decreased at a similar rate on both diets (P > 0.90); passage rates of potentially digestible NDF and indigestible NDF were not related to pVDMI, regardless of treatment (P > 0.40). Because mean and minimum ruminal pH were lower for LF than for HF (P < 0.0001, P = 0.02), a slight numerical reduction in pH with increasing pVDMI observed for both diets would likely inhibit NDF digestion more for LF than for HF. Inhibition of NDF digestion might cause low-forage and high-forage diets to have similar effects on DMI, depending on the VDMI of individual cows.

Key Words: Dietary forage content, Digestion kinetics, Intake

310 Effect of SilAll4x4 inoculation on silage fermentation and protein quality of grass silage at different levels of dry matter. A. M. van Vuuren^{*}, P. G. van Wikselaar, and A. H. van Gelder, Animal Sciences Group of Wageningen UR, Lelystad, The Netherlands.

To study the influence of silage inoculant SilAll4x4 (Alltech, Lexington, KY) on the fermentation process in grass silages and on the nutritive value of the produced silages, an experiment with lab silos using perennial ryegrass was carried out. In May and September 2004, good quality grass was harvested and wilted to DM concentrations of 20, 35 and 50%. Wilted grass was cut and ensiled in 1-l Weck jars with or without SilAll4x4 (10 mg per kg of grass). After 3, 14, 28 and 90 days of ensiling, at least two jars per treatment were opened and analyzed for DM, ash, fermentation products (lactic acid, VFA, ammonia), and microbiological composition (lactic acid bacteria, entero bacteria, yeasts and moulds). After 90 days, samples were also incubated in rumen fluid and gas production was measured in time to determine the rate of OM degradation. At maximum rate of gas production the amount of purines in each vial was analyzed as a parameter for microbial biomass. The inoculated silages started with 10 times more LAB than the control silages which resulted in a faster pH drop and faster formation of lactic acid. Inoculated silages reached a stable pH value of 3.8 to 4.2 between day 14 and 28; control silages reached a

stable pH value of 4.2 to 4.6 after 28 days. The faster decline of pH in the inoculated silages resulted in a faster drop of enterobacteria. The levels of ammonia were significantly lower in inoculated silages. The insoluble nitrogen fraction was slightly ($P > 0.05$) higher in inoculated silages. The differences between inoculated and control silages were more pronounced in the high DM silages. Yeasts and moulds were detected at ensiling, but numbers were below detection levels after 90 days with no effect of inoculation. At maximum fermentation rate, amounts of purines in the incubation vials were higher for inoculated silages (18.8 versus 17.7 RNA-equivalents per g of OM for Control; $P = 0.02$). This suggests that inoculation with SilAll4x4 resulted in a better protein quality of the silage, which influences the efficiency of rumen microbial protein synthesis.

Key Words: Silage, Additive, Protein

311 Treating corn silage with formaldehyde and urea: Their effect on nutritive value using gas production technique. A. Taghizadeh*, M. Hatami, and G. A. Moghaddam, *Tabriz University, Tabriz, East Azarbayjan, Iran.*

In vitro gas production technique was used to measure the gas production from Iranian treated and untreated corn silage by formaldehyde and urea as test feeds. The formaldehyde and urea were added during the ensiling process for examine of their effect on preserving and fermentation characteristics of corn silage. The corn silage samples were chopped to 2 cm length. Treatments contain CS: untreated corn

silage, CSF: CS + 4 g/Kg DM formaldehyde, CSU: CS + 10 g/Kg DM urea, and CSFU: CS + 4 g/Kg DM formaldehyde + 10 g/Kg DM urea. Three sheep were used as donors of ruminal fluid for preparation of inoculum. The sheep (38±4 kg) were fed a diet consisting of 220 g kg⁻¹ concentrate and 780 g kg⁻¹ forage (corn silage and alfalfa) predicted metabolizable energy 2.98 Mcal/Kg DM and containing crude protein 140 g/Kg DM and used as ruminal fluid donor for the preparation of inoculums. The production of gas was measured in each vial after 2, 4, 8, 12, 16, 24, 36, 48, 72 and 96 h of incubation. The results were analyzed using completely randomized design (CRD) in each incubation time with Duncan's multiple range test used for the comparison of means. Feeds were the only sources of variation considered. Gas production data were in triplicate fitted to an equation of $p = a + b(1 - e^{-ct})$; where (p) is the gas production at time, t, (a+b) is the fermentation of soluble and the insoluble (but with time fermentable) fraction, (c) is the fractional rate at which b is fermented per hour. The soluble and insoluble fraction (a+b) for CS, CSF, CSU and CSFU was (ml/g) 241.8, 240.0, 225.0 and 238.1, respectively. The fractional rate (c) was (%/h) 0.028, 0.023, 0.025 and 0.027, respectively. The results showed the soluble and insoluble fraction (a+b) and the fractional rate (c) of CS was higher than the other treatments, ($P < 0.05$) The results showed that the differences between of chemical composition of treatments caused to change fermentation parameters determined by In vitro gas production technique. Urea and formaldehyde additions affected corn silage nutritive value.

Key Words: Gas production, Corn silage, Formaldehyde

Ruminant Nutrition: Transition Cow Metabolism

312 Phlorizin administration does not attenuate hypophagia induced by intraruminal propionate infusion. B. J. Bradford* and M. S. Allen, *Michigan State University, East Lansing.*

Propionate infusion decreases dry matter intake (DMI). Our working hypothesis is that propionate oxidation in the liver stimulates satiety and decreases meal size. In this experiment, phlorizin was used to increase glucose demand, which was expected to decrease propionate oxidation and attenuate the decrease in DMI caused by propionate infusion. Twelve multiparous Holstein cows (49 ± 33 DIM, 40 ± 7 kg/d milk; mean ± SD) were randomly assigned to square and treatment sequence in a replicated 4x4 Latin square experiment with a 2x2 factorial arrangement of treatments. Treatments were subcutaneous injection of phlorizin or propylene glycol in combination with intraruminal infusion of either Na acetate or Na propionate. Following a 7 d adaptation period, phlorizin (4 g/d) and control injections were administered every 6 h for 7 d. During the final 2 d of injections, Na acetate or Na propionate solutions (1 M, pH 6.0) were infused continuously at the rate of 0.80 L/h. Feeding behavior data were collected during the final 2 d of treatment. Statistical analyses were completed using mixed-effects models. Phlorizin caused urinary excretion of 400 g glucose/d across infusion types. Phlorizin increased plasma non-esterified fatty acid and beta-hydroxybutyrate concentrations in combination with Na acetate infusion, but not with Na propionate infusion. Phlorizin decreased and Na propionate increased plasma insulin and glucose concentrations (all $P < 0.01$). Infusion of Na propionate decreased DMI (18.4 vs. 21.1 kg/d, $P < 0.001$) through an increase in intermeal interval (77.3 vs. 89.2 min, $P = 0.03$), resulting in a decrease in the number of meals/d (13.7 vs.

11.6, $P < 0.001$). Phlorizin did not alter DMI or measures of feeding behavior, nor were there interactions with infusion type. We conclude that increasing glucose demand does not limit the extent to which propionate decreases DMI in lactating dairy cows.

Key Words: Propionate, Glucose demand, Dry matter intake

313 Response of plasma concentrations of gut peptides to abomasal infusion of casein, starch, or soybean oil in lactating dairy cows. A. E. Relling* and C. K. Reynolds, *The Ohio State University, Wooster.*

The effect of nutrient supply to the small intestine on gut peptide secretion in ruminants, and particularly cattle, has not been characterized. The objective of the present study was to determine the effects of abomasal infusion of macronutrients on DMI and plasma concentrations of glucagon-like peptide-1 (GLP1), glucose-dependent insulinotropic polypeptide (GIP), and cholecystokinin (CCK). Four rumen cannulated Holstein cows fed a ration containing (DM basis) 17 % alfalfa haylage, 38 % corn silage and 45 % concentrate were used in a 4 X 4 Latin square design with 2-wk periods. Treatments were 7 d abomasal infusions of water (12 kg/d), soybean oil (500 g/d), starch (1100 g/d), or casein (800 g/d). Hormone concentrations (pmol/L, Table 1) were measured in plasma from jugular vein samples (15/d at 30 min intervals) taken during day 1 and 7 of infusions. Oil infusion decreased DMI (kg/d), but not ME, decreased CCK concentration, and increased GLP1 concentration on day 7. Casein and starch infusion had no effect on DMI, but ME and GIP concentration were increased on day 1 and 7. Casein infusion increased CCK concentration on day 1 and

7. Increased GIP concentration with increased ME may be related to effects of this peptide on adipose synthesis.

Table 1. Dry matter intake and plasma concentrations of gut peptides on day 1 and 7 of abomasal infusions of water, casein, starch, or oil.

	Day	Water	Casein	Starch	Oil	SEM	Inf ¹	Day ¹	Int ¹
DMI	1	21.9	21.0	21.0	21.6	2.5	0.82		
	7	23.7	23.5	24.0	21.0*	2.0	0.04		
GLP-1	1	27.6	34.0**	26.3	27.8	1.6	0.01	0.01	0.01
	7	29.8	31.2	26.9*	33.5**				
GIP	1	564	671**	614†	638*	50	0.01	0.05	0.35
	7	558	631*	614**	576				
CCK	1	7.3	8.6†	7.2	6.0†	1.3	0.01	0.05	0.85
	7	8.5	9.6†	8.1	6.6**				

¹Probability for effect of infusion (Inf), day, or their interaction (Int). **P < 0.01 compared with water. *P < 0.05 compared with water. †P < 0.10 compared with water.

Key Words: Gut peptides, Abomasal infusions, Lactation

314 Effect of fatty acid saturation on gut and pancreatic hormone concentrations. B. J. Bradford*, K. J. Harvatine, and M. S. Allen, Michigan State University, East Lansing.

Saturated and unsaturated fat sources were evaluated for effects on plasma metabolites and gut and pancreatic hormone profile from before feeding through the second meal of the day. Eight ruminally and duodenally cannulated cows were used in a replicated Latin square design with 21 d periods. Treatments were control (CON) and 2.5% added rumen-protected fatty acids in the form of saturated (SAT; prilled hydrogenated free FA, Energy Booster 100[®]) and unsaturated (UNS; calcium soaps of long-chain FA, Megalac-R[®]) fat supplements. All experimental diets included 2.5% rumen available vegetable oil as whole cottonseed. Blood samples were collected every eight minutes with an automated blood collection system that minimizes influence on behavior. Feeding and ruminating behavior were observed during sample collection and for the following 4 days by a computer data acquisition system. Duodenal flow of unsaturated FA was greater for UNS (471 g/d) than SAT (360 g/d) or CON (330 g/d) while flow of saturated FA was greater for SAT (1350 g/d) than UNS (840 g/d) or CON (890 g/d). Dry matter intake for SAT was not different from control, while UNS decreased DMI 3.2 kg/d by decreasing mean meal size by 0.22 kg (9%). Blood plasma data was analyzed using a mixed model with repeated measures in time. UNS increased plasma NEFA concentration relative to SAT and CON (223 vs. 116 and 81 μEq/mL, respectively), and increased insulin concentration compared to CON (3.9 vs. 2.1 μIU/mL). Both UNS and SAT increased glucagon concentration compared to CON, and SAT increased glucose concentration compared to CON. UNS increased CCK concentration relative to both SAT and CON (16.6 vs. 13.8 and 12.2 pmol/L), and tended to increase GLP-1 concentration compared to CON (12.0 vs. 10.2 pg/mL). Finally, rumen-protected fat treatments tended to suppress ghrelin concentration relative to CON immediately prior to the first meal (28.3 vs. 53.9 pg/mL). Temporal changes in concentrations of plasma variables during the early feeding period suggest that insulin, CCK, GLP-1, and/or ghrelin may be involved in intake depression induced by unsaturated fatty acids.

Key Words: Dry matter intake, Gut peptide, Fat supplements

315 Prepartum nutrient intake alters gluconeogenic capacity in liver slices from peripartal dairy cows. N. B. Litherland*, H. M. Dann, and J. K. Drackley, University of Illinois, Urbana.

Plane of nutrition before parturition might affect hepatic gluconeogenic capacity, which might impact subsequent cow health and productivity. Our objectives were to determine the effects of nutrient intake during far-off (FO) and close-up (CU) dry periods, and their interaction, on adaptations in metabolism of propionate and alanine in liver slices. Multiparous Holstein cows (n = 71) were assigned to treatments in a 3 (FO diet) × 2 (CU diet) factorial arrangement. During the FO period (d -60 to -25) cows received a high-straw control diet fed for ad libitum intake (FOCA) to meet NRC recommendations for NE_L, a higher-density diet fed ad libitum to exceed NRC recommendation for NE_L by 60% (FOHA), or the higher-density diet at restricted intake to meet 80% of NE_L requirements (FOHR). During the CU period (d -24 until parturition), cows were fed one diet for either ad libitum intake (CUA) or in restricted (CUR) amounts to provide 80% of NE_L requirements. All cows received a lactation diet postpartum. Liver slices from biopsies at d -30, -14, +1, +14, and +28 relative to parturition were utilized to determine in vitro conversion of [1-¹⁴C] alanine and [1-¹⁴C] propionate to glucose and CO₂. Interactions of FO and CU diets were not significant. Gluconeogenesis from propionate was numerically greater on d -14, +1, and +14 and was significantly greater on d -14 and d +28 for FOHR cows than for FOCA and FOHA. Oxidation of propionate to CO₂ on d -14 tended (P = 0.08) to be lower for FOCA than for FOHA and FOHR. Gluconeogenesis from alanine tended (P = 0.06) to be greater for CUR on d +14 and was also numerically greater on d +1 and +28. Oxidation of alanine to CO₂ did not differ among treatments. The CU treatment had minimal impact on gluconeogenesis and substrate oxidation. Cows restricted in energy intake during the FO dry period had greater hepatic gluconeogenic capacity prepartum and postpartum than cows allowed to consume energy in excess of requirements.

Key Words: Transition cow, Gluconeogenesis, Liver

316 Effects of PPAR-α agonists on in vitro liver fatty acid metabolism in Holstein calves. N. B. Litherland*, D. B. Carlson, R. L. Wallace, and J. K. Drackley, University of Illinois, Urbana.

Our hypothesis was that peroxisomal proliferator-activated receptor (PPAR)-α agonists would increase hepatic β-oxidative capacity for fatty acids, which would decrease circulating NEFA and hepatic lipid accumulation in transition cows. The objectives of this study were 1) to determine if weaned Holstein calves are a suitable model for liver metabolism in periparturient cows, 2) to determine if PPAR-α agonists alter NEFA metabolism in bovine liver, and 3) to compare in vitro metabolism of palmitate and oleate by liver slices. Male Holstein calves (n=15) were assigned at 7 wk of age to 1 of 3 groups for a 5-d treatment period: untreated control, clofibrate (62.5 mg/kg BW), or fish oil (250 mg/kg BW). Calves were euthanized on d 6 and liver slices were incubated for 2, 4, and 8 h to determine conversion of [1-¹⁴C] palmitate and [1-¹⁴C] oleate to CO₂, acid-soluble products (ASP), and esterified products (EP). Calves treated with clofibrate tended (P = 0.05) to consume less dry matter. Body weight, liver weight, and ratio of liver to body weight were not significantly different among treatments. In liver slices incubated for 8 h, conversion of palmitate to CO₂ was greater (P < 0.05) for calves treated with clofibrate than for untreated or fish oil. Conversion of palmitate to ASP was numerically greater for calves treated with clofibrate or fish oil compared with controls. Palmitate conversion to EP, total palmitate metabolism, and

metabolism of oleat did not differ among treatments Conversion of NEFA to CO₂ was greater for palmitate than oleate for all treatments ($P < 0.05$), but rates of total metabolism were not different. Rates of palmitate oxidation by liver slices from calves in this study were nearly 10 times greater than rates previously observed for adult cows. Clofibrate increased the rate of oxidation of palmitate in liver slices from male Holstein calves. Applications of PPAR- α agonists may be of interest in enhancing the rate of hepatic fatty acid oxidation in transition dairy cows.

Key Words: Liver, PPAR- α , Bovine

317 Effects of abomasal lipid infusion on liver triglyceride accumulation during fatty liver induction. A. E. Kulick*, T. F. Gressley, J. A. A. Pires, and R. R. Grummer, *University of Wisconsin, Madison.*

Previous research has implicated linseed oil in altering lipid metabolism of dairy cattle when infused intravenously as lipid emulsion. The objective was to determine the effects of abomasal linseed oil (LO) infusion on liver triglyceride (TG) accumulation and subcutaneous adipose tissue lipolysis during fatty liver induction. Eight nonpregnant, nonlactating Holstein cows were randomly assigned to treatments in a replicated 4 x 4 Latin square design. Treatments included abomasal infusion of water (W), tallow (T), LO, or half tallow plus half LO (LOT) at a rate of 0.56 g/kg BW per day for 4 d. Daily treatments were administered directly into the abomasum, divided into 6 doses and administered every 4 h. Infusion of treatments was concurrent with a 4 d fast. Cows were fed *ad libitum* for 24 d between periods of fasting and lipid infusion. T contained 43% C18:1, 24% C16:0 and 14% C18:0. LO contained 51% C18:3, and 17% C18:2. For most parameters, contrasts were: W vs. LO + LOT + T (effect of lipid), LO vs. T (linear effect of LO), and LOT vs. LO + T (nonlinear dose effect of LO). For measurement of blood fatty acid composition, differences among treatment means were determined using the PDIFF procedure of PROC MIXED. Infusion of linseed oil (LO or LOT) increased α -linolenic acid (g/100 g fatty acid) in serum ($P < 0.05$) but not in the nonesterified fatty acid (NEFA) fraction of plasma. Treatments had no effect on plasma NEFA concentrations. Infusion of LO increased total serum fatty acid concentration (nonlinear dose effect; $P = 0.06$). Abomasal infusion of lipid significantly increased isoproterenol stimulated lipolysis by subcutaneous adipose tissue explants *in vitro*. Liver TG content increased 4.8, 4.9, 2.3 and 2.3 $\mu\text{g TG}/\mu\text{g of DNA}$ during the fast for W, LO, LOT and T, respectively; infusion of lipid decreased liver TG accumulation ($P = 0.06$) when compared to W, but this was due to T (LO vs. T; $P = 0.03$). Abomasal LO infusion failed to reduce liver TG accumulation, plasma NEFA concentration or alter subcutaneous adipose tissue lipolysis.

Key Words: Linseed oil, Abomasal infusion, Liver triglyceride

318 Acute effects of subcutaneous injections of glucagon and/or oral administration of glycerol on blood metabolites and hormones of dairy cows affected with fatty liver disease. M. A. Osman*, N. A. Mehyar, G. Bobe, J. F. Coetzee, D. C. Beitz, and K. Keohler, *Iowa State University, Ames.*

Our objective was to study the effects of the subcutaneous injection of glucagon and /or oral administration of glycerol for the first 14 days postpartum on blood metabolites and hormones of Holstein dairy cows

induced with fatty liver disease. Twenty multiparous cows were fed a dry cow ration supplemented with 12 kg of cracked corn during the dry period to increase the likelihood of fatty liver disease development. Cows with a body condition score of 3.5 points (1-5 scale) were assigned randomly to one of four treatment groups--saline, glucagon, glycerol, and glucagon plus glycerol. Following treatment, serial blood samples were collected to determine the effect of glucagon and/or glycerol on blood composition. Glucagon injection alone increased plasma glucose ($P=0.001$), glucagon ($P=0.0044$), decreased plasma BHBA ($P=0.0217$), and did not affect plasma NEFA during the postpartal period. Glucagon plus glycerol treatment significantly increased plasma glucose postinjection ($P \leq 0.001$), glucagon ($P=0.0001$) and insulin. Treatment of cows with glucagon plus glycerol increased plasma glucose and decreased plasma BHBA. Glucagon plus glycerol treatment caused the greatest response in plasma glucose BHBA, and glucagon. These responses suggest that treatment of postpartal cows with glucagon plus glycerol as well as with glucagon alone would decrease the likelihood of fatty liver disease in dairy cows.

Key Words: Fatty liver disease (hepatic lipidosis), Glucagon, Glycerol

319 Effect of prepartum anionic diets on cortisol, adiponectin, and tumour necrosis factor-A expression at varying levels of body mass index in preparturient dairy cows; implications for insulin resistance. S. B. Puntenney* and P. D. French, *Oregon State University, Corvallis.*

Twenty-six Holstein and 18 Jersey multiparous cows were assigned to a randomized block design by calving date and breed to either a control group fed a traditional non-anionic diet (CTRL) or to a treatment group with the diet containing the commercial anionic salt supplement (Animate[®]- IMC-Agrico, Bannockburn, IL). The control and treatment diets were formulated to a dietary anion-cation difference (DICAD) of 21.3 and -14.29 meq/100 grams, respectively. Cows were evaluated for body condition score (BCS) prior to parturition and assigned to one of six BCS groups by breed the week prior to parturition. The effects of prepartum dietary treatment by BCS were evaluated for serum concentrations of cortisol, adiponectin, insulin, TNF- α , calcium and magnesium. on days -21 preparturition through 21 days postparturition. No significant effect of treatment on energy balance was observed; however, cows receiving the anionic diet numerically returned to positive energy balance faster than their cohorts on the control diet. Dry matter intake differed significantly by day, with the anionic diet resulting in an additional 3.71 kg/day of DMI for the Holsteins, providing more than enough NE to account for the increase in milk yield. Herd health parameters were not significantly different by treatment. Plasma NEFA and adiponectin concentrations were unaffected by dietary treatment, nor were they affected by BCS. BHB concentrations were not directly affected by dietary treatment; however, cows on the anionic diet had higher serum BHB concentrations until BCS reached 3.5 and, beyond that point serum BHB concentrations increased dramatically for the control diet. Plasma cortisol concentrations were not different by dietary treatment. TNF- α significantly increased and insulin significantly decreased based on BCS on the anionic diet.

Key Words: TNF- α , Insulin, Adiponectin

320 Parturition energy intake affects health and lactational performance in primiparous and multiparous Holstein cows. N. A. Janovick Guretzky*, N. B. Litherland, K. M. Moyes, and J. K. Drackley, *University of Illinois, Urbana*.

Previous research from our group has demonstrated that control of prepartum energy intake improved transition success in multiparous cows; however, data are lacking for their primiparous counterparts and for cows in single-group dry period management. Primiparous (n=23) and multiparous (n=24) Holsteins were randomly assigned by expected date of parturition to one of three prepartum energy intakes. A high energy diet (1.62 Mcal NE_L/kg; 15% CP) was fed for either ad libitum intake (HI-E) or restricted intake (REST) to supply 150 or 80% of NRC (2001) energy requirement for dry cows in late gestation. To limit energy intake to 100% of NRC requirement at ad libitum intake (CON), a high straw (29% of DM) diet (1.30 Mcal NE_L/kg DM; 14% CP) was fed. Multiparous and primiparous cows began dietary treatments on d -65 and d -42 prior to expected parturition, respectively. Data were analyzed as repeated measures. Postpartum intake (% of BW) did not differ among treatments ($P=0.16$). Multiparous cows consumed more DM than primiparous cows ($P=0.01$), which likely influenced parity differences in energy balance postpartum ($P<0.01$). HI-E cows were in greater negative energy balance than CON and REST cows postpartum ($P<0.01$). Weekly FCM yield (kg/d) tended ($P=0.10$) to be higher for HI-E compared to CON or REST cows. Incidences of ketosis ($P=0.03$) and DA ($P=0.01$) were higher for HI-E than CON and REST cows regardless of parity ($P>0.48$). Liver total lipid (% of wet wt) tended to be higher ($P=0.07$) for multiparous HI-E cows than for CON or REST on d 1 and 14 after parturition. Blood glucose tended to be higher ($P=0.05$) prepartum for multiparous HI-E cows than for CON or REST, but BHBA was higher ($P=0.03$) postpartum for multiparous HI-E cows than for CON or REST cows. HI-E cows gained body condition during the dry period (initial BCS=3.3), but were not overconditioned by calving (BCS=3.5). Overfeeding energy during the dry period, even in absence of overconditioning, can adversely affect transition success.

Key Words: Primiparous cow, Energy intake, Transition period

321 Effect of dietary energy source on energy partitioning in dairy cattle in early lactation. A. van Knegsel*, H. van den Brand, J. Dijkstra, S. Tamminga, and B. Kemp, *Wageningen University, Wageningen, The Netherlands*.

Nutrition has been indicated to be important to limit the severity of a negative energy balance (NEB) and related metabolic disorders in dairy cattle in early lactation. The NEB related metabolic problems suggest a role for the balance in supply of lipogenic and glycogenic nutrients. Therefore, the objective of this study was to compare the effects of a mainly glycogenic and a mainly lipogenic diet on energy partitioning in dairy cows in early lactation. The roughage composition of both diets was identical. Maize and milocorn or rumen protected fat and beet pulp were the main concentrate ingredients of the glycogenic and lipogenic diet, respectively. Energy and nitrogen balance of 16

lactating dairy cows in four batches, were determined by indirect calorimetry in climate respiration chambers from week 2 to 9 postpartum (pp). Repeated analysis of variance was used for data analysis and results are presented as MEANS \pm SE. There was no effect ($p \geq 0.05$) of diet on gross energy intake (3453 ± 59 kJ/(kg^{0.75}•d)), metabolizable energy intake (2102 ± 41 kJ/(kg^{0.75}•d)) and heat production (1110 ± 10 kJ/(kg^{0.75}•d)). However, cows on a lipogenic diet partitioned more energy to milk than cows on a glycogenic diet (1175 ± 18 vs. 1073 ± 12 kJ/(kg^{0.75}•d); $p \leq 0.05$) and had a higher milk fat yield (1.67 ± 0.03 vs. 1.89 ± 0.02 kg/d; $p \leq 0.05$). No difference was found in energy retained as body protein (19 ± 6 kJ/(kg^{0.75}•d)), but energy mobilised as body fat tended to be higher in cows fed the lipogenic diet than in cows fed the glycogenic diet (190 ± 23 vs. 113 ± 26 kJ/(kg^{0.75}•d); $p \leq 0.10$). Cows fed the glycogenic diet were in a positive energy balance from week 8 pp, whereas cows fed the lipogenic diet had still a NEB in week 9 pp. This study confirms the hypothesis that energy partitioning between milk and body tissue can be altered by feeding isocaloric diets differing in lipogenic and glycogenic nutrient content.

Key Words: Energy partitioning, Negative energy balance

322 The effect of calcium pantothenate on productive and reproductive performance in lactating dairy cows. J. Nocek¹ and M. Vazquez-Anon^{*2}, ¹*Spruce Haven Farm and Research Center, Auburn, NY*, ²*Novus International, St. Louis, MO*.

Two hundred cows were balanced by parity and previous lactation 305d ME to one of two treatments to determine the effect of supplementing calcium pantothenate (CP, CRYSPANTM, beta crystalline form of calcium pantothenate, Daiichi Fine Chemical Co. Ltd.) on production and reproductive performance in lactating dairy cattle. The Control group was fed a pre- and postpartum diet to meet NRC (2001) requirements. The CP group was fed the Control diet with the addition of 6g/cow/d of CP in the TMR. Cows were housed in free stall group pens (approx. 100cows/group). The experimental period started 21 days before estimated calving date to about 160 days in the subsequent lactation. Approximately 100 cows were assigned to each treatment. The design was a split-plot in time with repeated measures, with cow as the experimental unit. Milk production was not significantly influenced by CP supplementation; however, cows receiving CP produced 0.5 kg more than Control. The 3.5% fat-corrected milk was higher ($P = .01$) for cows consuming CP compared to Control (38.9 vs. 37.4 kg). This difference was primarily influenced by a higher ($P = .02$) fat test for cows receiving CP (3.65 vs. 3.51%). This resulted in an increased fat yield ($P = .01$) for cows receiving CP. Protein percentage was not influenced by treatment; however, yield of protein was higher ($P = .02$) for cows receiving CP. Cows receiving CP had fewer ($P = .10$) days open (88.7 vs. 95.6) and a greater ($P = .03$) percentage of cows pregnant by 150 DIM (76.9 vs. 61.3%) compared to Controls. Supplementing CP in diets of lactating cows improved productive and reproductive performance.

Key Words: Calcium pantothenate, Lactation, Reproduction

Sheep Species

323 Effect of supplementation and stage of lactation on performance of grazing ewes. C. M. Mikolayunas*, D. L. Thomas, K. A. Albrecht, and Y. M. Berger, *University of Wisconsin, Madison*.

This study evaluated the effects of stage of lactation and supplementation on lactation performance of 95 dairy ewes grazing kura clover-

orchardgrass pastures. Ewes lambed in January or April and consumed 0 or 0.82 kg/d of supplement (16% CP mixture of corn and high protein pellet) in a 2 x 2 factorial arrangement of treatments. The trial began when ewes went to pasture on May 25 and continued for 82 days. Unsupplemented ewes in both lambing groups showed a greater range

in their daily milk yields than supplemented ewes throughout the trial, probably in direct response to variations in pasture quality during the grazing season. The January lambing ewes compared to the April lambing ewes produced less ($P < .001$) milk (91.1 vs. 136.8 kg, respectively), milk fat (5.6 vs. 7.8 kg, respectively), and milk protein (4.7 vs. 6.3 kg, respectively) during the trial. The supplemented ewes compared to the unsupplemented ewes produced more ($P < .01$) milk (123.2 vs. 104.2 kg, respectively), milk fat (7.2 vs. 6.2 kg, respectively), and milk protein (5.9 vs. 5.0 kg, respectively). Supplementation had a similar positive effect on milk, milk fat, and milk protein yield in both lambing groups. Milk urea nitrogen (MUN) can be used as an indicator of the efficiency of protein utilization in sheep. Trial MUN levels across treatments tended to be higher (18 to 34 mg/dL) than recommended levels for sheep (14 to 22 mg/dL), indicating an excess of protein intake. This can be explained by the high quality pastures, which ranged in crude protein from 16 to 30%. Across all treatments, the correlation between pasture crude protein and MUN was .65. Within the supplementation treatment, the correlation was numerically higher but not significantly different than the correlation within the unsupplemented treatment ($r = .78$ and $.52$, respectively).

Key Words: Dairy sheep, Grazing, Milk urea nitrogen

324 The effect of bypass fat in the diet on milk composition of dairy ewes. M. M. Stradiotto, E. R. Siqueira, R. M. S. Emediato*, S. A. Maestá, and A. Piccinin, *São Paulo State University, Botucatu, São Paulo, Brazil.*

The objective of this work was to investigate the effect of dietary bypass fat on milk composition of Bergamasca dairy ewes. The experiment was carried out at the Ewe Milk Production Research Unit of the College of Veterinary Medicine and Animal Science of São Paulo State University. Eighty Bergamasca ewes were divided into two groups and fed one of two diets: A – balanced diet (concentrate + corn silage); or B – same diet as A, with bypass fat (35 g/ewe/day) added to the concentrate. Lambs were kept with their mothers on pasture during daytime and were separated at night. After the morning milking, the lambs were returned to their mothers and weaned at 45 days of age. The ewes were machine-milked for 60 days. Milk samples were collected once weekly for analysis of lactose, protein, fat and total solids. The data were analyzed by one-way analysis of variance. For the first 45 days of lactation, significant differences ($P < .05$) were observed for protein and lactose, with ewes fed diet B having higher means, whereas differences were not observed ($P > .05$) for fat and total solids. After 45 days of lactation, significant differences ($P < .05$) were found only for fat and lactose, which may be explained by the higher milk production of ewes fed diet B because some researchers have reported a negative correlation between production and concentration of milk constituents.

Key Words: Unsaturated fatty acids, Dairy sheep, Milk constituents

325 Effect of fermentable fiber level and protein source on feed intake and efficiency of growing lambs. A. Carneiro, A. Esquivel, D. E. Hogue, and M. L. Thonney*, *Cornell University, Ithaca, NY.*

When hay is expensive, by-products that contain high concentrations of fermentable NDF (FNDF) and protein can be used to formulate diets for self-feeding ewes prior to lambing and during lactation. Because lambs also have access to the self-fed ewe diet, an experiment was conducted to compare the feed intake and efficiency of lambs fed three 14.5% CP diets similar in calculated digestible dry matter but differing in calculated FNDF and source of supplemental protein (Table 1). The experiment was a randomized complete block (gender and location) with seven pens of 2 rams and six pens of 2 ewes fed a diet with 20% soy hulls for FNDF and 10% soybean meal for protein (SH); four pens of 2 rams and six pens of 2 ewes fed a high fiber diet with 34% corn gluten feed for FNDF and protein and 23% soy hulls for FNDF (HF), and six pens of 2 rams and six pens of 2 ewes fed a diet with 37% corn gluten feed for FNDF and protein (CGF). The cracked corn-based diets also contained limestone, 2% vitamin-mineral premix, and 2% vegetable oil. After weaning at 6 to 10 wk of age and a 3-d adjustment to the pens, lambs were fed the diets for 42 d. Fresh water was provided and feed was added daily to each feeder to ensure that feed was available at all times. Lambs were weighed at the start of the experiment and weekly. Linear regression of weight on d was used to compute IW, FW, and ADG. Lambs fed HF consumed more DM, but gained less per unit DMI than lambs fed SH or CGF (Table 1). ADG of lambs fed HF was not significantly decreased compared to lambs fed CGF. These results demonstrated that the high-FNDF ewe diets consumed by lambs can increase intake by 12% and reduce feed efficiency by about 14%, but with limited effect on ADG, and that protein from CGF can replace more expensive protein from soybean meal.

Table 1. Effect of fiber level and protein source on growing lambs

Item	SH diet	HF diet	CGF diet	SEM	P value	
					SH vs others	HF vs CGF
Number of pens	13	10	12			
DDM, % DM	78.5	77.1	77.5			
NDF % DM	22.4	32.9	21.1			
FNDF, % DM	16.2	29.9	17.5			
IW, kg	20.6	20.8	20.6	0.51	ns	ns
FW, kg	33.4	32.5	32.7	0.68	ns	ns
Gain, g/d	305	280	289	10.7	0.10	ns
DMI, kg/d	0.992	1.069	0.953	0.0297	ns	0.007
Gain/DMI	0.307	0.263	0.303	0.0074	0.012	0.001
DMI, % BW	3.69	4.09	3.63	0.083	0.076	<0.001

Key Words: Sheep, Fiber, Protein

Swine Species

326 Factors related to piglet pre-weaning mortality in a bedded group farrowing system. Y. Z. Li*, L. J. Johnston, and A. M. Hilbrands, *University of Minnesota, Morris*.

Recently there has been increased interest in loose farrowing systems in North America due to sow welfare concerns. However, piglet mortalities of 25 to 33% have been reported in these systems. We investigated factors related to piglet mortality in a group farrowing system. A total of 156 sows (Landrace x Yorkshire) in parity 0 to 5 and their litters were studied in three farrowing rooms. All sows were group housed during gestation, and moved to the farrowing room one wk before expected farrowing dates. Each farrowing room (9.6 x 10.8 m) was equipped with eight straw-bedded, 'get-away' pens (2.4 x 3.0 m) to accommodate eight sows and their litters. A communal eating/drinking/dunging area was provided in each room. The pens were removed about d 10 post farrowing, so sows and their litters mingled in a group. Minimal cross fostering was conducted within 2 d of farrowing. Piglets were weaned at 28 to 36 d of age. The PROC MIXED procedure of SAS was used to analyze effects of sire breed (Yorkshire vs Landrace) of the sows, sire breed (Duroc, Yorkshire vs Landrace) of the litter, birth location of the sows (group vs crate), previous farrowing location (group vs crate), and sow parity on total born, live born, number of piglets nursed and weaned, and piglet mortality. Overall pre-weaning mortality of piglets was 26%. Piglet mortality increased with increasing sow parity (from Parity 0 = 22.4 ± 3.11% to Parity 3~5 = 33.7 ± 3.92%; $P = 0.04$), which was coincident with increasing litter size (from Parity 0 = 12.5 ± 0.53 to Parity 3~5 = 15.0 ± 0.65 total piglets born/litter; $P = 0.01$). Piglet mortality was greater for Landrace-sired sows compared with Yorkshire-sired sows (27.5 ± 2.45 vs 23.5 ± 2.37 %; $P = 0.05$), possibly due to the larger litter size of Landrace-sired sows ($P = 0.05$). There was a positive correlation ($R^2 = 0.89$, $P < 0.01$) between number of piglets nursed and piglet mortality. Sire breed of the litter, sow birth place, and previous farrowing location did not affect piglet mortality. In the current study litter size at farrowing appeared to be the primary factor influencing piglet mortality in a bedded, group farrowing system.

Key Words: Piglet mortality, Group farrowing

327 Impact of gestation housing system on weaned pig production costs. P. J. Lammers* and M. S. Honeyman, *Iowa State University, Ames*.

Construction and operating costs for two gestation housing systems—1) individual gestation stalls in a mechanically ventilated confinement building with slatted floor (C) and 2) group pens with individual feed stalls in deep-bedded naturally ventilated hoop barns (H) were compared. Cost comparisons were based on previous reports that reproductive performance of group-housed sows in hoop barns is equal or better than for individually stalled sows, in that sows housed in hoop barns for gestation farrowed 0.7 more ($P = 0.002$) live pigs per litter and had equal ($P = 0.66$) pre-wean mortality rates as sows housed in individual gestation stalls. All litters were farrowed in a mechanically ventilated building with raised farrowing crates. No bedding was used during farrowing or by the C sows during gestation. For the last trimester of pregnancy and in winter months, feed allowance was increased for both gestation housing systems. During the winter, H sows received 20% more feed than C sows. Lactating sows were fed ad libitum. It is assumed that feed consumption was equal during lactation

for both housing systems. In a one-year period, C sows received 93% of the feed that H sows were fed during gestation and lactation. Hoop barn gestation facilities can be constructed for 67.7% of the cost of typical confinement facilities with gestation stalls. Fuel and electricity use in mechanically ventilated gestation buildings is greater than utility use in hoop barns, although bedding costs only occur in bedded systems. Assuming equal prolificacy, feed cost per pig weaned is more for sows housed in hoop barns. Total cost per pig weaned is less for sows housed as groups in hoop barns compared to individual stall confinement systems. When observed production differences were included in the cost analysis, the group housing in hoop barns resulted in a weaned pig cost that was 11% less than the cost of a weaned pig from the individual stall confinement system. Group housing of gestation sows in deep-bedded hoop barns may produce pigs at a lower cost than individual gestation stalls in confinement facilities.

Key Words: Gestation housing systems, Weaned pig production cost

328 Effects of physiological traits on weaning-to-estrous interval in first-litter gilts. Y. Wang*¹, T. Wise², G. Rohrer², K. Hanford¹, and D. Van Vleck², ¹*University of Nebraska, Lincoln*, ²*U.S. Meat Animal Research Center, Clay Center, NE*.

Delayed return to estrus after weaning is a significant problem for swine producers. We investigated relationships among weaning-to-estrous interval (WEI) and body weight (BW), backfat (BF), plasma leptin (L), choline (C), glucose (G), albumin (A) and litter traits to identify physiological traits associated with WEI. Data were from sows in 2002 and 2003 prior to farrowing (f, 110 d gestation), at weaning (w) and at first estrus (e) after weaning. In 2001, Yorkshire-Landrace sows were crossed with Duroc or Landrace boars to establish two lines. Sows from these two crosses farrowed in 2002 (n=247). The cross of the two crosses farrowed in 2003 (n=228). Separate analyses by year showed that WEI was positively associated with Le or with Le*Lw, and was negatively associated with Ae ($p < 0.05$). At f, w and e, BF was positively associated with L and A ($p < 0.05$). Correlations were positive between changes in BW and L between f, w and e ($p < 0.05$). With WEI classified as early/normal (1-10 d, EI), late (11-20 d, LI), very late (>20 d, VI) and no estrus (NI), stepwise logistic regression was used to generate models with reduced sets of traits to discriminate between pairs of populations: EI vs. LI+VI+NI (M1), EI+LI vs. VI+NI (M2), EI+LI+VI vs. NI (M3), EI vs. LI+VI (M4), EI+LI vs. VI (M5). M1, 2, 3 included traits through weaning, M4, 5 included all traits. For 2002 farrowing gilts, number of pigs weaned in litter (NWL), Lw had significant effects with M1. With M2, effects of Aw, NWL were significant. With M3, Lw, NWL and number of pigs born (NB) had greatest effects. With M4, Ae, NWL had significant effects. With M5, Ae had greatest effect. For 2003 farrowing gilts, BWe-BWw, number of pigs alive at birth (NAB), Cw and Aw had significant effects with M1. With M2 and M3, BW, Aw were significant, respectively. With M4, BWe-BWw, NAB and Ae had significant effects. With M5, Le, BWe-BWw, Bfw, Aw-Af had greatest effects. These results suggest there are metabolic components associated with WEI that may have a genetic basis.

Key Words: Swine, Estrus, Reproduction

329 Influence of a phytogetic feed additive on performance of weaner piglets. A. Kroismayr^{*1,3}, T. Steiner¹, and C. Zhang², ¹*Biomin GmbH, Herzogenburg, Austria*, ²*Biomin Feed Additive Co. Ltd, Shanghai, China*, ³*University of Natural Resources and Applied Life Sciences, Vienna, Austria*.

This study was carried out to investigate the effect of a combination of essential oils and FOS (Biomin[®] P.E.P.) on performance parameters in piglets. 120 crossbred (Duroc x Landrace x Yorkshire) piglets, weaned at 23 d of age, were randomly assigned to two dietary treatments, comprising five replicates per treatment with twelve piglets per replicate. Piglets were fed ad libitum a commercial weaner diet based on corn and soybean meal, either supplemented or not supplemented with a phytogetic additive (Biomin[®] P.E.P., 125 g/t). Individual body weight (BW) of the piglets and pen feed consumption were recorded every 14 d and after the conclusion of the experiment. Data were subjected to ANOVA using SPSS software. During the first two weeks of the experiment, there were no treatment effects ($P > 0.05$) on BW of the piglets (Table 1). However, from day 28 until the conclusion of the experiment, pigs fed the diet supplemented with the phytogetic feed additive were heavier ($P < 0.05$) compared to pigs fed the control diet. Furthermore, supplementation of the basal diet with the phytogetic additive increased ($P < 0.05$) pen feed intake by 10 % from trial day 1 to 50. Finally, Biomin[®] P.E.P. supplementation tended ($P < 0.1$) to lower feed conversion ratio, measured from day 0 to 28 and 0 to 42, respectively. The data shows that the investigated phytogetic feed additive enhanced feed intake and growth performance. These data are consistent with the results of GOESSLING (2001) and KROISMAYR (2005). Furthermore, supplementation of diets with the same additive tended to improve feed conversion as reported by STONI (2005). The investigated phytogetic feed additive (Biomin[®] P.E.P.) had a positive influence on performance of weaner piglets.

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Table 1 Effect of Biomin[®] P.E.P. on body weight (kg)

	Control	Biomin [®] P.E.P.	P value
Weaning	6.4±0.05	6.4±0.07	0.891
14 d	9.5±0.21	9.8±0.16	0.237
28 d	14.7±0.64	16.3±0.30	0.035
42 d	21.9±0.85	24.2±0.46	0.025
50 d	26.1±1.02	29.2±0.52	0.013

Key Words: Piglet nutrition, Essential oils, Phytogetic feed additive

330 Liquid feeding of newly weaned pigs using whey permeate. T. D. Woods*, C. Zhu, E. Jeurond, and C. F. M. de Lange, *University of Guelph, Ontario, Canada*.

Liquid feeding can reduce post-weaning growth lag in pigs and allows the use of liquid feed ingredients. A total of 378 newly-weaned purebred Yorkshire piglets (14-16 pigs per pen; initial BW 5.8 kg) were assigned to one of three treatments (8 pens per treatment): conventional ad libitum feeding of crumbled dry feed (Dry), liquid feeding of the crumbled dry feed (Liq), and liquid feeding whereby the whey present in the dry feeds was replaced with liquid whey permeate (LiqWhey). Pigs were fed according to a three phase feeding program. In Dry the three subsequent diets contained 20, 10 and 0 % whey. Whey permeate contained 35% DM and 4.8% CP within DM. Within LiqWhey, the inclusion level of whey permeate was kept constant at 20% of DM (4 pens; LiqWheyFix) or reduced from 20 to 10 and 0% of DM in the subsequent diets (4 pens; LiqWheyVar). Between phases, feed was changed gradually on days 8 to 11 and 27 to 30 post-weaning. Liquid fed pigs were fed 6 times daily (28% DM; 6, 9, 12, 15, 18, 21 h) using a computer-controlled liquid feeding system that only delivered meals when the trough was empty. During week 1, ADG (99 ± 10 , 87 ± 9 , 95 ± 11 g/d for Dry, Liq and LiqWhey, respectively) did not differ between treatments ($P > 0.10$), while F:G was better ($P < 0.05$) for Dry than LiqWhey (1.57 ± 0.21 vs. 2.09 ± 0.22 ; $P < 0.05$) and intermediate for Liq (1.94 ± 0.21). During week 5 and 6, treatment did not influence ($P > 0.10$) ADG (616 ± 55 , 541 ± 57 , 509 ± 107 , 616 ± 58 g/d for Dry, Liq, LiqWheyVar and LiqWheyFix, respectively) and F:G (1.50 ± 0.31 , 1.37 ± 0.30 , 1.53 ± 0.48 , 1.20 ± 0.25 , for respective treatments). Also over the entire 6 week post-weaning period, treatment did not influence ADG (399 ± 26 , 334 ± 27 , 331 ± 51 , and 377 ± 27 g/d; $P > 0.07$) and F:G (1.41 ± 0.14 , 1.50 ± 0.14 , 1.53 ± 0.27 , 1.42 ± 0.14 ; $P > 0.10$). Liquid feeding did not enhance growth performance of weaned piglets, likely because of feed intake restriction. Liquid whey permeate represents an effective alternative for dry whey in diets for weaned pigs.

ADSA Southern Section Symposium: Practical and Applied Approaches to Managing Dairy Businesses in the Future

331 Labor management strategies in the next decade. D. C. Grusenmeyer*, *New York Farm Viability Institute, Syracuse, NY*.

Agricultural labor needs span a broad spectrum from hand labor to highly technical expertise and from production management to strategic business planning and finance. The first step in developing a labor management strategy for the next decade is envisioning who the

labor force will be. Agriculture will increasingly depend on foreign labor, for the next decade primarily Hispanic, to fill a wide array of positions. Also, with the Graying of America and people staying in the workforce longer, there will be a wider age range in the workplace. Over the coming decade managers will have as many as three or four generations working in their business at the same time. The result will

be a workforce with unprecedented cultural and generational diversity creating management challenges in building highly functioning teams and a smooth running work environment. The next driver for a labor management strategy is an evaluation of business labor needs. What types of positions will the business need as it grows? Will technology be adopted as a trade off against labor? Will new technology change the extent and type of education required for employees to function successfully in the business? Where and how will you recruit a workforce with the necessary attributes and skills? Will employees come from foreign countries, the ranks of the retired looking for new careers, from high school, technical school, community college or university? Each employee source has implications for recruiting, labor cost, workforce diversity, training and development needs, and employee retention. What are the opportunities and implications for attracting or developing a workforce? The final step in a labor management strategy is the selection and implementation of organizational and human resource management practices, such as standard operating procedures, an employee handbook, job descriptions, performance feedback systems, and training and development of the talent resource within the business. The appropriate labor management strategy will be different for each business given its' unique situation. This presentation will investigate some of the options.

Key Words: Labor, Employee, Management

332 Challenges for feeding dairy cows in the next decade. M. Hutjens*, *University of Illinois, Urbana.*

An industry survey of extension educators, consultants, and veterinarians conducted in 2001 revealed factors that would limit milk yield were transition cow management, feed bunk management, forage quality, and nutrient availability. This symposium paper will discuss factors that will challenge feeding high producing dairy cows. Herd size and management systems will determine feed delivery systems (pasture vs. stored feeds, number of groups, and feed storage systems). Feed efficiency will be broadened including dry matter conversion, protein capture, and energy balance. Rations will reduce nitrogen loss, lower manure phosphorous levels, and lessen odor emission. Nutrient sources may improve fertility (essential fatty acids), improve milk nutrient (CLA), increase nutrient absorption in the digestive tract, and increases rumen fermentation. Computer models will be used to predict rumen yield and achieve desired milk yield and components. Forage quality and yield will be balance to produce the optimum nutrient yield (such as Milk 2006) as forage breeders genetically improve forage quality. Feed additives will focus on statistical responses using type 1 and type 2 error analyses, increase rumen microbial yield, and reduce transition cow health risks. Economics benchmarks may include milk yield per stall, milk yield per acre, feeds cost per unit of dry matter, feed costs per 45 kg of milk produced, and milk yield per unit of dry matter evaluated by days in milk, parity, level of milk, and pen average. One concern will be resources to conducting basic and applied nutrition research as land-grant college research herds and trained applied dairy nutritionist may be limiting. The feed industry has a major role in this arena and can not rely on government or competitive grants to address feeding issues. Regional and national leadership will be required.

Key Words: Feeding, Challenges, Dairy cows

333 Future challenges for reproductive management of dairy cattle. P. M. Fricke*, *University of Wisconsin, Madison.*

Within a dairy herd, total milk production is determined by the proportion of cows producing milk at any given time and the level of milk production of the individual cows within the herd. Improving reproductive efficiency helps to maintain the maximal number of cows producing milk at optimal levels. Reproductive efficiency in dairy cattle currently is suboptimal primarily due to four factors: 1) poor detection and expression of estrus behavior, 2) a high incidence of anovular cows near the end of the voluntary waiting period, 3) poor conception rates of lactating cows, and 4) a high incidence of pregnancy loss for cows that conceive. Over the past decade, the development of hormonal protocols that synchronize follicular development, luteal regression, and ovulation thereby allowing for timed AI without the need to rely on visual estrus detection has helped to overcome factor 1 and to some extent factor 2 above, and development of systematic resynchronization systems for cows failing to conceive to an AI service is underway. Regarding factor 3, the body of scientific literature supports the notion that fertility of lactating dairy cows has decreased over the past 50 years. Factor 3 is closely related to factor 4 because fertility assessed at any point during pregnancy is a function of both conception rate and pregnancy loss. Development of strategies that reduce the rate of embryonic loss after AI will therefore result in an increase in conception rate. A final factor that negatively affects reproduction in dairy cattle is twinning, and the observation that twinning has increased in dairy cattle over time suggests a concurrent change in one or more of these causative factors during this same period. Management strategies need to be developed to avoid or mitigate the negative effects of twinning in dairy herds, especially if twinning rates continue to increase. Future development of reproductive management strategies during the next decade must be focused on both the applied and basic aspects of understanding and overcoming the limitations imposed by these factors.

Key Words: Anovular cows, Pregnancy loss, Twinning

334 Dairy facilities and cow comfort for the next decade. J. Smith*, J. Harner III, K. Dhuyvetter, and M. Brouk, *Kansas State University, Manhattan.*

The U.S. dairy industry is consolidating rapidly, resulting in fewer herds with a greater number of animals per herd. Producers are attempting to dilute fixed assets over a greater number of cows by utilizing employees to operate the facilities more hours per day. A number of factors will determine how decisions concerning dairy facilities are designed and constructed. These factors include investment cost, equity position, labor efficiency, milking parlor performance, cow comfort, environmental regulations, climate, management philosophy, urban pressure, milk marketing criteria and access to land for manure application. Producers must balance these factors with issues of cow comfort. When constructing new facilities they must choose between cow comfort and minimizing their investment in facilities per cow. The economic pressure of managing a dairy many times does not allow producers to construct facilities that maximize cow comfort. In recent years the emphasis has been placed on cow comfort and its impact on milk production, reproduction and health. A number of factors need to be considered concerning cow comfort when facilities are designed. Some of the major factors include feedline space, access to water, grouping strategies, group size, time spent milking, travel distances

to the parlor, cow handling systems, ability to manage heat stress and housing design (freestalls, bedded pack, and dry-lots). It is important that all the components of the dairy are compatible with each other.

Local climatic and regulatory conditions will have a major impact on how dairy facilities will be designed and built in the future.

Key Words: Dairy facilities, Cow comfort

Animal Health: Immunophysiology of Host-Environment Interactions: Implications for Disease Pathogenesis and Health Management of Production Livestock

335 The effect of transport by road and sea on physiology, immunity, and behavior of beef cattle. B. Earley*, *Teagasc, Grange, Beef Research Centre, Dunsany, Co. Meath, Ireland.*

The overall objective of the studies was to investigate the physiological, hematological and immunological responses of weanling heifers transported to Spain, and of weanling bulls transported to Italy under EU legislation (91/628/EEC) and to evaluate the implications in terms of animal welfare. During these studies, appropriate physiological, hematological and immunological measurements were made on the animals which quantified the effect of transport (by road and sea) on the degree of stress imposed and the performance of the animals over a 38-day study period. Physiological, hematological and immunological parameters (including interferon- γ production, cortisol, protein, globulin, urea, white blood cell numbers and differentials, and haptoglobin) were used to determine the welfare status of animals, before, during and after the respective transport journeys. Age-matched control animals that were blood sampled for the same parameters at times corresponding to the transported animals were retained in Ireland as controls. Heifers transported to Spain, lost, 7.6% of their liveweight during the sea crossing to France. However, by the time of their arrival in Spain they had regained 3.3% of their liveweight and had fully recovered to their pre-transport liveweight values within six days of arriving in Spain. Weanling bulls lost 7.0% of their liveweight during the sea crossing from Ireland to France. The liveweight loss in control animals ranged from 1-2% during the same period. The percentage of time that bulls spent lying during the transport journey was 63.5% for the sea journey and 35.4% for the journey from the French lairage to the Italian feedlot. The performance (average daily gain kg/day) of all transported animals was greater ($P < 0.05$) than control animals from day 11 to day 38 of the studies. While transient changes in physiological, hematological and immunological parameters were found in the transported and control animals relative to baseline levels, the levels that were measured were within the normal physiological range for the age and weight of animals that were studied.

Key Words: Animal welfare, Transport, Immune function

336 Making sense about stress and immunity: Th1 and Th2 aspects of the immune system respond differently to stress. J. L. Salak-Johnson*, *University of Illinois, Urbana.*

Stress is generally considered to suppress the immune system which leads to an increase in disease occurrence in the face of a pathogen. The immune system serves as a primary defense against bacterial and viral challenges. The immune system is brought back to baseline levels after a challenge to homeostasis that involves the hypothalamic-pituitary-axis (HPA). Often, findings reported from various studies investigating the effects of stress on the immune system are conflicting and difficult to interpret. These discrepancies may be partly explained by the types and durations of the stressors and whether researchers measured Th1 or Th2 aspects of the immune system. Cytokines

produced by the innate immune system lead to differentiation of the Th1/Th2 immune pathways. Activation of Th1 involves stimulation of cellular immunity and Th2 is associated with humoral immunity. When animals experience stress, it is possible that there is a shift toward either a Th1 or a Th2 response. For example, a certain stress may stimulate Th1 response while suppressing Th2, resulting in a shift toward a Th1. At any moment, animals have some certain balance between Th1 and Th2 immune arms, and stress can disrupt that balance by lowering Th2 and increasing Th1 cytokines and cell activity. How farm animals perceive the stressfulness of their environment depends not only on traditional environmental stressors (e.g., heat, cold, humidity, pollutants) but also on aspects of the social environment. Social status can interact with environments to cause unusual relationships. For example, dominant animals may have enhanced immune activation while subordinates have suppression of the same trait. This could help explain why individual animals in a group respond differently to stressors and disease challenges. A better understanding of the consequences and complex interactions between social and environmental stressors for both innate and adaptive immune traits must be developed so we can fully understand stress effects on immunity. Once these complex relationships are better understood, more effective interventions can be designed to improve animal health.

Key Words: Stress, Immune, Health

337 Nutritional modulation of innate immunity: Practical approaches. N. Forsberg*¹, S. Puntenney¹, Y. Wang¹, and J. Burton², ¹*Oregon State University, Corvallis*, ²*Michigan State University, East Lansing.*

The immune system may be divided into the innate and antibody systems. The innate system provides a first line-of-defense and time for antibodies to develop. Included in the innate system are neutrophils. Neutrophils roll along the vascular wall via an adhesion molecule (L-selectin). In response to local production of IL8, neutrophils migrate toward pathogen and kill it. A third molecule links the innate with the antibody system. Specifically, activation of the innate system via pathogen up-regulates the antibody system via secretion of interleukin-1-beta (IL1B). The rate-limiting enzyme to IL1B synthesis is IL1-converting enzyme (ICE). We have used a variety of models to study effects of nutritional supplements on markers of innate immunity (L-selectin, IL1B, IL8R and ICE). Models included: 1) dexamethasone (DEX)-induced immunosuppression of sheep, 2) parturition-associated stress in dairy cattle and 3) shipping stress in sheep and beef cattle. Injection of DEX into sheep reduced L-selectin and IL1B ($P < 0.05$). Administration of the supplement restored normal levels of both markers ($P < 0.05$). Ability of the supplement to elicit this effect was enhanced ($P < 0.05$) by fungal pathogen. In dairy, parturition is a normal stress which brings about immunosuppression. We determined, using microarray analysis (BoTL-5 arrays) and quantitative RT-PCR, that supplementation of dry cows for 28 days prior to parturition causes up-regulation ($P < 0.05$) of over twenty neutrophil genes including ICE.

Ability of the supplementation protocol to augment ICE expression may, in part, explain ability of the product to stimulate neutrophil IL1B synthesis in immunosuppressed sheep. The microarray study also revealed up-regulation ($P < 0.05$) of IL8R. This implies that the product may sensitize neutrophils to pathogen signaling during the peri-parturient period. Finally, we examined ability of a nutritional product to affect immune function during shipping. Shipping is a stressful event and methods to augment immunity during this time are needed. The nutritional product augmented ($P < 0.05$) indexes of innate immunity (neutrophil IL8R and L-selectin) in neutrophils of cattle and sheep during shipping stress.

Key Words: Immunity, Nutrition, OmniGen-AF

338 Cumulative physiological events influence the inflammatory response of the bovine udder to E.coli infections during the transition period. C. Burvenich^{*1}, M. Kehrl², M. Paape³, D. Bannerman², and J. Lippolis², ¹*Ghent University, Faculty of Veterinary Medicine, Milk secretion and mastitis research center, Merelbeke, Belgium*, ²*Periparturient Diseases of Cattle Research Unit, USDA, ARS, Ames, IA*, ³*Bovine Functional Genomics Laboratory, U.S. Department of Agriculture, Agricultural Research Service, Beltsville, MD*.

A high proportion of cows with intramammary coliform infections at parturition display signs of severe inflammation and develop systemic complications and sepsis during the first 60-70 days of lactation. In the lactating bovine mammary gland, the innate immune system plays a critical role in the host response to infection and the eventual outcome of mastitis. Since the beginning of the 1990's, research on bovine mammary innate defense mechanisms in connection with the pathogenesis of coliform mastitis has increased significantly. There is no doubt that the viable neutrophil in the cisterns and ducts is a key factor in the protection of the mammary gland. However, in the bovine udder the protective role by the neutrophil seems to be influenced by a cumulation of physiological events occurring during the transition period. During the last 30 years most efforts have been focused on diapedesis, phagocytosis and killing by neutrophils, one of the most important components of the efferent innate arm. How these functions modulate the clinical outcome of coliform mastitis and how they are influenced by hormones and metabolism have also been the subject of intensive research. The study of the afferent (sensing) arm of innate immunity that enables host recognition of a diverse array of pathogens is a new area of interest and differences in the ability of the immune system to detect the presence of a pathogen may vary depending on stage of lactation and influence the inflammatory response.

Key Words: Mastitis, Escherichia coli, Innate immunity

Breeding and Genetics: Genetic Fitness

339 Stillbirth (co)variance components for a sire-maternal grandsire threshold model. J. Cole*, G. Wiggans, P. VanRaden, and R. Miller, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD*.

with pure maternal effects. Economic values of sire and MGS effects for stillbirth are less than for calving ease, and all four traits may be combined into a calving index.

Key Words: Stillbirth, (Co)variance components, Threshold model

(Co)variance components for stillbirth in US Holsteins were estimated under a sire-maternal grandsire threshold model using subsets of data from the national calving ease database, which includes over 7 million calving records with associated stillbirth scores. Stillbirth was coded as a binomial trait indicating whether or not the calf was alive 48 h postpartum; 10.8% of calves born to heifers were stillborn, versus 4.8% of calves born to cows. Records were selected from calves with sire and maternal grandsire (MGS) among the 2600 most-frequently appearing bulls (2578 distinct sires and 2586 distinct MGS). Herd-years were required to contain at least 20 records and only single births were used. After edits, the dataset included 2,083,979 calving records from 5765 herds and 33,304 herd-years. Six sample datasets of approximately 250,000 records each were created by randomly selecting herd codes. Quasi-REML and Gibbs sampling approaches were used to estimate (co)variance components from each sample. The model included fixed year-season, parity-sex, birth year group of sire, and birth year group of MGS effects and random herd-year, sire, MGS, and residual effects. Quasi-REML point estimates fell within the corresponding Gibbs sampling 95% confidence intervals for all samples, indicating good agreement between the two estimation procedures. Marginal posterior means (and standard deviations) averaged 0.0085 (0.0015), 0.0181 (0.0020), 0.0872 (0.0538), and 0.00410 (0.0001) for sire, MGS, and herd-year variances and the sire- MGS covariance, respectively. Mean direct and MGS heritabilities were 0.030 (0.003) and 0.058 (0.003), respectively, and the genetic correlation between direct and MGS effects was 0.331 (0.079). Heritability estimates were lower than some literature results, but the genetic correlation between direct and MGS effects was larger than previous estimated correlations of direct

340 Genetic parameters for calf vigor in the Montana Line 4 inbred Hereford herd. J. M. Rumph^{*1}, D. D. Kress¹, K. C. Davis¹, D. C. Anderson^{1,2}, H. C. Van Wagoner³, and D. L. Boss², ¹*Montana State University, Bozeman*, ²*Montana State University, Northern Agricultural Experiment Station, Havre*, ³*Montana State University, Bair Ranch, Martinsdale*.

Records for 510 Hereford calves produced in the Line 4 Hereford herd at the Northern Agricultural Research Center (NARC) in Havre, Montana from 1997 to 2004 were analyzed to determine the genetic parameters associated with calf vigor. This herd is descended from the Miles City Line 1 Hereford herd and has been a closed herd in Havre since 1963. Inbreeding is increasing in this herd at an average rate of 0.7% per year and animals born in 2004 had an average inbreeding coefficient of 36.5%. Since 1995, selection in this herd has been based on single trait selection for yearling scrotal circumference adjusted for age of dam. For calf vigor, the model included fixed effects of year, age of dam, sex, calving ease score, and the linear and quadratic covariates of day of birth and birth weight. Random effects included were direct genetic, maternal genetic, direct-maternal correlation, and the proportion of variance attributed to maternal permanent environmental effects. Estimates of the genetic parameters were 0.14, -0.23, 0.06, and 0.00 for direct heritability, direct-maternal correlation, maternal heritability, and proportion of variance attributed to maternal permanent environmental effects, respectively. Genetic trends in this data for both direct and maternal breeding values are not significant for animals born from 1993 through 2004 which includes many of

the dams of the calves in this dataset. Calf vigor is a moderately heritable trait that does not appear to be affected by selection for scrotal circumference or the increasing level of inbreeding in this population.

Key Words: Calf vigor, Inbreeding, Scrotal circumference

341 Genetic parameters for rear legs/rear view in Brown Swiss cattle. G. R. Wiggans¹, L. L. M. Thornton*¹, and R. R. Neitzel², ¹*Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD*, ²*Brown Swiss Association, Beloit, WI*.

Genetic parameters for rear legs/rear view (RLRV) and the 15 current linear type traits in Brown Swiss cattle were estimated. Appraisers record linear traits on a 1 to 9 scale. Reported scores were multiplied by 5 to make them compatible with earlier scores that were on a 1 to 50 scale. The Brown Swiss Association began scoring RLRV in 2004 so only two years of data with all traits recorded were available. These 7,511 records were on 6,896 cows in 375 herds. Pedigree data included 14,168 ancestors and seven unknown parent groups, each including four years of birth. The model included fixed effects for herd appraisal date, and age within parity effects, and random effects animal, permanent environment, and error. The multitrait analysis for the 16 linear type traits used canonical transformation, multiple diagonalization with the F-G algorithm and the expectation-maximization REML algorithm. Heritabilities ranged from 0.073 for RLRV to 0.438 for stature. They averaged 0.046 lower for the 15 currently evaluated traits and ranged from 0.114 lower for teat placement to 0.030 higher for udder height. Strength and udder width had heritability 0.102, the lowest of the currently evaluated traits. The highest genetic correlations for RLRV with the other traits were 0.55 with udder width, 0.47 with strength, and 0.35 with thurl width. The most negative correlation was -0.15 with rear legs side view. The lower heritabilities may reflect the short period of data collection and change in parameters over time. The trait RLRV has the lowest heritability and relatively high correlations with several other traits, but may still be useful in the type program because of the importance of locomotion traits. It is likely to be included in the feet and legs composite. This would affect net merit values.

Key Words: Locomotion, Type traits, Genetic evaluation

342 Quantifying the impact of multiple independent heterozygous loci on survival. H. A. Adams* and R. D. Shanks, *University of Illinois, Urbana*.

The objective was to quantify the impact multiple independent heterozygous loci have on the survival of progeny of a bull. A simulation was created to demonstrate the impact of changes in inbreeding (%F), number of heterozygous loci (HeL), and total number of loci (TL), on the amount of survival reduction. Homozygous recessive alleles were assumed to be lethal. All heterozygotes were considered carriers of a lethal defect. Other simulation components included calf mortality rate (%CM) and total survival reduction of the bull (%TSR). Calf mortality was calculated as a function of inbreeding. Total survival reduction was calculated as $\%CM * (HeL / TL)$. Results were based on three scenarios: (1) fixed %F and HeL with changing TL, (2) fixed %F and TL with changing HeL, and (3) fixed HeL and TL with changing %F. In the first scenario, inbreeding was set to a value of 5.1%, the

average inbreeding percentage of cows born in 2005. The variable HeL was fixed at 2. Increasing the number of loci decreased the amount of total survival reduction for a fixed number of defects per bull. For bulls with 5, 50, and 500 loci influencing a trait, bull survival was reduced by 5.1%, 0.51% and 0.051% respectively. Offspring of a bull with a greater number of loci had a greater chance of homozygosity of favorable alleles among the loci, and their chance for survival increased. The second scenario fixed %F at 5.1%, and TL at 15. As heterozygosity increased, %TSR increased. Bulls with 1, 5, and 10 HeL out of 15 TL had a total survival reduction of 0.85%, 4.25%, and 8.5%, respectively. The final scenario fixed TL at 4 and HeL at 2, or heterozygosity fixed at 50%. Bulls with inbreeding percentages of 1, 3 and 5 had a total survival reduction of 1.25%, 3.75% and 6.25% respectively. This scenario showed a negative impact of inbreeding on survival regardless of the genotype of the individual. Greatest survival was associated with more loci influencing survival, few heterozygous loci and low inbreeding.

Key Words: Inbreeding, Survival, Heterozygosity

343 Mapping quantitative trait loci affecting calves immune function and birth weight in a Holstein x (Holstein x Jersey) backcross population. C. Maltecca*, H. Khatib, V. R. Schutzkus, and K. A. Weigel, *University of Wisconsin, Madison*.

Calf birth size and health status are related, and they both influence the ability of the adult animal to avoid culling. Health problems from which an animal appears to recover early in life can in fact impair its productivity later. Objective of the study was to identify molecular markers associated with traits related to calf size and immune function. A resource population consisting of 250 backcross calves (118 females, 132 males) was created via backcross matings, in which lactating Holstein cows were randomly selected from the University of Wisconsin – Madison herd and randomly mated to 7 young F1 Holstein x Jersey sires to produce $\frac{3}{4}$ Holstein : $\frac{1}{4}$ Jersey offspring. Calves were measured for weight immediately after birth (mean 38.52 kg \pm 2.21kg) and their immune function was evaluated through total serum protein level and serum IgG levels. Serum was harvested from jugular vein between 24 and 78 hours of age. Total serum protein level (mean 5.03 g/100ml \pm 0.06 g/100ml) was measured using a refractometer, while serum IgG level (mean 1053.55 mg/dl \pm 345.12 mg/dl) was determined by radial immunodiffusion assay. Results from a whole genome scan are discussed. 182 microsatellites markers were chosen among 270 after sires genotyping. Sires heterozygosity were of 62.83%, 62.76%, 62.10%, 63.49%, 58.53%, 65.32% and 57.36%, for sire one to seven respectively. Spacing between markers ranged from 3.4 cM to 32.85 cM with an average of 15.93 cM. Average number of markers per chromosome was 7.06 with a minimum of 4 and a maximum of 11. Analysis was carried out through selective genotyping in which the top and bottom 20% of the population were included. Phenotypic averages for the upper tail were 6.57 g/100ml, 2648 mg/dl and 46.55 kg for total serum protein, IgG protein level and birth weight respectively. Phenotypic averages for the lower tail were 3.49 g/100ml, 448.64 mg/dl and 34.45 kg for total serum protein, IgG protein level and birth weight respectively.

Key Words: Bovine, Quantitative trait loci, Immune function

344 Genetic parameters of cortisol and creatinine in pigs as indicators for behavioral and nutritional disorders. H. N. Kadarmideen^{*1}, S. Gebert², and C. Wenk², ¹*Statistical Animal Genetics, Institute of Animal Science, Federal Institute of Technology (ETH), Zurich, Switzerland*, ²*Nutritional Biology, Institute of Animal Science, Federal Institute of Technology (ETH), Zurich, Switzerland*.

This study reports results from the genetic analysis of pig populations that were under 20 year selection experiment in the experimental animal research station of ETH Zurich, Switzerland. The overall aim of this experiment was to study the possible differences of the activity of *hypothalamo-pituitary-adrenal axis* in two lines of Large White pigs, which had differences in response (Cortisol and Creatinine levels) to various stress stimuli. Pigs were also recorded for urinary excretion of cortisol and creatinine and their ratio in 24-h periods. The ratio between cortisol and creatinine represents protein metabolism. The main dataset had 417 animals. Pedigrees for these pigs contained a total of 483 animals. The data were analyzed by residual maximum likelihood approach, implemented by ASReml software. The statistical model for genetic analysis of cortisol (CRT), creatinine (CRE) and their ratio: CRT-CRE (CCR) included effects of year, weight, urine output and feed intake and direct genetic value of animals. Multiple-trait animal models were used to estimate variance and covariance components and subsequently heritabilities (h^2) and all correlations. The weight, sex and feed intake significantly affected all traits. The h^2 (s.e.) of CRT, CRE and CCR were 0.40 (0.02), 0.39 (0.03) and 0.17 (0.01), respectively, which show strong genetic control and inheritance patterns. The genetic and phenotypic correlations (with s.e.) were: CRT-CRE: 0.07 (0.04) and 0.05 (0.01), CRE-CCR: 0.26 (0.01) and 0.08 (0.01) and CRT-CCR: 0.28 (0.01) and 0.11 (0.01). These results show common co-inheritance patterns as well as environmental conditions that increase (genetic merit for) cortisol and creatinine levels. Results suggest that these indicator traits can be used in genetic selection for physiologically and metabolically stable and healthy pigs in national pig breeding programs. These results will also have strong implications for human diseases such as obesity and diabetes.

Key Words: Genetics, Cortisol, Pigs

345 Success of rebreeding given first parity calving ease scores in Canadian Charolais cattle. M. L. Spangler^{*}, R. Rekaya, and J. K. Bertrand, *The University of Georgia, Athens*.

Field data from Canadian Charolais herds were used to investigate the genetic relationship between calving ease (CE) scored from 1 to 3 and rebreeding within a 90 day opportunity period post partum (R90). Data were analyzed using a bivariate threshold model where CE was treated as categorical and R90 as binary. At the liability scale, the linear mixed model included herd, yr, and month of mating as fixed effects; unrelated service sire, additive animal and residual as random effects; and linear and quadratic effects of age at mating as covariates. The model for R90 included the CE score as a covariable in order to account for the recursive relationship between both traits. For females who were bred via artificial insemination (AI) in the second parity the conception date and thus the success or failure of rebreeding within the opportunity period is known. For natural service mating data, an average gestation length (GL) and standard deviation (SD), by sex, derived from AI records was used to determine the approximate date of conception. Females who have delayed conceptions create added expenses in the form of increased labor, breeding costs, extended calving seasons, and lighter weaning weights. Therefore, the current study had two main objectives: 1) Estimate genetic parameters for

CE and R90 and 2) to determine if calving difficulty as a first calf heifer had a negative impact on the ability to conceive within a 90 day period post partum. The results indicated, in general, a decrease in reproductive performance with the increase in calving difficulties. Although the difference was minimal between cows scored 1 (no calving problems) and 2 (some assistance or mal presentation), it was significant for cows with calving score of 3 (hard pull or surgery). In fact, cows with CE scores of 2 and 3 have a 3% and 11% less chance of getting pregnant compared with cows with a CE score of 1. The small difference in R90 between cows with CE scores of 1 and 2 could be due in part to the subjective nature of calving ease scoring and the lack of clear boundaries between both classes.

Key Words: Beef cattle, Calving ease, Recursive function

346 Conception rates trend of Holsteins in South-East USA. C. Huang^{*1}, S. Tsuruta¹, I. Misztal¹, T. J. Lawlor², and J. S. Clay³, ¹*University of Georgia, Athens*, ²*Holstein Association USA Inc., Brattleboro, VT*, ³*Dairy Records Management System, Raleigh, NC*.

The purpose of this study was to estimate trends in conception rate (CR) of Holsteins. Data were obtained from Dairy Records Management Systems in Raleigh, NC. Raw data includes 13,533,978 services from 1988 to 2004 in 10 states: VA, KY, NC, SC, TN, GA, FL, AL, MS, LA, TX. Edits removed services with missing cow ID, birth date, calving date, and service date and retained services with days to service after calving between 21 and 250 d in the first parity and born between 1985 and 1999. Edits also removed data from FL because trends calculated with FL data were different from the remaining states. After these edits, there were 1,582,209 services for 765,652 cows. After elimination of censored lactations, there were 776,470 services of 388,028 cows with confirmed next calving. Analyses used SAS PROC GLM. The model included the effects of birth year (1985-89, 1990-94, 1995-99), service at DIM interval group, milk production level during the first 3 test days (< Mean-SD, Mean±SD, >Mean+SD), service month, service type (only natural insemination, only artificial insemination and both for all service) and two-way interactions. For AI services, the average CR decreased from 55% in 1985-89 to 46% in 1995-99. Considering the month of service, the smallest decrease was 5% in January and the steepest decrease was 15% in June. High performing cows had CR about 3% lower. For cows born in 1995-99, CR was 28% at 50 DIM, increased to 40% at 125 DIM, and again to 55% at 250 DIM. Estimated CR of natural bulls was 10% higher, which may be due to incomplete and inaccurate recording of natural service. Fertility of Holsteins declined over time. Only a fraction of that decline can be attributed to increased milk yield in the first 100 days. The length of declined CR in the summer is increased indicating deterioration of heat tolerance over time. The deterioration in CR over time can be offset by extending the voluntary waiting period by 75-100 d.

Key Words: Conception rate, Fertility, Holstein

347 Relationship between reproduction traits and functional longevity in Canadian dairy breeds. A. Sewalem^{*1,2}, G. Kistemaker², F. Miglior^{1,2}, and B. Van Doormaal², ¹*Agriculture and Agri-Food Canada - Dairy and Swine Research and Development Centre, Lennoxville, QC, Canada*, ²*Canadian Dairy Network, Guelph, ON, Canada*.

The aim of this study was to assess the relationship between reproduction traits and functional survival of Canadian dairy breeds using a Weibull proportional hazard model. Data consisted of 47,949 heifers

in 650 herds from 969 sires for Ayrshire, 33,548 heifers in 815 herds from 932 sires for Jersey. Functional longevity was defined as the number of days from the first calving to culling or death or censoring. Reproduction traits were calving ease (unassisted, easy pull, hard pull or surgery), calf size (small, medium or large), stillbirth (dead or alive within 24-h of calving), non return rate (unsuccessful or successful), number of services and days from first service to conception. The statistical model included the effects of stage of lactation, season of production, the annual change in herd size, type of milk recording supervision, age at first calving, effects of milk, fat and protein yields calculated as within herd-year-parity deviations, herd-year-season of calving, each fertility trait and sire. The relative culling rate was calculated for animals in each class after accounting for the above-mentioned effects. The result showed that heifers that require hard pull, producing large calf size and dead calves were more likely to be culled compared to the average group in each breed. For instance, heifers producing dead calves were 35% and 14% times more likely to be culled compared heifers producing live calves in Ayrshire and Jersey, respectively. In all breeds, as number of services increased there was a trend toward higher risk of culling among heifers. The relative risk ratio for heifers that required greater than 120 days from first service to conception were 1.35 (Ayrshires) and 1.25 (Jersey) times more likely to be culled compared to heifers that did conceive with the first insemination.

Key Words: Functional longevity, Reproduction traits, Canadian dairy breeds

348 Factors that impact longevity of Holsteins in the United States.

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Region, herd size, inbreeding, and performance were examined to determine their impact on longevity of 8 million US Holsteins from 1980 through 2005. Seven geographical regions (5 to 9 states each) were defined. Ten inbreeding groups were defined based on percentage of inbreeding: 0, 0.1 to 1.0, 1.1 to 2.0, 2.1 to 3.0, 3.1 to 4.0, 4.1 to 5.0, 5.1 to 7.0, 7.1 to 10.0, 10.1 to 15.0, and >15.0. Seven herd-size groups were defined: <50, 51 to 100, 101 to 200, 201 to 500, 501 to 1,000, 1,001 to 2,000, and >2,000 cows. Cows were excluded if sold for dairy purposes or if the herd discontinued testing during productive herd life of the cow. Time restraints were imposed so that cows had an opportunity to survive to parity 8. Differences in number of calvings for the most recent year with complete data were notable between regions; number of calvings ranged from 2.59 (Southeast) to 2.92 (Northeast). Differences based on herd size were smaller; number of calvings ranged from 2.75 (101 to 200 cows and >2000 cows) to 2.83 (<50 cows and 501 to 1,000 cows). Inbreeding coefficients have

increased over time, and inbreeding had a large impact on number of calvings and productive herd life. For the latest year with survival opportunity, mean number of calvings decreased with increasing inbreeding from 2.97 calvings at 0% inbreeding to 2.53 calvings at >10% inbreeding. First-parity yield traits (milk, protein, and fat) had greater impact on cow longevity than did region or herd size. For terminal records, lactations were shortest for cows with mastitis or high somatic cell score (197 d) or that died (200 d) and longest for cows with reproductive problems (389 d). Cows that were culled after early parities had longer lactations than those culled after later parities. As cows aged, fewer were sold because of low yield or poor reproduction, and more died or were culled because of mastitis and high somatic cell score.

Key Words: Culling, Longevity, Survival

349 Health, immune function, and survival of calves from Holstein dams and Holstein or crossbred Jersey x Holstein sires.

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Differences in birth weight, calving ease, serum protein level, serum IgG level, fecal consistency score, respiratory disease score, and perinatal and pre-weaning survival were evaluated in calves resulting from the random mating of lactating Holstein cows to young Holstein sires (N = 74) or young F1 Jersey x Holstein sires (N = 7). Calves from Holstein sires (N = 99) were 1.9 kg heavier than calves from crossbred sires (N = 211), leading to greater likelihood of an assisted calving (estimated odds ratio of 1.24). Furthermore, mean serum protein level at 24 to 72 hr of age was significantly higher (P < 0.01) for calves from crossbred sires than for calves from purebred sires, as was mean serum IgG level (P < 0.05), suggesting an improvement in the attainment of passive immunity among crossbred calves. Rates of perinatal survival, as measured by stillbirths and calves that died by 24 hr of age, and pre-weaning survival, as measured by deaths that occurred between 24 hr and 6 wk of age, were also significantly higher (P < 0.05) among calves from crossbred sires, as compared with calves from Holstein sires. Mean fecal consistency scores from birth to 7 d of age and average number of days with scours also tended to be lower (P < 0.10) among calves from crossbred sires. No differences were observed in the incidence or severity of respiratory disease. Results of this study suggest that the introduction of Jersey genes into Holstein herds via crossbreeding may lead to a reduction in calving problems and improvements in calf health, immune function, and survival. Future studies should address other traits related to dairy farm profitability, including milk composition, female fertility, longevity, feed efficiency, and resistance to infectious and metabolic diseases.

Key Words: Health, Immune function, Calves

Dairy Foods: Chemistry and Microbiology

350 Effect of EPA and DHA fortification on the oxidation stability of caprine milk infant formula analogue.

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Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are polyunsaturated fatty acids (PUFA) that are present in human milk and infant formulas, and required for proper growth and healthy brain development of infants. Oxidation alters the nutritional quality of

PUFA due to their high unsaturation and produces toxic compounds, which may cause the milk unacceptable for consumption. Some standard methods can determine oxidative deterioration of PUFA, which include peroxide value (primary oxidative products) and P-anisidine value (secondary oxidative products). The objective of this study was to determine the effect of EPA and DHA fortification on the oxidation rate of caprine milk infant formula analogue. Skim goat milk was modified for two preparations: coconut, safflower and soybean

oils in the ratio of 2.5:1.1:0.8 (VGM), and coconut, safflower, soybean and menhaden fish oils in the ratio of 2.1:1.1:0.8:0.4 (FOGM). Both fortifications were made to contain 4.4g fat/100ml milk. Lecithin (0.5g/100ml) was added to both preparations before homogenization, freeze-drying and storage in airtight containers at room temperature for 6 weeks. A subsample from each batch was reconstituted every 14 days by dissolving 12.5 g dried sample in 87.5 g water, and then extracted for lipids. Peroxide value (POV) and P-Anisidine value (P-Anv) were determined for each subsample and TOTOX value was calculated as $2POV + P-Anv$. For VGM samples, the respective ranges of POV, P-Anv and TOTOX were: 2.55-3.55, 0.60-2.06 and 3.55-9.16, while for FOGM samples the corresponding ranges for the three parameters were: 5.55-5.90, 12.0-18.38 and 23.1-29.8 for the 6 weeks storage period. The oxidation values for VGM were significantly ($P < 0.05$) lower than those of FOGM. Although there may be a greater risk of oxidation for EPA and DHA fortified infant formulas, the study revealed that oxidative rate could be reduced significantly by use of antioxidants as well as low temperature storage treatment.

Key Words: EPA and DHA fortification, Oxidative stability, Infant milk analogue

351 Identification and putative proteolytic origin of some major water-soluble peptides produced during ripening of Ragusano cheese. C. Pediliggieri¹, T. M. Carnemolla¹, V. Gagnaire², D. Mollé², V. Fallico¹, S. Carpino¹, G. Licitra^{1,3}, and S. Lortal^{*2}, ¹CoRFiLaC, Regione Siciliana, Ragusa, Italy, ²UMR Science et Technologie du Lait et de L'Oeuf, Rennes Cedex, France, ³D.A.C.P.A. Catania University, Catania, Italy.

Raw milk was collected from two farms of the Hyblean region sited on mountain level (ML) and sea level (SL). Raw milk was transformed in Ragusano cheese at the CoRFiLaC experimental cheese plant. The extent of proteolysis was estimated by soluble nitrogen at pH 4.6 and at 12%TCA; respectively 20.57 ± 2.25 and 17.52 ± 2.97 % for ML cheeses; 25.74 ± 2.21 and 21.37 ± 2.77 % for SL cheeses after 210 days of ripening. Cheeses after stretching (0 days), as well as 120 days and 210 days aged cheeses were analyzed by RP-HPLC and the peptides further identified by tandem mass spectrometry. RP-HPLC profiles were similar for ML and SL after stretching and exhibited slight differences during ripening. After stretching, 224 peptides were successfully identified: 163 peptides arising from β -casein, 45 from α s1-casein and 16 from α s2-casein. Some peptides were common between ML and SL: 21% out of the β -casein peptides, 29 out of the α s1-casein and 56% out of the α s2-casein. Protein splitting corresponding to plasmin and cathepsin D, cell envelope proteinase of lactic acid bacteria and peptidase activities were observed. After 120 and 210 days of ripening most of these peptides were hydrolyzed. As observed in other cheese varieties, phosphopeptides were more resistant and can be found till the end of ripening like peptides from the N-terminal part of the β - and α s1 caseins. Some peptides like the fragment α s2 CN (100-115)(105-114)(153-162) and β (11-28)(29-52)(193-206) and α s1 (1-9)(14-23)(83-93), were released in cheese after manufacture and remained after 210 days of ripening; this suggested that these peptides might be used as markers of cheese age. These results showed that the raw milk origin and its variable bacterial ecosystem might lead to a certain modulation of the general proteolysis pathway. However, many identical peptides were also found indicating the importance of the process.

Key Words: Ragusano cheese, LC/MS-MS, Peptides

352 Measurement of ionic calcium in milk by molecular probes and front face fluorescence spectroscopy. R. R. Gangidi* and L. E. Metzger, MN-SD Dairy Research Center, University of Minnesota, St. Paul.

Ionic calcium influences the visco-elastic properties of the milk and other dairy products. Molecular probes, such as Fluo-5N, have the potential to be used to determine the ionic calcium content in milk. However, Fluo-5N was designed to measure calcium ions in the range of 1 to 1000 μ M at a physiological pH of 7.0, whereas the typical calcium ion concentration of milk is in the range of 2.5 to 3mM. The objective of the current study is to develop a simple calibration to measure calcium ion in milk with Fluo-5N and fluorescence spectroscopy. The calcium concentration of a milk sample was adjusted to various ranges by addition of 7.3 and 14.5mM of disodium-EDTA or 2mM of CaCl₂. Additionally a control milk sample without added EDTA or CaCl₂ was also used in the study. The pH of all the samples is adjusted to 6.6-6.7. After addition of EDTA or CaCl₂, the milk concentration was 80% in all samples. Fluo-5N (2.62 μ M) was added to the samples and thoroughly mixed. Fluorescence spectra (excitation at 470nm, and emission from 500-560nm) were collected on each sample before and after addition of the probe. The spectra of each sample prior to probe addition was used as the background and subtracted from the spectra collected from each sample after probe addition. The entire experiment was subsequently repeated with two additional milk samples. The fluorescence intensity at 519nm of each sample was correlated ($R^2 = 0.84$) to the logarithmic calcium ion concentration determined using a calcium ion selective electrode. These results indicate that the ionic calcium content of milk can be determined with Fluo-5N and fluorescence spectroscopy. The molecular probes, with further modifications, may also be used to measure ionic calcium in other dairy products.

Key Words: Calcium ion, Molecular probes, Ion selective electrode

353 Effect of mountain and sea level pasture on Conjugated Linoleic Acid content in plasma and milk. S. La Terra*¹, S. Carpino¹, S. Banni², M. Manenti¹, M. Caccamo¹, and G. Licitra^{1,3}, ¹CoRFiLaC, Regione Siciliana, Ragusa, Italy, ²Cagliari University, Cagliari Italy, ³D.A.C.P.A Catania University, Catania, Italy.

Total CLA in plasma and CLA isomers on bovine milk were studied in four groups of cows from two different located farms. Three groups of cows, from a mountain level (ML) farm, fed at 3 different levels of pasture. Group 1 fed TMR (ML0) no pasture; group 2 fed TMR supplemented with 30% DM of pasture (ML30), and group 3 fed TMR supplemented with 70% DM of pasture (ML70). The fourth group of cows, from a farm sited on sea level (SL), fed with TMR supplemented with 30% DM of pasture (SL30). Cattle breed, lactation days and milk production level were similar for all the 4 groups of cows. Blood from the jugular vein and milk samples were collected at the same time during the afternoon milking. Samples were transported to the lab and stored at -80°C. The experiment was repeated three times. The effect of pasture in the diet was significant ($P < 0.01$) for CLA concentration in plasma. CLA level increased with the percentage of pasture in the diet: 1.17 (nmoli/mg fat) in the ML0, 2.07 (nmoli/mg fat) in the ML30, and 2.70 (nmoli/mg fat) in the ML70 treatment. In milk samples the comparison of amounts of the total CLA was significant ($P < 0.01$) and was higher than the plasma samples: 10.41 nmoli/mg fat, 11.75 nmoli/mg fat and 15.26 nmoli/mg fat respectively. Milk isomers showed statistically different concentrations related to the percentage of pasture in the diet and in the different date of sampling. Isomers

trans 12 trans 14, trans 10 cis 12, cis 9 trans 11 and cis 10 cis 11 increased ($P < 0.01$) with the percentage of pasture in the diet and the concentration of trans 11-trans 13, trans 10-trans 12, cis 11-trans 13, and cis 7-trans 9, and cis 9-cis 11 isomers increased linearly with time ($P < 0.01$). The comparison of the level altitude (ML30 vs SL30) had no impact for total CLA in plasma and milk samples. Isomers trans 9 trans 11 (0.19 vs 0.11 nmoli/mg fat), and cis 10 cis 12 (18 vs 101 nmoli/mg fat) of the milk had a significant impact ($P < 0.01$), and cis 9 trans 11 increased with time.

Key Words: Mountain and sea level pasture, CLA, Plasma and milk

354 Immunobiotic lactic acid bacteria induce immune responses in immature gut-associated lymphoid tissues via Toll-like receptors 2 and 9. H. Kitazawa*, M. Tohno, T. Shimosato, H. Aso, Y. Kawai, and T. Saito, *Graduate School of Agricultural Science, Tohoku University, Sendai, Japan.*

Studies comparing the composition of intestinal microflora in allergic and nonallergic infants have suggested a relationship between intestinal microflora and the development of allergies; however, the molecular mechanisms by which immature gut-associated lymphoid tissues (GALT) of newborns recognize microbial molecules have been unclear. Our laboratory has focused on the specific effectors on immunobiotics, probiotic bacteria, such as lactic acid bacteria, that promote health by activating intestinal immunity. Here, we investigated the expression patterns of Toll-like receptor (TLR) 2 and 9, which are receptors for bacterial components, and the immune responses induced by their ligands in the immature GALT of presuckling newborn swine. We found that TLR2 and 9 mRNAs are expressed at higher levels in ileal Peyer's patches (Pps) and mesenteric lymph nodes (MLNs) than in the duodenum, jejunum and ileum. We confirmed that the TLR2 and 9 proteins were also highly expressed and that their ligands were preferentially recognized by TLR2- or TLR9-expressing cells in the ileal Pps and MLNs. Zymosan, CpG2006, and lactic acid bacteria promoted mitogenesis and the production of multiple cytokines in the MLNs and ileal Pps. In addition, double immunostaining for cytokeratin 18 and either TLR2 or TLR9 revealed that both TLR2 and 9 are strongly expressed in the columnar membranous cells. Interestingly, although the apical membrane of the columnar membranous cells strongly expressed TLR2 protein and preferentially recognized zymosan, both TLR2 expression on the apical membrane and TLR2-mediated zymosan binding were negligible in neighboring enterocytes. These results indicate that TLR2 and 9 allow ileal Pps and MLNs to respond to a variety of bacterial components immediately after birth, thereby providing newborns with a host defense system. Understanding the functional role of TLR2 and 9 in the immature GALT should also aid the development of oral vaccines and immunobiotic foods that specifically target immune responses in the GALT.

Key Words: Immunobiotics, Toll-like receptor 2 and 9, Gut-associated lymphoid tissues

355 Microbiological safety of Ragusano cheese through traditional farmhouse manufacturing: A preliminary study. G. Licitra*^{1,2}, A. Fiori¹, M. Manenti¹, S. La Terra¹, P. Campo¹, and S. Carpino¹, ¹CoRFiLaC, Regione Siciliana, Ragusa, Italy, ²D.A.C.P.A. Catania University, Catania, Italy.

Ragusano is a raw milk pasta-filata cheese produced in the south-eastern region of Sicily at farmhouse level using natural rennet and traditional wooden tools. The cheese manufacturing process involves

two rounds of cooking, stretching of the overnight-ripened curd, moulding, brining and aging. Slight differences in the manufacturing process among producers lead to different flavor and texture of the final product. In an attempt to define the key steps of the process that lead to a safe cheese, we monitored the production of PDO Ragusano cheese in five farms. During each of three subsequent days, two blocks of Ragusano were produced per farm, for an overall count of thirty blocks of cheese. Chemical and microbiological analysis were performed on milk, production intermediates and different sections (sub-rind, intermediate, and core) of cheese aged for 2, 3 and 4 months. Results point to the importance of the second cooking of the curd as a key step in establishing the necessary conditions for a fast acidification. In fact, in the only farm where this step takes place for 10 minutes only (as opposed to an average length of 150 minutes), acidification of the curd appears to be noticeably slower, with a concomitant higher susceptibility to contamination. Manufacturing conditions proved to be very effective in causing death of the small number of *Staphylococcus aureus* cells found as contaminants of raw milk. No contaminations by *Listeria monocytogenes*, *Salmonellae* and *Escherichia coli* were detected at any stage of the process. On the other hand, after 2 months from manufacturing already, cheeses showed water activity levels which are hardly compatible with growth of the above mentioned pathogens, and which decreased further with subsequent aging. Our results show that the cheese-making technology of Ragusano guarantees high levels of microbiological safety as long as good practices are maintained throughout the entire process. The high temperatures used for cooking and stretching the curd, fast acidification, low aw values and high salt content contribute to make Ragusano a hostile environment for the growth of pathogens.

Key Words: Ragusano cheese, Safety, Traditional

356 Development of a new evaluation system for the selection of probiotic lactic acid bacteria (LAB) with specific adhesion to human blood type A-antigen of intestinal mucosa. H. Uchida*¹, H. Kinoshita¹, Y. Kawai¹, H. Kitazawa¹, K. Miura², K. Shiiba², A. Horii², K. Kimura³, N. Taketomo³, M. Oda³, T. Yajima³, and T. Saito¹, ¹Graduate School of Agricultural Science, Tohoku University, Sendai, Miyagi, Japan, ²Graduate School of Medicine, Tohoku University, Sendai, Miyagi, Japan, ³Meiji Dairies Corporation, Odawara, Kanagawa, Japan.

A new evaluation system for selecting probiotic lactic acid bacteria (LAB) with activity for specific adhesion to human colonic mucin by recognizing differences in ABO-blood type was established. Sixteen strains that showed strong adhesion to human blood type-A antigen [GalNAc- α -1-3 (Fuc- α -1-2) Gal-] of intestinal mucosa were selected from 237 probiotic strains with a biosensor BIACORE, by surface plasmon resonance (SPR). Similarly, sixteen and eleven strains were selected with strong activity to human B-antigen [Gal- α -1-3 (Fuc- α -1-2) Gal-] and H-antigen [Fuc- α -1-2 Gal-], respectively. Because there is a lot of population of human blood type-A in Japan (40%), we experimented the LAB recognizing human A-antigen for further evaluation. The adherence of the SLPs (surface layer proteins) prepared from the selected strains towards human A-antigen was reevaluated by BIACORE and the *L. brevis* strains revealed strong adhesion to the A-antigen. The SLP from *L. brevis* strain OLL2772 showed a single band at ca. 48 kDa using SDS-PAGE analysis and it had a very high adherence to the human A-antigen as shown using an anti-A lectin blocking technique. A partial N-terminal sequence of the band showed high homology to a S-layer protein of *L. brevis* ATCC 8287^T. There are few reports of LAB recognizing human blood type antigens in

comparison to those showing the adhesion of LAB to the human intestine. The new assay system will be useful for the selection of probiotic candidates in future construction of functional foods including yogurt.

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2) International patent number: PCT/JP2005/011043

Key Words: Lactic acid bacteria (LAB), Adhesion, Human blood type-A

357 Identification of the microflora in the complete Ragusano cheese processing from milk produced at two different farm locations. G. Licitra^{1,2}, S. Parayre³, H. Falentin³, S. Carpino¹, V. Fallico¹, C. Pediliggieri¹, and S. Lortal^{*3}, ¹CoRFiLaC, Regione Siciliana, Ragusa, Italy, ²D.A.C.P.A. Catania University, Catania, Italy, ³UMR Science et Technologie du Lait et de L'Oeuf, Rennes Cedex, France.

Raw milk was collected in two farms of the Hyblean region sited on mountain level (ML) and sea level (SL). Raw milk was transformed in Ragusano cheese, using two different wood vats 'tina' at the CoRFiLaC experimental cheese plant. Milk, curd before and after cooking, stretching and cheeses (4 and 7 months aged) were analyzed by PCR-TTGE and enumeration microbiology. In addition the biofilm of the vats 'tina' was studied before putting milk in it. The total count for the raw milk samples from ML farm and SL was respectively $6 \cdot 10^4$ and $2.3 \cdot 10^5$. Using universal primers PCR-TTGE revealed many differences between the raw milk profiles, excepted few common bands identified as *S. thermophilus*, *L. lactis*, *L. delbrueckii*, and *E. faecium*. Other various species detected were *Lactobacillus helveticus*, *Propionibacterium freudenreichii*, *Staphylococcus xylosum*, *Lactobacillus plantarum*. 'Tina' exhibited different biofilms: the 'tina' for ML milk was colonized by two clearly predominant species: *S. thermophilus* and *L. delbrueckii* whereas the one used for SL milk exhibited at least 5 different bands, *S. thermophilus* being predominant. By numeration, the count of Enterococcus and Lactic acid bacteria

increased (0.5 to 1 log) when milk was transferred in the 'tina'. In both cases (ML-SL), the stretching step induced a simplification of the profiles and 3 of 5 dominant species only were detected by TTGE through the entire process of ripening. At this stage and whatever the milk origin the profiles were rather similar. Classical numeration confirmed the presence of predominant viable thermophilic lactic acid bacteria growing until stretching and decreasing until the end of the ripening. In conclusion, the cheese making process of Ragusano cheese (pH and temperature, mainly during stretching) has a major role in selecting predominant natural microflora. The exact role of the tina in inoculating the milk has to be further explored.

Key Words: Ragusano cheese, PCR-TTGE, Microbiology

358 Rheological properties of rennet-induced milk gels made from milk protein concentrate solutions with different ratios of α_s -: β -casein. J. A. O'Mahony^{*1,2}, P. L. H. McSweeney¹, and J. A. Lucey², ¹University College, Cork, Ireland, ²University of Wisconsin, Madison.

The rheological properties of rennet-induced milk gels made from milk protein concentrate (MPC) solutions with α_s - (i.e., α_{s1} - + α_{s2} -): β -casein ratios of 1.00:0.80 (MPC A), 1.00:0.70 (MPC B) or 1.00:0.87 (MPC C), each having identical concentrations of total casein (2.5%), were studied using dynamic low amplitude oscillatory rheometry. The ratio of α_s -: β -casein had no significant ($P > 0.05$) effect on rennet coagulation time. Storage modulus (G' ; index of firmness), measured 30 min after addition of rennet, decreased with increasing ratio of α_s -: β -casein. Storage modulus for gels made using each of the three MPC solutions reached plateau values ~200 min after addition of rennet, with the plateau value of G' decreasing significantly ($P < 0.05$) as relative concentration of β -casein increased in the MPC solutions. There were no significant ($P > 0.05$) differences in the frequency dependence of G' in the frequency range 0.001 to 1 Hz between gels made using any of the three MPC solutions. On shearing the gels at a rate of 0.01 s^{-1} , the value for apparent yield stress and apparent yield strain increased significantly ($P < 0.05$) as relative concentration of α_s -casein increased in the MPC solutions. Thus, the ratio of α_s -: β -casein influenced the small and large deformation rheological properties of rennet-induced milk gels.

Key Words: Casein, Rennet, Rheology

Dairy Foods: Production Meets Processing: A Vital Link for High Quality Dairy Foods

359 Production meets processing: A vital link for high quality dairy foods. S. A. Rankin^{*1}, S. P. Washburn², B. Luth³, G. Licitra⁴, S. Carpino⁴, and P. Kindstedt⁵, ¹University of Wisconsin, Madison, ²North Carolina State University, Raleigh, ³Tillamook County Creamery Association, Tillamook, OR, ⁴CoRFiLaC, Regione Siciliana, Ragusa, Italy, ⁵University of Vermont, Burlington.

The American Dairy Science Association has a strong heritage of facilitating cutting edge research in the areas of milk production

and milk processing. However, few research programs or symposia highlight the findings and benefits of research that involves both disciplines working in complement. The ADSA annual meeting provides a unique opportunity where researchers from both disciplines are present. This symposium is designed to present work linking the production of raw milk with the quality and safety of finished dairy foods. Symposium presenters will discuss collaborative research models, benefits and challenges of conducting such work.

Key Words: Production, Processing

Extension Education

360 The Pennsylvania RFID project – An overview. K. E. Olson^{*1}, G. T. Cudoc², J. High³, J. S. Clay⁴, and J. Mattison¹, ¹National Dairy Herd Improvement Association, Verona, WI, ²Dairy One, Ithaca, NY, ³Lancaster Dairy Herd Improvement Association, Manheim, PA, ⁴Dairy Records Management Systems, Raleigh, NC.

The Pennsylvania Department of Agriculture received funding from USDA APHIS for one of the initial cooperative agreements to facilitate implementation of the National Animal Identification System (NAIS). The overall purpose of the ‘Pennsylvania Premises Identification and Animal Tracking Initiative’ was verification of premise ID in the state and initial field testing of Radio Frequency Identification (RFID) technology as a tool to track animal movement with reporting of this information to the state database (PA HERDS). National DHIA, working with field service affiliates DairyOne and Lancaster DHIA, with cooperation from Dairy Records Management Systems (DRMS), implemented the dairy portion of the project which focused on RFID tagging 50,000 dairy animals, then entering their basic identification and location information into PA HERDS. DHI used its existing infrastructure, together with enhancements needed for this project, to tag animals, collect verify and transfer the needed data to the movement repository. This minimized problems for producers and assured that they did not need to develop a separate data collection system for ID. Through the dedicated effort of field staff, tags were distributed and applied in a timely manner, with validated data submitted to PA HERDS. Approximately 42 staff members from the two field service providers were involved in the effort. Data in the table were gathered by field staff from the project herds.

Table 1. Field Performance

	Dairy One	Lancaster DHIA
Tags Assigned	24,750	25,000
Unreadable tags	5	6
Broken preinstall	0	0
Broken during	0	77
Lost	50	33
Initial Retention %	≥ 95	≥ 95
Infection %	≤ 5	≤ 5
% Primary site	50	20
Read 2 to 4'	75%	100%
Read 4' to 6	25%	
Unique ID	24,355	24,135
Unique Premise	149	61
Total files	204	163

NDHIA was sent 250 tags

Key Words: RFID, NAIS, Identification

361 Factors affecting udder singeing in dairy cattle. T. Harrington¹, J. Pennington^{*1}, Z. Johnson², A. H. Brown², D. W. Kellogg², C. Rosenkrans², M. Andrews¹, and J. Hawkins¹, ¹University of Arkansas Cooperative Extension Service, Little Rock, ²University of Arkansas, Fayetteville.

To determine factors affecting udder singeing in dairy cattle, cattle on a 1000-cow dairy (herd S) and 120-cow dairy (herd A) were assigned to unsinged or singed (2x/year) groups. Cows were evaluated on scales of 1 to 10 for cleanliness, length of hair, ease to clean, and time to clean (i.e., udder traits). Unsinged cows in herd S were used to determine the

effects of month of year ($P < 0.01$) and breed ($P < 0.01$) on udder traits. Hair on the udder (10=2.5 cm) was longer in the colder months of the year and shorter in the warmer months (Feb, 7.8; Mar, 7.7; May, 6.6; Jun, 7.2; Jul, 6.9; Aug, 6.6; Oct, 7.6; Nov, 8.0; Feb, 8.9). Jerseys (6.2) and Brown Swiss (6.4) had the shortest hair, followed by Holsteins (6.6), then Ayrshires (7.5) and crossbreeds (7.6); Milking Shorthorns had the longest hair (8.4). After the winter singes in both herds, udder traits were improved ($P < 0.01$), but only length of hair improved ($P < 0.01$) following the summer singes; other traits were improved in the days after singeing. Udder traits of Holstein cows differed ($P < 0.01$) between herds. The time required for the singed hair to grow back to the same length as hair of unsinged cattle was approximately 80 days in both winter and summer. SCC was not affected ($P > 0.10$) by singeing of cows in herd A, but variation in SCC was large and herd A was very clean. A shorter interval between singeing might alter the effects on SCC and improve other udder traits in the summer. Overall, these results indicated that timely singeing of the udders can be used to improve udder cleanliness and appearance, thus reducing labor for preparing cows for milking and time in the parlor for cows.

Key Words: Dairy, Singeing, Udder

362 CowTime: Making milking more productive and easier. D. Klindworth^{*1}, R. Greenall², and D. Carr¹, ¹Primary Industries Research Victoria (PIRVic), Ellinbank, Victoria, Australia, ²University of Melbourne, Parkville, Victoria.

CowTime is Australia's national learning package for milk harvesting - making milking easier and more productive. It covers all aspects of milk harvesting from the time the cows leave the paddock until after the clean up. The Program has 4 main components: 1. The Milking Monitor is a web-based milking performance benchmarking tool. Farmers answer a few questions about their milking process and receive back a personalised report benchmarking their performance against their peers. 2. The Shed Shake-up is a field day with a difference, combining structured and unstructured learning sessions with technical experts, a dairy visit and discussion. Topics covered to date include stock handling, work practices and conditions and saving power. 3. Designed to assist decision making, the CowTime Course helps participants work through the issues relevant to them when considering making major changes or building a new dairy. Currently the Course is being modified to be available on a CD-ROM format. The main sections include: First Steps - to set goals for the farm business; Future options - looks at the future scale of the business; Analyse your current system - a tool to benchmark current performance; Making the big decision - models possible change options; Plan for Change- where farmers commit to a course of action and print reports. 4. Technical resources developed to support the Program include the CowTime Guidelines (a book on best practise in Australian milk harvesting), Quick Notes (short information sheets on specific milk harvesting topics), CowCoster (a tool used to model the performance and cost of various options), and a range of training videos to support the farmer training program. Since rolling out in 2002 the project has achieved high impact with independent evaluation showing around 65% of participants had implemented changes on their farm, with a further 18% still intending to do so. Most of the CowTime information is freely available at www.cowtime.com.au

Key Words: Extension, Decision making, Milk harvesting

363 Development of a stochastic simulation model to assess the potential economic benefits associated with investments in precision dairy farming technologies. J. M. Bewley*¹, M. D. Boehlje¹, A. W. Gray¹, S. J. Kenyon¹, S. D. Eicher², and M. M. Schutz¹, ¹*Purdue University, West Lafayette, IN*, ²*USDA-ARS, West Lafayette, IN*.

A dynamic, stochastic, mechanistic simulation model of a modern dairy enterprise was developed to evaluate the costs and benefits associated with investments in Precision Dairy Farming (PDF) technologies. The model was designed to represent the biological and economic complexities of a dairy system within a partial budgeting framework by examining the cost and benefit streams coinciding with investment in a PDF technology. A primary objective of this effort was to provide a flexible, user-friendly, farm-specific decision making tool for dairy producers and technology manufacturers to use in on-farm decision making. The basic deterministic model was created in Microsoft Excel. The @Risk Excel add-in was used to consider the stochastic nature of key variables in the Monte Carlo simulation. Net Present Value and break-even bid prices are the primary metrics used to assess the economic profitability of investments. Estimates of relationships within the model were obtained from the literature. U.S. means and distributions, where available, were used to describe initial herd parameters within the model. In an example to demonstrate the model's utility, investment in an automatic core body temperature monitoring system was considered. The pricing strategy of the MaGiiX™ Cattle Temperature Monitoring System (CTMS) was used to estimate costs of investment. Benefits of the system were considered by estimating the impact and timeliness of interventions resulting from information provided by deviating temperatures obtained from the MaGiiX CTMS. Sensitivity analysis was conducted to identify the impact of different scenarios and benefit combinations on profitability. Monte Carlo simulation resulted in a series of net present values used to identify the probability of observing a positive net present value associated with investment in the MaGiiX CTMS. This analysis provides a framework for future economic analyses of other Precision Dairy Farming technologies.

Key Words: Economic analysis, Net present value, Precision dairy farming

364 SPAC – Information on demand. K. E. Olson*¹, K. Roy², B. Carlson³, and A. F. Kertz⁴, ¹*KEO Consulting, Schaumburg, IL*, ²*Federation of Animal Science Societies, Savoy, IL*, ³*American Dairy Science Association, Savoy, IL*, ⁴*ANDHIL LLC, St Louis, MO*.

Each year regional, national and international conferences provide cutting edge information on a wide range of topics for individuals participating in the conferences. Presentation information is frequently captured in proceedings; however, awareness of and access to this information is often limited to conference participants. The ADSA Foundation recognized the interest among producers, animal professionals, extension and researchers in this information and supported development of the 'Searchable Proceedings of Animal Conferences' (SPAC) as a tool to provide ready access to this valuable resource. SPAC is available on-line at <http://spac.adsa.org/index.asp>. An electronic copy of each individual proceeding article is stored as a PDF file in the SPAC database, and is available to subscribers. A search engine allows complete user-defined searches of all files to identify articles of potential interest as well as facilitating conventional searches such as author, conference, year and title. The search engine lists articles in order based upon how closely they match the requested search. Over a dozen conferences have made their proceedings available

for distribution through SPAC. In many cases proceedings from several years are available. In addition, abstracts from recent ADSA and ASAS meetings are included in the database. Additional conferences will continue to be added to the database as well as new proceedings from existing conferences.

Key Words: SPAC, Proceedings

365 Choosing the best forage species for a dairy farm - The Whole-farm approach. M. Neal*¹, J. Neal^{2,3}, and W. Fulkerson³, ¹*Risk and Sustainable Management Group, University of Queensland, Brisbane, Queensland, Australia*, ²*New South Wales Department of Primary Industries, Camden, New South Wales, Australia*, ³*Faculty of Veterinary Science, University of Sydney, Camden, New South Wales, Australia*.

Although a handful of forage species such as perennial ryegrass are predominant, there are a wide range of forage species that can be grown in sub tropical and temperate regions in Australia as dairy pastures. These species have differing seasonal yields, nutrient quality and water use efficiency characteristics, as demonstrated in a large water use efficiency study of 30 species being undertaken at the University of Sydney in New South Wales, Australia. Some species can be grazed, while others require mechanical harvesting that incurs a further cost. Previous comparisons of species that relied on yields of dry matter per unit of some input (typically land or water) cannot simultaneously take into account the season in which forage is produced, or other factors related to the costs of production and delivery to the cows. To effectively compare the profitability of individual species, or combinations of species, requires the use of a whole-farm model. Linear programming was used to find the most profitable mix of forage species for an irrigated dairy farm. It was concluded that a mix of species was most profitable under the conditions faced by a typical dairy farmer situated in an irrigation region of New South Wales, Australia.

Key Words: Forage, Whole-farm model, Linear programming

366 Choosing corn hybrids for silage: A partial budget approach. M. S. Allen*, *Michigan State University, East Lansing*.

Genetic differences in corn hybrids allow the opportunity to increase farm profits by selecting hybrids with the optimal combination of yield and quality traits. Determining this optimum combination is complex because hybrids vary in several different economically important traits that affect the amount of land required, supplemental feeds, and milk yield. Selection indices simplify ranking corn hybrids for silage by combining yield and quality differences among hybrids into a single number. However, selection indices fail to consider many important biological and cost differences and cannot accurately rank hybrids according to farm profitability across farms. CornPicker is a spreadsheet developed to calculate a partial budget for evaluating effects on farm profits among different corn hybrids for silage. Calculations include only those costs and returns that change in response to the hybrids being compared and ignore those not affected. Input variables include data about specific hybrids related to yield and quality, relevant farm practices, and prices (e.g. for milk, corn grain, and soybean meal). Forage NDF concentration is used to calculate the corn silage concentration in diets because it limits feed intake and diets normally are formulated to the same or similar forage NDF concentrations. The cost of producing the required amount of corn silage is calculated as the total costs for seed, land, and other production costs, as well as

the costs and DM losses for harvesting, storing, and feeding the corn silage. Cost adjustments are then made for differences in supplemental feed and milk yield. Differences in concentrations of NDF and CP between hybrids affect the amount of corn grain and soybean meal fed per year, and in vitro NDF digestibility differences affect milk yield and feed intake of lactating cows. CornPicker output is an estimate of the land required and production costs of hybrids being compared. Corn hybrids for silage should be selected using this partial budget approach because it accounts for economically important factors related to hybrid selection that vary from farm to farm and over time.

Key Words: Corn silage hybrids, Selection, Profitability

367 Review of Wisconsin corn silage milk per ton models. R. Shaver* and J. Lauer, *University of Wisconsin, Madison.*

An index of forage quality, milk per ton of forage DM, was originally developed using an energy value of forage predicted from ADF content and DMI potential of forage predicted from NDF content as its basis (MILK1991; Undersander et al., 1993). In vitro DMD was included in a later revision of the milk per ton model (MILK1995). The milk per ton model was later modified specifically for corn silage (Schwab et al., 2003) using as its basis an energy value derived from summative equations that included in vitro NDF digestibility (NDFD, % of NDF) and starch digestibility predicted from whole-plant DM content and kernel processing, and DMI potential predicted from both NDF content and in vitro NDFD. This milk per ton quality index (MILK2000) has become a focal point for corn silage hybrid-performance trials and hybrid-breeding programs in academia and the seed-corn industry (Lauer et al., 2005). An update to the MILK2000 milk per ton model has been developed (MILK2006). Analysis of correlations between corn silage NDF, NDFD, starch, and starch digestibility and milk per ton estimates from MILK2006, 2000, 1995, and 1991 models (n = 3727 treatment means) is presented in the Table. MILK2000 model was the first milk per ton model to recognize NDFD as an important quality parameter, while the earlier models were influenced mostly by whole-plant starch (grain) content. The MILK2006 milk per ton model relative to MILK2000 reflects the relatively minor fine-tuning of equations, but the spreadsheet will allow for more user-defined flexibility. Model comparisons using other datasets and evaluation of models for potential effects on hybrid rankings are in progress. Future development of laboratory methods for determining starch digestibility may influence its relationship to milk per ton estimates relative to the other quality measures.

Table 1. Correlations for selected corn silage nutrients and their digestibility coefficients with milk per ton estimates.

r-values	MILK2006	MILK2000	MILK1995	MILK1991
NDF%	-0.46	-0.40	-0.94	-0.99
Starch%	0.48	0.44	0.75	0.74
NDFD, % NDF	0.49	0.70	0.16	-0.10
StarchD, % Starch	0.30	0.21	-0.25	-0.27

Key Words: Corn silage, Milk per ton, NDFD

368 Sustainable self-financed producer study groups in Oregon. W. Lane*, *Lane Livestock Services, Roseburg, OR.*

Forage management and nutrition are complex topics that require ongoing education for successful application. Our university-based

education system is primarily designed for young adults who have no family responsibilities or decision-making roles in their farms. In contrast, adult producers obtain information through a patchwork of occasional workshops, the Internet, Extension agents, and neighbors. This strategy may not deliver the complex, integrated training needed by professional graziers. Livestock producers in Oregon have addressed this problem by forming three private, fee-based study groups that meet regularly to obtain information and share experiences: Umpqua Valley Forage Study Group (UVFSG, formed 1995, 15 current members), Forage And Nutrition Group (FANG, 2000, 10 current members), and Willamette Valley Grazing And Nutrition Group (WVGANG, 2002, 25 current members). These groups are financially self-supporting with annual membership fees of \$150-200 per operation. Each group maintains a bank account and hires a facilitator to coordinate meetings. Membership crosses county lines, but new members must have prerequisite knowledge, either through formal education or suitable experience. Members include livestock operations raising beef, dairy, sheep, meat goats, horses, or hay, and also seed companies, feedstores, and government agencies. Marketing goals include commercial, seedstock, direct, grass-fed, and organic. Meetings occur monthly at sites rotating among member ranches or alternative sites and are closed to non-members. Each meeting lasts 3+ hr and includes a pasture walk and an in-depth discussion of a focus topic. Extension agents are invited as courtesy guests. From July 1995 through January 2006, these groups conducted 211 meetings and included a total of 73 member operations. In addition to supplying technical information, these Producer Study Groups have also provided mutual support for new ideas, facilitated cooperative financial arrangements, and acted as venues for on-farm research, special workshops, tours, and guest speakers. As fee-based organizations, private Producer Study Groups are relatively insulated from the vagaries of public budgets.

Key Words: Training, Discussion groups, Forages

369 Methodology of Connecticut's horse industry survey: Results and implications for future studies. J. Nadeau*¹, F. Shah¹, A. Chaudhry², and J. Maripani^{1,2}, ¹*University of Connecticut, Storrs,* ²*University of Wyoming, Laramie,* ³*University of Magallanes, Punta Arenas, Chile.*

Surveys of the horse industry have been undertaken more frequently in recent years with the realization that it has a significant economic impact on individual states and the nation as a whole. Our survey of Connecticut's horse industry was designed to arrive at an accurate horse count and determine the demographic and economic characteristics of Connecticut's horse industry. In order to gather this data, three survey instruments were developed: one for veterinarians to determine the horse count, one for horse owners to describe the industry's demographic characteristics, and one for businesses to evaluate economic impact of the industry. Included in the horse owners' survey were questions about the owner's willingness to sell the horse at fair market value. One of the fundamental limitations of previous horse surveys is that enumeration of horses is based on a survey of owners. With the incomplete nature of mailing lists, it is difficult to predict the margin of error using this method. By surveying a complete mailing list of veterinarians obtained from the state veterinary association, we determined that there are approximately 43,059 horses in Connecticut. This number correlates well with anecdotal reports. Of horse owners surveyed, 80% would not be willing to sell their horses at fair market value. The implication is that any statewide value of horses based on market prices alone is likely to seriously underestimate the true social value of horses. The methodology used in our survey may be of use

to other states in order to get accurate horse counts and true values of horses. In addition to surveying veterinarians, a cross check of results could be obtained by surveying other service providers such as farriers or feed stores. The inclusion of the question about willingness to sell at fair market value question is also justified based on our findings. Finally, even though our three survey instruments attempt to reach the

major interest groups associated with the industry, a wider population may need to be included to more accurately estimate the aesthetic and recreational value of horses.

Key Words: Survey, Demographic, Horse

Nonruminant Nutrition: Amino Acid Nutrition - Nursery to Finisher

370 True ileal digestible isoleucine requirement and ratio in 12 to 22 kg pigs. S. X. Fu^{*1}, A. M. Gaines¹, R. W. Fent¹, G. L. Allee¹, and J. L. Usry², ¹University of Missouri, Columbia, ²Ajinomoto Heartland, LLC, Chicago, IL.

Two experiments were conducted to determine the true ileal digestible (TID) Ile requirement and ratio of late-nursery pigs (TR-4×C22). In Exp. 1, 924 pigs were used in a five-point TID Ile titration (0.597, 0.662, 0.726, 0.791, and 0.856%, respectively) with seven replicate pens per treatment (21 to 23 pigs/pen). The basal diet (0.70% L-Lys HCl) was formulated to contain 1.30% TID lysine. Graded levels of L-Ile were added to increase the TID Ile level from 0.597 to 0.856%. Both ADG and ADFI were not affected by dietary TID Ile level. A quadratic response in G:F (P = 0.04) was observed with increasing dietary TID Ile. Based on these data, the TID Ile requirement of late-nursery pigs is not greater than 0.597% in corn-soybean meal diets. In Exp. 2, 297 barrows were used to determine the effects of protein source on the TID Ile:Lys ratio in 12 to 22 kg pigs with five replicate pens per treatment (five to six pigs/pen). Diet 1 was a corn-soybean meal control diet with an inclusion of 0.30% L-Lys HCl. Diets 2 to 11 were a 2 × 5 factorial design. The factors included: two protein sources 17% soybean meal (SBM) plus crystalline amino acids or 10.75% spray-dried blood cells (SDBC) and five TID Ile:Lys ratios (46, 53, 60, 67, and 74%, respectively). Diet 1 contained 1.20% TID lysine and all other diets were formulated to contain 1.10%. Pigs fed the control diet had improved growth performance (P ≤ 0.05) indicating that lysine was indeed limiting in diets 2 to 11. In corn-soybean meal diets, no response was observed with increasing TID Ile:lys ratio. However, increasing the TID Ile:Lys ratio in corn-SDBC diets improved ADG (linear and quadratic (P ≤ 0.01) and G:F (linear and quadratic P ≤ 0.001). The TID Ile:Lys ratio of 12 to 22 kg barrows fed corn-SDBC diets was estimated to be 65.7% for G:F and at least 70.3% for ADG.

Key Words: Isoleucine, Blood cells, Pigs

371 Branched chain amino acid interactions and isoleucine imbalance in late-finishing pigs. S. X. Fu^{*1}, R. W. Fent¹, G. L. Allee¹, and J. L. Usry², ¹University of Missouri, Columbia, ²Ajinomoto Heartland, LLC, Chicago, IL.

Two experiments were conducted to explore why late-finishing (TR4 × C22) fed corn-spray-dried blood cell (SDBC) diets require higher Ile to maximize growth performance than pigs fed corn-soybean meal (SBM) diets. The positive control (basal diet) was a corn-SBM diet with 3% SBM and 0.32% L-Lysine HCl and the negative control diet contained 3.85% SDBC. All diets contained 0.52% TID lysine and a TID Ile:Lys of 54%. In Exp. 1, 120 pigs were used with six replicate

pens of five pigs per treatment to determine the effects of excess Val and Leu. Crystalline L-Val and L-Leu were added to the basal diet to achieve the same level of Val and Leu as the negative control. An additional high protein corn-SBM control diet (0.15% added L-Lysine HCl) was also included. Pigs fed the positive control diet had comparable ADG, ADFI, but tended to have lower G:F (P = 0.06) than pigs fed the high protein control diet. With the same dietary TID Ile:Lys of 54%, pigs on corn-SDBC diet had reduced (P = 0.04) ADG, ADFI, and G:F compared to pigs on corn-SBM diet. Adding Val and Leu to the corn-SBM basal diet resulted in similar ADG and G:F, but tended to reduce ADFI (P = 0.09). In Exp. 2, 60 individually penned pigs with 10 replications per treatment were used. Adding graded levels of Val and Leu to a corn-SBM basal diet resulted in a linear decrease in ADG (P = 0.05) and ADFI (P = 0.02), and tended to linearly reduce final BW (P = 0.10). The G:F was not affected by excess Val and Leu. Plasma free Val, Leu (P ≤ 0.01), and blood urea nitrogen (P = 0.05) increased linearly as dietary Val and Leu level increased while plasma free Ile decreased linearly (P = 0.004). Adding Val and Leu to the corn-SBM basal diet to the levels of corn-SDBC diet resulted in similar performance as the high protein corn-SBM control diet. Adding Val, Leu, His, and Phe to the corn-SBM control diet reduced (P = 0.05) final BW, ADG, ADFI, and plasma free Ile and increased serum urea nitrogen (P = 0.02), which resulted in a similar final BW, ADG, ADFI, and G:F as pigs fed the corn-SDBC diet.

Key Words: Branch chain amino acid, Imbalance, Isoleucine

372 Branched chain amino acid interactions increases isoleucine requirement in late-finishing pigs. S. X. Fu^{*1}, R. W. Fent¹, G. L. Allee¹, and J. L. Usry², ¹University of Missouri, Columbia, ²Ajinomoto Heartland, LLC, Chicago, IL.

Two experiments utilizing 10 individual pigs per treatment were conducted to explore why late-finishing pigs (TR-4 × C22) fed corn-spray-dried blood cell (SDBC) diets require higher Ile to maximize growth performance than pigs fed corn-soybean (SBM) diets. The positive control (basal diet) was a corn-SBM diet with 3% SBM and 0.32% L-Lys HCl and the negative control diet contained 3.85% SDBC. All diets contained 0.52% TID lysine and a basal TID Ile:Lys of 54%. L-Val, L-Leu and/or L-Phe, L-His were added to the basal diet to achieve the same as the negative control. In Exp. 1, adding Val and Leu to the corn-SBM basal diet to the levels present in the corn-SDBC diet did not affect performance. However, adding Leu alone to corn-SBM basal diet resulted in reduced (P = 0.05) ADG, final BW, and G:F. In the corn-SBM basal diet, excess of Val, Leu, His, and Phe did not affect G:F (P = 0.20), but reduced ADFI (P = 0.03),

and tended to reduce final BW ($P = 0.08$) and ADG ($P = 0.07$). Further adding Ile to the diet containing an excess of Val, Leu, His, and Phe restored growth performance to the level of corn-SBM control pigs. In Exp. 2, with same dietary TID Ile:Lys of 54%, pigs on the corn-SDBC had reduced final BW ($P = 0.01$), ADG ($P = 0.01$), ADFI ($P = 0.01$), and G:F ($P \leq 0.06$) compared to pigs on corn-SBM basal diet. Adding Val alone or with Leu to corn-SBM control diet did not affect growth performance. These data suggest when Ile is marginally deficient in a late-finishing diet, excess Leu depresses pig performance, while excess Val had no deleterious effects on growth performance. Excess Val helped reduce the severity of excess Leu. Adding all excess amino acids (Leu, Val, His, and Phe) to the corn-SBM control diet depressed pig performance to the level of pigs fed corn-SDBC diet, which was fully restored by Ile addition. Significant branched chain amino acid interactions and Ile imbalance caused by excess Leu, His, and Phe necessitate higher Ile for pigs fed diets containing SDBC as the major protein source.

Key Words: Branch chain amino acid, Imbalance, Isoleucine

373 Stimulation of muscle protein synthesis by leucine is dependent on plasma amino acid availability. J. Escobar*, J. W. Frank, A. Suryawan, H. V. Nguyen, and T. A. Davis, *Baylor College of Medicine, Houston, TX.*

We have reported that a physiological increase in plasma leucine increased translation initiation factor activity during 60- and 120-min leucine infusion. Muscle protein synthesis was stimulated at 60 min but not at 120 min, perhaps due to the decrease (-50%) in plasma essential amino acids (AA). Thus, the objective of the present study was to determine the effect of AA replacement during a 120-min leucine infusion on muscle protein synthesis. Piglets (5 d of age) were food-deprived overnight and infused intra-arterially with saline or 400 $\mu\text{mol} \cdot \text{kg}^{-1} \cdot \text{h}^{-1}$ of leucine for 120 min to raise plasma leucine within the physiological postprandial range. Leucine was infused in the presence or absence of an AA mixture (without leucine) to maintain baseline levels of plasma AA. At the end of the infusion, protein synthesis and the activation of translation initiation factors were determined in longissimus dorsi muscle and liver. Administration of AA prevented the leucine induced reduction ($P < 0.05$) in plasma essential AA. Leucine infusion, with and without AA replacement, increased ($P < 0.05$) the phosphorylation of eukaryotic initiation factor (eIF) 4E binding protein-1 (4E-BP1), decreased ($P < 0.01$) the inactive 4E BP1•eIF4E complex, and increased ($P < 0.02$) the active eIF4G•eIF4E complex in skeletal muscle. Protein synthesis was increased ($P < 0.02$) in muscle by the infusion of leucine replacement with AA, but not by leucine alone. In liver, translation initiation factor activation was not affected by leucine infusion with or without AA replacement. Hepatic protein synthesis was unaffected by leucine alone, but tended to increase ($P < 0.06$) with AA replacement. Our results indicate that the leucine induced stimulation of skeletal muscle protein synthesis in neonatal pigs during prolonged leucine infusion is dependent on plasma AA availability (NIH AR 44474 and USDA 58-6250-6-001)

Key Words: Leucine, Protein synthesis, Translation initiation factor

374 Evaluation of the true ileal digestible (TID) valine requirement of 8 to 20 kg pigs. A. M. Gaines*¹, P. Srichana¹, B. W. Ratliff¹, G. L. Allee¹, and J. L. Usry², ¹University of Missouri, Columbia, ²Ajinimoto Heartland LLC, Chicago, IL.

Two experiments were conducted to determine the true ileal digestible (TID) valine requirement for 8 to 12 kg and 12 to 20 kg pigs. In Exp.1,

a total of 1,104 (TR-4 \times C22; 8.44 ± 0.05 kg) were used to evaluate the TID valine requirement from 8 to 12 kg BW. Pigs were assigned to one of four dietary treatments in a completely randomized design with 12 replicate pens/treatment. Dietary treatments included four concentrations of TID valine (0.81, 0.88, 0.95, and 1.02%). The basal diet was corn-soybean meal based (4.20 g TID lysine/Mcal ME) and contained 0.63% L-lysine HCl. Dietary valine concentration was increased by the addition of L-valine to the basal diet. In Exp.2, a total of 552 pigs (TR-4 \times C22; 11.9 ± 0.09 kg) were used to evaluate the TID valine requirement from 12 to 20 kg BW. Pigs were assigned to one of four dietary treatments in a completely randomized design with 6 replicate pens/treatment. Dietary treatments included four concentrations of TID valine (0.68, 0.74, 0.81, and 0.87%). The basal diet was corn-soybean meal based (3.86 g TID lysine/Mcal ME) and contained 0.70% L-lysine HCl. Dietary valine concentration was increased by the addition of L-valine to the basal diet. For Exp.1, increasing dietary valine increased (linear, $P < 0.01$; quadratic, $P < 0.01$) ADG (367, 404, 409, and 404 g/d) and improved (linear, $P < 0.01$; quadratic, $P = 0.11$) G/F (0.700, 0.722, 0.735, and 0.729). Furthermore, increasing dietary valine resulted in an increase (linear, $P < 0.03$; quadratic, $P < 0.01$) in ADFI (522, 563, 558, and 554 g/d). For Exp.2, increasing dietary valine increased (linear, $P < 0.001$; quadratic, $P < 0.01$) ADG (490, 581, 595, and 599 g/d) and improved (linear, $P < 0.001$; quadratic, $P < 0.01$) G/F (0.634, 0.682, 0.687, and 0.685). Furthermore, increasing dietary valine resulted in an increase (linear, $P < 0.001$; quadratic, $P < 0.01$) in ADFI (772, 849, 867, and 872 g/d). The TID valine requirement of 8 to 12 and 12 to 20 kg pigs was estimated to be 0.92 and 0.78%, respectively.

Key Words: Valine, Pigs, Growth

375 Dietary supplementation of L-Arginine for finishing pigs. N. R. Augspurger*¹, D. M. Webel¹, and G. Wu², ¹JBS United, Inc., Sheridan, IN, ²Texas A & M University, College Station, TX.

Endogenous nitric oxide (NO), a product of arginine metabolism, has been shown to be a potent stimulator of mitochondrial oxidation and lipolysis. In obese rats, dietary supplementation of L-arginine increased NO synthesis and fatty acid oxidation, and reduced abdominal and epididymal fat mass by 44 and 25%, respectively (Fu et al., 2005). Based on those data, an experiment was done to determine the effect of L-arginine supplementation on growth performance and carcass backfat depths of finishing pigs. Eighty pigs (Ausgene genetics, equal barrows and gilts, 64.3 ± 2.3 kg) were individually-housed and fed corn-soybean meal-based diets formulated to be adequate in all nutrients. Diets were fed in two phases with phase 1 (0.99% dig. Lys, 1.10% dig. Arg) fed for 29 d and phase 2 (0.81% dig. Lys, 0.90% dig. Arg) fed for the remainder of the trial period. Pigs were blocked by initial weight within sex into 20 replicates and randomly allotted to one of four treatments. Arginine was added to experimental diets as L-arginine at the expense of cornstarch to achieve supplemental concentrations of 0, 0.5, 1.0, and 2.0%. Pigs in replicates one through 10 were fed phase 2 diets for 34 d, while those in replicates 11 through 20 were fed phase 2 diets for 28 d. All pigs were ultrasounded for measurement of 10th rib backfat depth and loin depth prior to being slaughtered at a commercial processing facility, where backfat and loin depths were measured for each carcass. Dietary supplementation with 2% L-Arg increased ($P < 0.10$) weight gain (5.2%) and gain/feed ratio (3.2%) in the first dietary phase. In the second dietary phase, 2% L-arginine increased ($P < 0.11$) weight gain by 5.6% compared to the control, and feed intake was increased ($P < 0.05$) 4.2% by 1.0 and 2.0% L-Arg. Dietary supplementation of L-Arg reduced ($P < 0.10$)

ultrasound backfat thickness [18.8 vs 17.6 (\pm 0.8) mm, respectively], but L-Arg had no effect ($P > 0.10$) on carcass backfat [19.6 vs 19.8 (\pm 0.8) mm, respectively], loin depth, or calculated carcass lean content. In genetically-lean pigs, dietary supplementation of arginine during the finishing period has potential to enhance weight gain but may not affect carcass backfat depths.

Key Words: Arginine, Pigs, Backfat

376 Nitrogen retention response of pigs to DL-methionine (DLM) and methionine hydroxy analog free acid (MHA-FA). J. A. Jendza^{*1}, M. Rademacher², and O. Adeola¹, ¹Purdue University, West Lafayette, IN, ²Degussa AG, Hanau-Wolfgang, Germany.

Graded equimolar concentrations of DL-methionine (DLM, 99%) or methionine hydroxy analog free acid (MHA-FA, 88%) were used in a study to evaluate N retention responses of pigs. A methionine-deficient basal diet was formulated to contain 2.2 g methionine/kg; to which was added (in mg/kg) DLM at 0, 200, 400, and 600 mg/kg or MHA-FA at 227, 455, and 682. The 7 diets were fed to 63 barrows (average body weight = 14.2 kg; 9 pigs/diet), housed in stainless-steel metabolism crates, using protocols that consisted of a 5-d adjustment period followed by a 5-d period of total but separate collection of feces and urine. Output of N in the urine linearly decreased ($P < 0.01$) as the concentrations of either DLM or MHA-FA increased in diets. Nitrogen retention expressed as a percent of N intake (NRNI) linearly increased ($P < 0.01$) with increasing dietary concentrations of either DLM or MHA-FA. Furthermore, as dietary concentrations of either DLM or MHA-FA increased, N retention expressed as a percent of N absorbed (NRNA) linearly increased ($P < 0.01$). Common-intercept, multiple linear regression equations were: NRNI = 60.08 + 0.01255 (SE = 0.00295) DLM + 0.01087 (SE = 0.00277) MHA-FA, NRNA = 74.01 + 0.01464 (SE = 0.00233) DLM + 0.01192 (SE = 0.00218) MHA-FA using analyzed dietary concentration as the independent variable; or NRNI = 60.06 + 0.01217 (SE = 0.00290) DLM + 0.00976 (SE = 0.00255) MHA-FA, NRNA = 73.96 + 0.01427 (SE = 0.00229) DLM + 0.01080 (SE = 0.00202) MHA-FA using added dietary concentration as the independent variable. Based on these N retention responses, the biological efficacy of MHA-FA relative to DLM is between 81 and 87% on an equimolar basis; or between 71 and 77% on a weight for weight basis.

Key Words: Methionine, Methionine hydroxy analog free acid, Swine

377 The effect of soybean hulls inclusion on the apparent and true ileal digestibility of selected amino acids in growing pigs. L. Dégen^{*1}, J. Tossenberger², V. Halas², and L. Babinszky², ¹Agribroads Europe Hungary RT, Karcag, Hungary, ²University of Kaposvár, Kaposvár, Hungary.

Soybean hulls (SBH) have become a widely used component in growing and fattening pig feeds. The aim was to study the effect of SBH on the apparent and true ileal digestibility (AID and TID, respectively) of selected amino acids (AAs). The trial was conducted with a total of 40 PVTC-cannulated hybrid barrows in 2 replicates (n=8, 4 pigs/treatment/replicate) in a live weight range of 30-40 kg. AID and TID of AAs were studied, the ileal endogenous AA excretion was determined in a separate study with a total of 8 growing pigs fed N-free diets. The dietary treatments were achieved by supplementing the basal corn-soybean diet with 0, 25, 50, 75 or 100 g/kg of SBH. The experimental diets were formulated according to the NRC (1998)

recommendations. Daily feed allowance of the pigs was 2.6 times their maintenance energy requirement. The trial consisted of a 5-day adaptation and three times 12-hour collection period. Data were analyzed by ANOVA (SAS, 1990), and the relationships between SBH inclusion in the diet and AID and TID of the amino acids were examined with regression analysis. Our data show that inclusion of 25 g/kg SBH in the diet significantly decreased the AID of Lys, Met, Cys from 80.6 to 75.3%, from 85.4 to 81.6% and from 76.8 to 72.6% ($P \leq 0.05$), respectively. Further increment of SBH in the diet did not result significant reduction in AA digestibility. Similar results were obtained for TID. It was confirmed by regression analyses being linear-plateau manner with sharp transition that for Lys, Met and Cys the AID did not drop after the transition points of 29, 38, 31 g/kg SBH inclusion in the diet, respectively. Therefore, the benefit of using SBH is depending on financial calculation, considering that 25 g/kg SBH decreases significantly the digestibility of AAs, however, more than approximately 30 g/kg SBH inclusion does not reduce it further.

Key Words: Soybean hulls, Amino acid digestibility, Growing pigs

378 Amino acid digestibility and measurement of blocked lysine in five samples of distillers dried grains with solubles in growing pigs. A. A. Pahn^{*1}, D. Hoehler², C. Pedersen¹, D. Simon¹, and H. H. Stein¹, ¹South Dakota State University, Brookings, ²Degussa Corp., Kennesaw, GA.

An experiment, which is a part of a two-phase study, was conducted to determine the application of the furosine procedure as an in vitro method to predict the standardized (SID) ileal digestibility of Lys in five sources of distillers dried grains with solubles (DDGS) fed to growing pigs. Twelve barrows (Ausgene Intl., Gridley, IL) with initial BW of 36.9 \pm 5.6 kg were fitted with a T-cannula in the distal ileum and randomly allotted to a replicated 6 x 4 Youden square design with six diets and four periods. Five diets were based on DDGS (67.5%) and one diet was a N-free diet. Each feeding period lasted 7 d with ileal digesta collection every 6 and 7 d. Values for AID and SID were calculated for all DDGS sources and compared using an analysis of variance. Furosine contents were determined in DDGS samples and these values were correlated with the in vivo data. Results of the in vivo study showed that the AID and SID of CP did not vary among sources. However, the AID for Lys, Trp, Leu, and Arg and the SID for Lys and Leu varied ($P \leq 0.05$) among samples. The remaining indispensable AA did not differ in AID and SID among the five DDGS sources. The SID for Lys was poorly correlated with total CP ($R^2 = 0.22$) and total Lys content ($R^2 = 0$) indicating that total CP and total AA content may be inadequate to estimate Lys digestibility of DDGS in pigs. We hypothesize that this may be partly due to the heat damage of DDGS during processing which can alter Lys digestibility without altering its analyzed total Lys content. Results of the in vitro study showed that the average blocked lysine of samples (% of total Lys) estimated by the furosine method was 16.6 \pm 5.2%. This represents the proportion of the total Lys that is not available to the pig, possibly due to early Maillard reaction. Furosine and blocked lysine were correlated to SID Lys ($R^2 = 0.67$ and 0.70, respectively). In conclusion, furosine and blocked Lys can potentially be used to predict SID Lys in DDGS by growing pigs. However, additional data are needed to establish a reliable prediction equation using this procedure.

Key Words: Amino acid digestibility, DDGS, Furosine

379 Amino acid and energy digestibility in NutriDense corn and other cereal grains fed to growing pigs. C. Pedersen*, M. G. Boersma, and H. H. Stein, *South Dakota State University, Brookings*.

Two experiments were conducted to measure the AA and energy digestibility in NutriDense corn and compare these values to values obtained for other cereal grains. In Exp. 1, six growing barrows were fitted with a T-cannula in the ileum and used to measure apparent (AID) and standardized (SID) ileal digestibility values for AA in NutriDense corn, yellow dent corn, barley, wheat, and sorghum. Five diets based on each cereal grain were formulated and a N-free diet was used as well. Pigs were allotted to a 6 x 6 Latin square design and fed one of each of the six diets during one experimental 7-d period. Digesta were collected from the cannulas for ten h on d 6 and 7. The AID and the SID for AA were calculated for each grain. Results showed that the AID for most indispensable AA are greater ($P \leq 0.05$) in NutriDense corn and wheat than in the other cereal grains. The SID for Lys in NutriDense corn (77.6%) was greater ($P \leq 0.05$) than in yellow dent corn (68.5%) and sorghum (56.9%), but not different from wheat (75.1%) and barley (71.7%). The SID for Arg and Met in NutriDense corn also were greater ($P \leq 0.05$) than in yellow dent corn (88.1 and 87.2% vs. 84.5 and 82.8%, respectively). For the remaining indispensable AA, no differences in SID between NutriDense corn and yellow dent corn were observed. In Exp. 2, 12 growing barrows were placed in metabolism cages and used to measure the DE and ME of NutriDense corn and normal corn. Both grains were used in diets that were formulated either without or with supplemented crystalline AA. Therefore, a total of four diets were formulated. Each diet was fed to six pigs in a 2-period changeover design. Results of this experiment showed that the DE and ME in NutriDense corn (3,964 and 3,869 kcal/kg DM, respectively) were greater ($P \leq 0.006$) than in normal corn (3,872 and 3,781 kcal/kg DM, respectively). However, the DE and ME were not influenced by the addition of AA to the diets. It is concluded that NutriDense corn has a greater value than normal corn in diet formulations because of increased concentrations of digestible Lys, Met, and energy.

Key Words: Amino acid digestibility, Energy digestibility, NutriDense corn

380 Effect of increasing dietary crude protein and crystalline amino acids on carcass composition and IGF-I mRNA expression in growing pigs. R. Fischer*², P. Miller¹, A. Cupp¹, and D. Clopton¹, ¹University of Nebraska, Lincoln, ²Sioux Nation Ag Center, Sioux Falls, SD.

Fifty-six crossbred gilts with an initial BW of 33.1 kg were used in a 26-d growth study. Seven dietary treatments were used; four were standard corn-soybean meal diets, which were formulated by changing the corn and soybean meal ratio and three were low-protein, AA-supplemented diets formulated to contain similar lysine, methionine, tryptophan, and threonine concentrations as the corn-soybean meal diets. The dietary treatments were 1) 10% CP diet; 2) 14% CP diet; 3) 10% CP + AA; 4) 18% CP; 5) 14% CP + AA; 6) 22% CP; and 7) 18% CP + AA. At the end of the experiment, all gilts were slaughtered and the right side of each carcass was ground and a representative sample was used for chemical analysis. Also, at the time of slaughter liver, longissimus muscle, semitendinosus muscle, and adipose tissue samples were collected and used for the determination of IGF-I mRNA expression. Serum IGF-I concentrations (182, 357, 300, 568, 504, 589, and 531 ng/mL, respectively) on d 26 were affected by dietary

treatment ($P < 0.01$); and IGF-I concentration was different ($P < 0.10$) between gilts fed the corn-soybean meal versus AA-supplemented diets (505 vs 445 ng/mL, respectively). Protein accretion rates increased ($P < 0.01$) from 40 g/d in gilts fed the 10% CP diet to 128 g/d in gilts fed the 18% CP + AA diet and there was no difference between gilts fed the corn-soybean meal versus the AA-supplemented diets (101 and 105 g/d, respectively). Real-time PCR results indicated an effect of amino acid form with gilts fed corn-soybean meal diets having greater ($P < 0.01$) IGF-I mRNA expression in the semitendinosus muscle and adipose tissue compared to gilts fed AA-supplemented diets. These results suggest that the form of dietary amino acid supplementation does affect serum IGF-I concentrations and mRNA expression in semitendinosus muscle and adipose tissue; however, this reduction in expression and serum concentration of IGF-I had no impact on growth rate and carcass composition between gilts fed corn-soybean meal and low-protein, AA-supplemented diets.

Key Words: Amino acids, Pigs, IGF-I

381 Effects of dietary crude protein level and crystalline amino acid supplementation on odor from pig manure. P.-D. Le*, A. Aarnink, and M. Verstegen, *Animal Sciences Group, Wageningen, The Netherlands*.

Two experiments were conducted in growing pigs to determine the effects of dietary CP levels and specific crystalline amino acids supplementation to a diet on odor emission, odor intensity, hedonic tone, and ammonia emission from pig manure. In each experiment, pigs ($n=18$) were allocated in a randomized complete block arrangement having three treatments in six blocks. In the first experiment, treatment groups were 12%, 15% and 18% CP diets. In the second experiment, treatment groups were 1) diet with three times requirement of sulfur-containing AA (Met + Cys), 14.2 g/kg diet, 2) diet with two times requirement of Trp, and Tyr + Phe, 2.9 and 20.4 g/kg diet as fed basis, respectively and 3) control diet with 15% CP and with supplementation of these AA up to requirement. Pigs with initial body weight of around 39 kg were kept individually in partly slatted floor pens. Daily feed allowance was 2.8 x maintenance requirement for net energy (293 kJ W^{0.75}). Feed was mixed with water, 1/2.5 (w/w). Feces and urine of each pig were accumulated together in a separate manure pit during four weeks under the slatted floor. In the fifth week air samples for odor and ammonia analyses were collected directly from each manure pit. Reducing CP from 18% to 12% lowered odor emission and ammonia emission ($P < 0.05$) from pig manure by 80% and 53%, respectively, and increased odor hedonic tone (less unpleasant odor) ($P < 0.05$) but did not affect odor intensity ($P > 0.05$) of the odorous air. Supplementing S-containing AA in surplus of pigs' requirement increased odor emission by 723% and odor intensity and reduced odor hedonic tone ($P < 0.05$) of odorous air. Supplementing Trp, Tyr, and Phe in surplus of pigs' requirement did not affect odor emission, odor intensity and odor hedonic tone. No differences were observed in ammonia emission from manure of pigs fed different types of AA ($P > 0.05$). A reduction of dietary CP and minimizing S-containing AA are options to reduce odor emission and odor intensity, increase hedonic tone and ammonia emission from pig manure.

Key Words: Odor, AA, Protein

382 Dietary sources of starch affect intestinal absorption and metabolism of glucose and amino acids in growing pigs. J. Zhang¹, Y. L. Yin^{*1}, and G. Y. Wu^{1,2}, ¹*The Chinese Academy of Sciences, Changsha, Hunan, P.R. China*, ²*Texas A&M University, College Station*.

The objective of this study was to determine the effect of dietary starch sources on the balance of glucose and amino acids across the portal-drained viscera (PDV) of growing pigs. Four Duroc×Landrace×Yorkshire cross-bred barrows (with an average body wt of 22.5 kg) were housed individually in stainless steel metabolism cages and trained to consume feed provided daily. After a 2-wk adaptation period, pigs were fitted with permanent catheters in the portal vein, mesenteric vein, and carotid artery. After a 13-d recovery period, pigs were assigned randomly into one of 4 treatment groups in a 4×4 Latin square design representing 4 cornstarch- and casein-based isocaloric and isonitrogenous diets containing 52.0% corn, 65.8% brown rice, 65.3% sticky rice, and 51.8% Hi-Maize 1043 (resistant starch). Pigs were fed 3 times daily at 07:30, 15:30 and 23:30 at a feeding level of >963 kJ DE/kg diet. Each diet was fed to the pig

after a 6-d adaptation period. On d 7, blood samples were obtained simultaneously from the 3 catheters at 30 min prior to feeding and hourly for 8 h after feeding. Portal blood flow was measured using p-aminohippuric acid. Results showed that portal glucose absorption (expressed per 100 g feed intake) was lower ($P < 0.05$) for the resistant-starch diet compared with corn, stick rice and brown rice diets at all sampling times. In comparison with the corn diet, net portal glucose absorption was higher ($P < 0.05$) for the sticky rice and brown rice diets up to 4 h after feeding, but was reduced ($P < 0.05$) thereafter. Feeding the resistant-starch diet reduced ($P < 0.05$) the net portal absorption of total amino acids, particularly Pro, Leu, and Ile. The net appearance of total amino acids absorbed from the ileum differed ($P < 0.05$) among the treatment groups, and was 48.4, 63.8, 61.8, and 59.3%, respectively, for piglets fed the corn, brown rice, sticky rice, and resistant-starch diets. These findings indicate that dietary sources of starch affect intestinal absorption and metabolism of glucose and amino acids in growing pigs. Supported by funds from Chinese Academy of Sciences and China NSF.

Key Words: Glucose, Amino acids, Dietary starch

Physiology and Endocrinology: Metabolic Physiology

383 Fertility of lactating dairy cows administered bovine somatotropin during heat stress. F. D. Jousan*, L. A. de Castro e Paula, J. Block, and P. J. Hansen, *University of Florida, Gainesville*.

While administration of bovine somatotropin (bST) to lactating dairy cows increases milk production, it can also increase body temperature during heat stress and may therefore compromise fertility. However, bST increases secretion of insulin-like growth factor-I (IGF-I) and culture of bovine embryos with IGF-I blocks the reduction in blastocyst development and induction of apoptosis caused by heat shock. The purpose of this study was to determine effects of bST on reproductive function in lactating dairy cows during heat stress. The experiment was conducted in South Georgia from July to November 2005 using 271 lactating Holstein cows and heifers. For first service timed artificial insemination (TAI), cows were presynchronized with two injections of PGF2 α given 14 d apart followed by a modified Ovsynch protocol (GnRH given 72 h following PGF2 α). Pregnancy was diagnosed using ultrasonography on d 29 and reconfirmed by palpation between d 45-80 post-TAI. Non-pregnant cows were resynchronized with the modified Ovsynch protocol and received TAI. Treatment with bST (500 mg; Posilac, Monsanto) started 1 wk prior to the start of Ovsynch and continued at 2-wk intervals. A subset of cows (n=38) were bled for IGF-I profiles immediately prior to the first bST injection, 1 wk later, and at d 35 of bST treatment. Rectal temperatures were taken on d 29 of bST treatment. Pregnancy rates (d 45-80 post-TAI) did not differ between control (n=129) and bST-treated cows (n=142) for first- (15.5% vs 16.9%) or second-service TAI (17.2% vs 15.0%). Milk yield and plasma concentrations of IGF-I were higher for bST-treated cows following the initiation of bST treatment (bST x time interaction, $P < 0.01$) and bST increased rectal temperature ($P < 0.05$; 39.17°C vs 39.31°C for control vs IGF-I cows, SEM=0.05°C). In conclusion, treatment with bST during heat stress increased IGF-I concentrations and milk production over time and rectal temperature without compromising first- or second-service pregnancy rates. (Research Support: USDA TSTAR grant 2004-34135-14715 and IFAFS grant 2001-52101-11318).

Key Words: Dairy cows, Bovine somatotropin, Fertility

384 Effect of the addition of insulin-like growth factor-1 to embryo culture medium on pregnancy rate following timed embryo transfer in lactating dairy cows. J. Block* and P. J. Hansen, *University of Florida, Gainesville*.

Addition of insulin-like growth factor-1 (IGF-1) to embryo culture medium increases pregnancy rate following transfer of in vitro produced embryos to heat stressed, lactating dairy cows (Block et al., *J. Anim. Sci.* 81:1590, 2003). The objective of the present study was to determine whether the effect of IGF-1 on embryo survival was a general effect or one specific to heat stress. An embryo transfer field trial was conducted between March 2005 and January 2006 at 4 different locations. Embryos were produced in vitro using oocytes collected from abattoir-derived ovaries. After fertilization, presumptive zygotes were cultured in the presence or absence of 100 ng/mL IGF-1. Cows were synchronized for timed embryo transfer using the OvSynch protocol (3 locations) or 2 injections of prostaglandin F_{2 α} (25 mg, i.m.) 14 days apart (1 location). A total of 287 primiparous and multiparous, lactating cows were selected as recipients based on the presence of a corpus luteum. Grade 1 embryos were selected on d 7 after fertilization and randomly transferred to recipients that were at d 7 after anticipated ovulation. Pregnancy rate was diagnosed by ultrasonography at d 27-32 and by rectal palpation at d 41-49. The experiment was replicated 20 times with 6-28 recipients per replicate. Transfers were divided into two seasons, cool (Jan., Mar., April, Nov., Dec.) and hot (July, Aug., Sep.). There was a significant IGF-1 x season interaction for pregnancy rate at both d 27-32 and d 41-49 ($p < 0.01$). Addition of IGF-1 to embryo culture significantly increased pregnancy rate during the hot season (d 27-32: 34/69 = 49.3% vs. 15/71=21.1% and d 41-49: 28/67=41.8% vs. 13/71=18.3%, respectively), but not during the cool season (d 27-32: 19/70 = 27.1% vs. 23/66=34.9% and d 41-49: 16/73=21.9% vs. 21/74=28.4%, respectively). Results indicate that IGF-1 can be added to bovine embryo culture to increase pregnancy rate in lactating dairy cow recipients during heat stress but there is no advantage in the absence of heat stress. USDA-TSTAR 2004-34135-14715 and BARD US-3551-04

Key Words: Insulin-like growth factor-1, Embryo transfer, Cattle

385 Regulation of hepatic leptin receptor expression in periparturient dairy cows. S. R. Thorn*, R. A. Ehrhardt, M. J. Meyer, R. P. Rhoads, M. E. Van Amburgh, and Y. R. Boisclair, *Cornell University, Ithaca, NY*.

Transcription of the leptin receptor (Ob-R) gene produces transcripts encoding a single functional isoform (Ob-Rb) and truncated isoforms with poor signaling capacity. Assessing the sites of leptin action in cattle has been difficult in the absence of quantitative data on the spatial expression of Ob-R isoforms. To address this, we surveyed expression of one of the truncated isoforms (Ob-Ra), the fully functional isoform (Ob-Rb), and all isoforms (TOTAL) in tissues from four growing Holstein heifers. Abundance of TOTAL transcripts was between 2 to 500-fold higher in liver than in other peripheral tissues and 130-fold higher than in the hypothalamus, a recognized leptin target tissue. Ob-Ra and Ob-Rb respectively accounted for 95 and 2% of TOTAL transcripts in liver compared to 19 and 40% in the hypothalamus. To determine if hepatic expression was regulated, we focused on the transition from pregnancy to lactation. This period is characterized by the onset of negative energy balance and acutely decreasing plasma insulin and leptin. Liver biopsies were obtained from six dairy cows in late pregnancy (LP, 31 days prepartum) and in early lactation (EL, 7 days postpartum). TOTAL and Ob-Ra expression in liver increased by 75% between LP and EL ($P < 0.05$). Liver biopsies were also obtained from late lactating cows when underfed (UF, 30% of maintenance energy requirement) or well-fed (WF, 120% of requirement). TOTAL and Ob-Ra abundance was increased by 60% in UF cows ($P < 0.05$), suggesting that negative energy balance is partly responsible for elevated Ob-R expression in EL. Finally, we asked if insulin mediates the effects of negative energy balance by performing hyperinsulinemic-euglycemic clamps in six dairy cows in LP and EL. Insulin decreased TOTAL, Ob-Ra, and Ob-Rb abundance by 65% ($P < 0.005$) in EL but had no effects in LP. In all experiments, Ob-Ra accounted for over 75% of TOTAL abundance and Ob-Rb for less than 3%. We conclude that increased hepatic Ob-R expression in early lactation is caused in part by reduced plasma insulin and perhaps leptin. The consequence of high expression of the truncated, Ob-Ra, isoform in the liver remains unknown.

Key Words: Leptin, Leptin receptor, Insulin

386 Effect of dry period duration on reproductive measures during the subsequent lactation in Holstein cows. R. D. Watters*, M. C. Wiltbank, P. M. Fricke, J. N. Guenther, A. E. Kulick, and R. R. Grummer, *University of Wisconsin, Madison*.

In a previous study (Gumen et al., 2005; JDS 88:2401), although cows with a reduced dry period appeared to have improved reproduction, too few cows were evaluated to provide reliable data. Cows ($n=772$) in a commercial dairy herd were used in a randomized design to evaluate the effect of dry period duration on days to first ovulation, days to first AI, first service conception rate, days open, and percentage of cows pregnant at 150 DIM. Lactating cows analyzed for reproduction received a 55 (C; $n=342$) or 34 d (S; $n=353$) dry period. Cows that did not reach 45 DIM or more were classified as do not breed were removed from the study. Dry C cows were fed a low-energy diet until 34 d before their expected calving date and then all cows (C and S) were fed a moderate-energy transition diet until calving. Beginning two weeks postpartum, weekly blood samples were collected and analyzed for progesterone. Cows received AI based on removed tail-chalk after 45 DIM followed by Ovsynch and timed AI (37% of the first AIs) after 80 DIM if not previously inseminated. There was a treatment by week

interaction ($P < 0.01$) for body condition score with C greater than S at wk 3 prepartum (3.76 ± 0.02 vs 3.21 ± 0.02). Based on survival analysis, S cows had fewer ($P < 0.01$) days to first ovulation (median days = 35 vs 43 d) as determined by serum progesterone >1.0 ng/ml. Survival analysis showed a tendency ($P = 0.09$) for S cows to have fewer days to first service (median days = 67 vs 72 d); however, first service conception rate did not differ between treatments (29.8 vs 32.0%). The proportion of cows pregnant at 150 DIM was greater ($P < 0.05$) for S (51.8%) than for C (43.9%) cows. Survival analysis indicated a treatment effect for days open (median = 166 vs 130 for C vs S cows). Thus, decreasing the duration of the dry period from 55 to 34 d improved reproductive efficiency based on fewer days open and more cows pregnant at 150 DIM.

Key Words: Dry period length, Ovulation, Reproduction

387 Effects of dietary supplementation with trans- and omega-3 fatty acids on $PGF_{2\alpha}$ secretion and production parameters in dairy cows. B. C. Benefield*¹, E. Castaneda-Gutierrez¹, D. E. Bauman¹, T. R. Overton¹, R. O. Gilbert¹, N. D. Luchini², and W. R. Butler¹, ¹*Cornell University, Ithaca, NY*, ²*NutriScience Technologies, Inc., Fairlawn, OH*.

The objectives of this study were to evaluate uterine $PGF_{2\alpha}$ secretion and production responses in dairy cows fed different commercially available sources of rumen-protected fatty acids (FA). Postpartum Holstein cows ($n = 45$, 21 ± 1 DIM) were assigned to isoenergetic diets providing: calcium salts of tallow (180 g FA/d; C), calcium salts of trans-fatty acids as EnerGI Trans formula (180 g FA/d; Virtus Nutrition, Fairlawn OH; T), or calcium salts of omega-3 fatty acids as StrataG 1.0 (150 g FA/d; Virtus Nutrition; N-3). Cows were fed for 37 d and feed intake and milk yield were monitored over this period. Blood samples for determination of IGF-1 and NEFA were collected 3x/wk. At 30 ± 3 DIM, ovulation was synchronized in all cows with a modified Ovsynch protocol. On d 15 of the cycle cows were infused with 3 mg of estradiol-17 β (iv) and challenged with 100 IU of oxytocin (iv) 4 h later to stimulate uterine $PGF_{2\alpha}$ secretion; blood plasma was collected frequently over a 4 h period for determination of PGFM. Cows fed the T diet tended ($P = 0.11$) to have a greater PGFM response to the oxytocin challenge. Differences in IGF-1 were not significant. A treatment by day effect for decreased circulating NEFA was evident on d 11 on diet for cows fed N-3 and on d 18 for cows on N-3 compared to those fed T. Milk production (43.4, 42.2, and 41.8 kg/d for C, T, and N-3, respectively) and weekly fat and protein yield were similar ($P > 0.05$) across treatments although cows fed T tended ($P = 0.07$) to have increased milk fat percentage (3.20, 3.37, and 3.03%, respectively) compared to cows fed diet N-3 and tended ($P = 0.06$) to have a higher milk protein percentage (2.43, 2.55, and 2.51%, respectively) than cows fed diet C. Although FA treatments did not change milk or component yields, cows fed diet T tended to have increased uterine $PGF_{2\alpha}$ secretion in addition to increased milk fat and protein content.

Key Words: $PGF_{2\alpha}$, Uterus, Fatty acid

388 Effect of body weight gain and bovine somatotropin treatment on plasma concentrations of IGF-I in postpartum beef cows. M. J. Prado-Cooper*, I. Rubio, M. P. Davis, N. M. Long, R. P. Wettemann, and L. J. Spicer, *Oklahoma State University, Stillwater*.

Angus x Hereford cows (2 and 3 y of age) were used to determine the effects of postpartum weight gain and treatment with bovine somatotropin (bST) on concentrations of IGF-I in plasma during early

lactation. Cows (456 ± 52 kg, BCS = 4.6 ± 0.4) were stratified based on calving date and BCS at calving, and randomly assigned to a 2 x 2 factorial: weight gain (WG) to gain either < 0.4 kg/d (M, n = 18) or 0.40 kg/d (H, n = 19). Cows that achieved the programmed weight gain were injected with bST (250 mg; Posilac) or saline (C) on d 31 and 45 after calving. Concentrations of IGF-I, glucose and insulin were quantified in plasma collected twice a week, from d 24 until d 59 after calving. Data were analyzed using the Mixed procedure of SAS. Before bST treatment, H had greater ($P < 0.05$) concentrations of IGF-I in plasma compared with M cows (42.3 vs 30.6 ± 3.7 ng/mL). After bST treatment, there was a WG x bST x day effect ($P < 0.001$) on plasma IGF-I. Concentrations of IGF-I in plasma on d 21 were greater ($P < 0.01$) in HbST (223.1 ± 17.1 ng/mL) compared with MbST, MC or HC (67.0, 32.7 or 31.3 ± 17.1 ng/mL, respectively). After bST treatment, concentrations of glucose in plasma were greater ($P < 0.01$) in HbST compared with HC, MC and MbST (72.5 vs 68.4, 65.3 and 63.2 ± 1.3 mg/dL, respectively). Concentrations of insulin were greater ($P < 0.05$) in H (0.5 ± 0.2 ng/mL) compared with M cows (0.2 ± 0.2 ng/mL). Weight gain and treatment with bST did not influence the percentage of cows with luteal activity by 60 d after calving. Weights of calves at d 60 of age were greater ($P < 0.01$) in H compared with M cows (102 vs 86 ± 2 kg). Weight gain of young, lactating beef cows, influences plasma concentrations of IGF-I after treatment with bST. Further studies are needed to evaluate the effects of weight gain and bST on ovarian function and reproductive performance of lactating beef cows.

Key Words: Beef cows, Body weight gain, Somatotropin

389 Evaluation of the mechanism of action of conjugated linoleic acid (CLA) isomers on reproduction - uterine release of PGF_{2A}. E. Castaneda-Gutierrez^{*1}, B. C. Benefield¹, R. O. Gilbert¹, M. J. de Veth², W. R. Butler¹, and D. E. Bauman¹, ¹Cornell University, Ithaca, NY, ²BASF-AG, Offenbach/Queich, Germany.

The objective of this study was to evaluate uterine PGF_{2α} release (PGFM) in response to an oxytocin challenge after dietary supplementation with different CLA isomers. Lactating Holstein cows (n = 45, 20 ± 1 DIM) were assigned to one of 3 treatments: 70 g/d of Ca salts of tallow (CTL); 63 g/d of lipid-encapsulated CLA providing 7.1 g/d of *cis* 9, *trans* 11 CLA and 2.4 g/d of *trans* 10, *cis* 12 CLA (CLA 75:25), or ; 76 g/d of lipid-encapsulated CLA providing 7.1 g/d each of *cis* 9, *trans* 11 and *trans* 10, *cis* 12 CLA (CLA 50:50). Supplements were top-dressed for 37 d, milk production and DMI were recorded daily, and milk components measured weekly. Blood samples were taken 3x per wk for NEFA and 1x per wk for IGF-I analyses. At 30 ± 3 DIM ovulation was synchronized in all cows with a modified Ovsynch protocol. On d 15 of the cycle cows received an i.v. injection of 3 mg of estradiol 17β and 4 hr later an i.v. challenge with 100 IU of oxytocin; blood samples were obtained frequently over a 4 hr period. PGFM was determined by RIA and area under the curve was calculated. CLA 50:50 caused 16.6% reduction in milk fat content after wk 4 ($P < 0.03$), but milk fat content for CLA75:25 was not different from CTL. Milk fat yield was similar among treatments due to a trend ($P < 0.07$, wk 4) to increase milk yield of cows treated with CLA50:50 (43.5, 42.6 and 41.9 kg/d for CLA50:50, CLA75:25 and CTL, respectively). The oxytocin challenge resulted in an immediate elevation of circulating PGFM which gradually returned to basal levels over the next 4 h Area under the curve was not different among treatments ($P = 0.2$); likewise DMI and NEFA were similar among treatments ($P > 0.05$). Plasma IGF-I tended to be higher ($P < 0.07$) in cows treated with CLA 50:50 compared to CTL (81.4, 76.3 and 72.5 ng/ml for CLA50:50, CLA75:25

and CTL, respectively). Overall, results suggest that short periods of CLA supplementation do not impact reproductive performance via affects on uterine release of PGF_{2α}.

Key Words: Conjugated linoleic acid, Reproduction, PGF_{2α}

390 Liver expression of the clock gene *TIMELESS* is reduced by long day photoperiod in dairy steers. T. F. Gressley^{*1}, E. E. Connor², and G. E. Dahl¹, ¹University of Illinois, Urbana, ²Bovine Functional Genomics Laboratory, USDA-ARS, Beltsville, Maryland.

Regulation of circadian rhythms in the brain and peripheral organs occurs via differential expression of clock genes in response to external stimuli including light and feeding time. An experiment was conducted to determine whether expression of five clock genes in the liver of steers is affected by photoperiod manipulation. Eight Holstein steers averaging 100 d of age were exposed to 12 h of light and 12 h of darkness (12L:12D) for a 14-d acclimation period. Following acclimation, steers were assigned to a crossover design with a long day photoperiod (LDPP) or a short day photoperiod (SDPP) for 9 weeks followed by the opposite treatment for 4 weeks. Light cycles were 16L:8D for LDPP and 8L:16D for SDPP, with lights on at 0800h for both treatments. Steers were fed a grain and alfalfa cube mix at 1000h daily and had free access to water. Liver biopsies were taken beginning at 0830h during week 1 of the acclimation period and on week 4 of each treatment period. Liver samples were analyzed by quantitative real-time RT-PCR for mRNA expression of five clock genes (*BMAL1*, *CLOCK*, *Per1*, *Per2*, and *TIMELESS*) and three housekeeping genes (*RPS18*, *GAPDH*, and *ACTB*). Fold difference in clock gene expression between each treatment period and the acclimation period was calculated after normalizing to the three housekeeping genes and correcting for PCR efficiency. Results indicated expression levels of *BMAL1*, *CLOCK*, *Per1*, and *Per2* in LDPP were 99%, 97%, 101%, and 112%, respectively, of SDPP levels, with no significant differences between treatments. However, expression of *TIMELESS* for LDPP was reduced to 73% of SDPP ($P = 0.08$). The *TIMELESS* protein is involved in regulating circadian rhythms and has recently been implicated in coupling the cell division cycle to circadian rhythms. Photoperiod manipulation appears to entrain the circadian rhythm of clock gene expression in the bovine liver and may consequently affect liver metabolism.

Key Words: Clock genes, Gene expression, Liver

391 Effects of conjugated linoleic acid on prostaglandin production by bovine endometrial cells. A. Heravi Moussavi^{*1}, R. O. Gilbert², W. R. Butler², D. E. Bauman², E. Castaneda-Gutierrez², and H. B. Roman², ¹Ferdowsi University, Mashhad, Iran, ²Cornell University, Ithaca, NY.

The study was designed to test the effects of conjugated linoleic acid (CLA) on cyclooxygenase-2 (COX-2) level, and PGF_{2α} and PGE₂ production in cultured uterine endometrial cells. Uterine endometrium was collected by endometrial biopsy of cows in the luteal phase of the cycle and endometrial cells collected by enzymatic dispersion. Confluent cells were exposed for 24 h to 0, 50, 100, and 200 μM of c9, t11 CLA or t10, c12 CLA. After incubation, cells were washed and stimulated with phorbol 12-myristate 13-acetate (PMA) for 6 h. The c9, t11 CLA decreased PGF_{2α} production in a dose depend manner ($P < 0.001$; 18.91, 12.23, 10.97, and 7.76 ± 0.64 ng/ml, respectively). PGF_{2α} production also decreased with t10, c12 CLA supplementation ($P < 0.001$; 15.17, 4.30, 6.56, and 5.96 ± 0.59 ng/ml, respectively). The

t10, c12 CLA was more potent in reducing PGF2 α production than c9, t11 CLA. PGE2 production decreased linearly after supplementation of c9, t11 CLA ($P < 0.001$; 28.35, 13.29, 14.46, and 6.35 ± 1.7 ng/ml, respectively). The t10, c12 CLA also decreased PGE2 production in the cultured endometrial cells ($P < 0.001$; 24.57, 2.63, 10.68, and 8.28 ± 1.31 ng/ml, respectively) but the low dose of t10, c12 CLA was more potent than the higher doses ($P < 0.01$). The PGE2 to PGF2 α ratio was significantly reduced by c9, t11 CLA ($P < 0.01$; 1.49, 1.07, 1.32, and 0.80 ± 0.11 , respectively). The 50 μ M of t10, c12 CLA decreased the PGE2 to PGF2 α ratio ($P < 0.01$). The uterine endometrial level of COX-2 protein was not affected by the supplementations. Results from this experiment demonstrate that in vitro supplementation of the CLA isomers significantly decreases PGF2 α and PGE2 production with no apparent effect on COX-2 level after PMA challenge in cultured uterine endometrial cells.

Key Words: Dairy cow, COX-2, CLA

392 Prepartum administration of 2,4-thiazolidinedione alters metabolic dynamics and production of transition dairy cows. K. L. Smith*, S. E. Stebulis, M. R. Waldron, and T. R. Overton, *Cornell University, Ithaca, NY.*

Thiazolidinediones (TZD) are potent, synthetic ligands for PPAR- γ that have been shown to reduce plasma nonesterified fatty acids (NEFA) and potentiate the action of insulin in peripheral tissues of several species. Holstein cows ($n = 9$) entering second or greater lactation were used to determine whether late prepartum administration of 2,4-TZD would affect periparturient metabolism and production. Cows were fed a TMR during the prepartum period to provide no more than 150% of predicted energy requirements. During the postpartum period cows were fed a common TMR for ad libitum intake. Cows were administered either 2,4-TZD (4.0 mg/kg BW) or saline (control) by intrajugular infusion once daily from 25 d before expected parturition until parturition. Plasma samples were collected daily from 26 d prior to expected parturition through 7 d postpartum. Plasma NEFA concentrations were similar for cows assigned to the two treatments during much of the prepartum period, but were decreased at parturition and during the first 7 d postpartum for cows administered 2,4-TZD (treatment by time, $P = 0.009$). Plasma glucose concentrations were not affected ($P > 0.10$) by treatment. Average DMI was greater for cows administered 2,4-TZD compared to controls (14.8 vs. 13.8 kg/d; $P < 0.05$). Cows administered 2,4-TZD had lower milk yield than controls during the immediate postpartum period but then produced more milk than controls during the remainder of the postpartum study period (treatment by time, $P < 0.01$). Differences in milk fat and milk protein content measured on d 8 postpartum were not significant ($P > 0.10$). Administration of TZD during the late prepartum period has the potential to substantially improve metabolic health and production of transition dairy cows and warrants further investigation.

Key Words: Transition cow, Thiazolidinedione, PPAR- γ

393 Effect of breed on leptin concentrations in early lactation. P. J. Back* and N. A. Thomson, *Dexcel, Hamilton, New Zealand.*

Cows undergo large metabolic adaptations to meet the demands of milk production and rebreeding in early lactation. Adaptation depends on nutritional history and the immediate ability to mobilize body reserves to help meet energy demands. In this study, 3 genotypes (20 Friesian, 20 Jersey and 20 Jersey/Friesian crossbred multiparous cows) were used to determine the effect of breed on circulating leptin

concentrations and the relationship to other indicators of metabolic status and the post-partum anovulatory interval (PPAI). Cows were calved at pasture and weekly blood samples were taken for the first 6 wks of lactation. Milk progesterone analysis was used to determine PPAI. Body weight was different ($P < 0.001$) between breeds but there was no difference in BCS or BCS change during the trial period. There was a significant breed effect on circulating concentrations of BHBA ($P < 0.01$), NEFA ($P < 0.001$), triacylglycerides ($P < 0.001$) and leptin ($P < 0.01$), with Jersey cows having higher concentrations of these hormones and metabolites than Friesian or crossbred cows. Despite the concentration differences, only leptin showed a significant ($P < 0.01$) effect of time across breed (as determined by spline analysis). This resulted in Jersey cows having higher leptin concentrations from wk 1 to wk 4. The PPAI tended to be different between genotypes ($P = 0.18$) with Jersey cows having a shorter PPAI (34 vs 42 and 44 days for Friesian and crossbred cows respectively; SED 4). Correlations were determined between leptin and various indicators of metabolic status. Over the 6 wks monitored in early lactation, there was a negative correlation between concentrations of leptin and BHBA ($P < 0.01$) and NEFA ($P < 0.001$). There was positive correlations between concentrations of leptin and glucose ($P < 0.001$), IGF-1 ($P < 0.001$) and insulin ($P < 0.01$). Concentrations of leptin were also positively correlated to BW and BCS post-calving ($P < 0.05$, $P < 0.01$) and at wk 6 ($P < 0.001$, $P < 0.001$). These results indicate that grazing Jersey cows appear to have a different fat metabolism, which affects the regulation of circulating leptin concentrations and this may have contributed to their apparent ability to cycle earlier.

Key Words: Leptin, Breed, Pasture

394 Effects of heat stress and rbST on production parameters and glucose homeostasis. J. B. Wheelock*, S. R. Sanders, G. Shwartz, L. L. Hernandez, S. H. Baker, J. W. McFadden, L. J. Odens, R. Burgos, S. R. Hartman, R. M. Johnson, B. E. Jones, R. J. Collier, R. P. Rhoads, M. J. VanBaale, L. H. Baumgard, *University of Arizona, Tucson.*

Study objectives were to evaluate production parameters and glucose homeostatic variables in rbST-treated lactating dairy cattle during short-term heat stress (HS) or in pair-fed animals (UF). Twenty-two multiparous (99 DIM, 656 kg BW) Holstein cows [$n = 10$ (HS), $n = 12$ (UF)] were subjected to three experimental periods: 1) thermoneutral, ad libitum intake for 7d, 2) HS or UF for 7d, and 3) HS or UF with rbST (Posilac[®], Monsanto, St. Louis MO, administered on d1 of P3) for 7d. All cows received an I.V. glucose (d5) and insulin (d6) challenge during each period. HS conditions were cyclic to mimic an AZ July day, with temperatures ranging from 29.7 to 39.2°C. Milk yield, DMI, EBAL and body temperature indices were measured daily. Heat stress reduced DMI by 30%, and by design, UF cows had similar intake reductions (28%). Rectal temperatures and respiration rates increased during HS (38.6 to 40.5°C and 44 to 89 breaths/min, respectively). During HS and UF, milk yield decreased by 27.5% (9.7 kg) and 15.3% (4.8 kg) respectively, indicating reduced DMI only accounted for 50% of the decreased milk production. Milk yield increased with rbST (~13%) in both HS and UF. Cows in both treatments were in positive EBAL (>3.7 MCal/d) but entered NEBAL during HS and UF (<-3.7 MCal/d). No effect of HS on the rate of glucose disposal (mg/dL/min or AUC) was detected, but UF and rbST caused mild insulin resistance (16-30%, based on mg/dl/min and AUC). HS and UF treatments decreased (11%) basal glucose concentrations without an additional effect of rbST. HS had no effect on basal NEFA levels; however UF (despite a similar calculated EBAL) had increased (60%) basal NEFA concentrations. We conclude that reduced nutrient intake accounts

for only 50% of HS-induced decreases in milk yield and, based upon glucose challenge and basal NEFA data, increased extra-mammary

insulin sensitivity may contribute to the additional reduction in milk yield.

Key Words: Glucose homeostasis, Heat stress, rbST

Production, Management and the Environment II

395 Incorporating environmental compliance costs into livestock diet formulation. J. C. Hadrich, C. A. Wolf*, and S. B. Harsh, *Michigan State University, East Lansing.*

The current method to derive livestock diets is to minimize cost subject to animal performance and nutritional requirements that the performance level dictates. This approach allows nutritionists and farm managers to make livestock diet decisions based on the prices of alternative feed products. This method explicitly ignores the cost of over-feeding protein and minerals which must be disposed of with animal waste. Environmental compliance is a primary concern on livestock operations which must consider farm, and field, levels of phosphorus and nitrogen. Actual compliance costs are individual to the farm situation and depend on land availability, animal density, waste management methods, and feeding practices, among other factors. However, environmental compliance costs are significant on many farms and the feeding decision is a major source of nutrient import onto the farm. We reconsider livestock diet formulation to determine the cost effective diet using environmental compliance goals and resulting costs unique to the farm. A penalty function is incorporated in the feed cost minimization decision. Farm characteristics that influence this penalty function are animal density, amount of phosphorus (P) fed to the animals, cropping program, application of commercial fertilizers, land availability for manure application, current soil P levels and distance manure is hauled. Including the nutrient penalty function the ration formulation reallocates diet ingredients to accommodate lower levels of P in the ration. In the short run it may increase the ration costs, but simultaneously decreases the amount of by-product in the ration which may lead to cost savings when the total cost of nutrients are considered. With the increasing availability of by-product feeds, producers must be aware of the total cost rather than the input cost of feedstuffs. Incorporating nitrogen levels and alternative nutrient management strategies are ongoing.

Key Words: Diet cost, Environmental compliance

396 Development and integration of a national feed management education program and assessment tools into a comprehensive nutrient management plan. J. H. Harrison¹, R. A. White*¹, T. J. Applegate², R. T. Burns³, G. H. Carpenter⁴, G. E. Erickson⁵, and A. L. Sutton², ¹Washington State University, Puyallup, ²Purdue University, West Lafayette, IN, ³Iowa State University, Ames, ⁴USDA, NRCS, Beltsville, MD, ⁵University of Nebraska, Lincoln.

In 2003, the US Environmental Protection Agency (EPA) released new guidelines for Concentrated Animal Feeding Operations (CAFO). Under the new guidelines, permitted CAFOs will be required to develop a Nutrient Management Plan (NMP). In most cases, with minor additions, a USDA, Natural Resources Conservation Service (NRCS) Comprehensive Nutrient Management Plan (CNMP) will satisfy the requirements of an NMP. One of the Core Elements of the CNMP is feed management. In 2005, a national feed management education project was funded by the NRCS Conservation Innovation

Grant program (CIG). The project will develop, test, and implement a National Feed Management Education Program and Assessment Tools into a Comprehensive Nutrient Management Plan. The goal of the project is to increase the understanding of feed management to agricultural professionals, with an emphasis on environmental and financial sustainability of livestock and poultry operations. A team consisting of consulting animal nutritionists, technical service providers (TSPs), Extension Specialists, and research scientists will accomplish the following program objectives: 1) develop and evaluate a two-tier tool for assessing the impacts of feed management practices on whole farm nutrient balance for animal nutritionists, NRCS staff and TSP advisors, 2) develop the content of a Feed Management chapter for the NRCS Agricultural Waste Management Field Handbook (AWMFH), and 3) develop and implement an education program targeting integration of feed management into a CNMP. Specific outcomes are: 1) develop educational materials that are applicable at the national level, 2) provide training for NRCS staff, agricultural professionals, and TSPs in feed management concepts and practices that minimize import of nutrients to the farm, 3) provide training in the use of computer models and software for strategic ration balancing, whole farm nutrient balance, and nutrient excretion estimates based upon feed and animal performance inputs, and 4) develop a chapter for the NRCS AWMFH on Feed Management.

Key Words: Feed management, Nutrient management, Environment

397 Decision support model of nutrient excretion in beef feedlots. C. B. Williams* and T. G. Jenkins, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

Component biological models were developed at the U.S. Meat Animal Research Center to partition ME and protein intake to maintenance and gain, and partition protein and ME for gain to fat and protein accretion in growing and mature cattle. These models were integrated with a life cycle beef production model reported by Colorado State University, and phosphorus and potassium intake and utilization functions were added. Evaluations with independent sets of experimental data documented that the beef life cycle model could accurately predict responses under different levels of nutritional management. This model represents a nutrient utilization model for ME, nitrogen, phosphorus and potassium, and it was integrated with the nutrient supply model of the Cornell Net Carbohydrate Protein System to predict nutrient supply. Nutrient excretion was predicted as the difference between supply and utilization. Use of the biological model requires knowledge of computer programming, therefore a graphical user interface consisting of easy to use screens was developed to simplify data input and make the biological model more accessible to producers and professional animal scientists. The software package provides an easy to use decision support tool that predicts nitrogen, phosphorus, and potassium excretion in beef feedlots, in response to breed, management, and different dietary formulations.

Key Words: Beef cattle, Computer simulation, Decision support

398 Maximized lactational performance for improving postweaning reproductive performance on commercial farms. Y. Tanaka* and Y. Koketsu, *Meiji University, Kawasaki, Kanagawa, Japan.*

The objectives in this study were to study lactational performance across parities; associations between lactational performance and postweaning reproductive performance; and correlations of three lactational performances between consecutive parities. The three performances were weaning litter weight (WLWt), average pig weight at weaning (PIGWt), and number of pigs weaned (PW). This cohort study over 6 yr was conducted by using 94 farms containing 66,239 weaned records of 14,140 females born during 1999. Five groups of PW were formed on the basis of 5, 25, 75, and 95 percentiles of sows: ≤ 6 , 7 - 8, 9 - 10, 11, and ≥ 12 pigs. Three groups of WLWt were formed on the basis of upper and lower 25 percentile of sows: ≤ 48.0 , 48.0 - 70.0, and ≥ 70.0 kg. Pearson correlation analysis and partial correlation analysis using PW as a controlled variable were done. Mixed models were used to analyze the associations between farrowing rate, weaning-to-first-mating interval, and lactational performance. Across parities, the means of PW ranged from 8.9 to 9.7 pigs. The means of WLWt across parities ranged from 56.3 to 61.6 kg, and the heaviest WLWt was found at parity 2 and 3 ($P < 0.05$). The correlations were found between consecutive parities from 1 to 6 in WLWt and PIGWt ($0.38 \leq r \leq 0.56$; $P < 0.05$). Sows with PW ≤ 6 pigs had the longest weaning-to-first-mating intervals among the PW groups ($P < 0.05$). No differences in weaning-to-first-mating intervals were found in the PW ≥ 7 pigs groups. Sows with PW 9 - 10, 11, and ≥ 12 pigs had higher farrowing rates than those with PW ≤ 8 pigs ($P < 0.05$). Sows with WLWt ≥ 70.0 kg had the highest farrowing rate ($P < 0.05$), and had weaning-to-first-mating intervals similar to those with WLWt < 70.0 kg. Sows with PW 9 - 10 pigs had an approximately 100 g heavier PIGWt than those with PW 11 pigs ($P < 0.05$). Maximized WLWt with PW ≥ 9 pigs did not impair farrowing rates and weaning-to-first-mating intervals. High correlations in WLWt indicated that sows with heavy WLWt were more likely to be productive at subsequent parity.

Key Words: Management, Sows

399 Effect of parity and rearing segregation at birth on productive performance and health status of pigs. C. Pineiro*¹, J. Morales¹, G. G. Mateos², and X. Manteca³, ¹*PigCHAMP Pro Europa, S.A., Segovia, Spain*, ²*U.P. Madrid, Spain*, ³*U.A. Barcelona, Spain*.

Progeny of primiparous sows (GIL) have lower birth weights, higher mortality and poorer performance than the progeny from multiparous sows (SOW). The reason is unknown but might be related to differences in colostrum quality. To confirm this hypothesis a total of 10 GIL and 10 SOW (3rd to 5th parturition) were selected from a group of 100 sows. Half of the piglets of each sow were reared by its own mother whereas the other half was fostered off to the other group of sows before colostrum intake. Therefore, there were four treatments arranged factorially with two types of sows (GIL vs SOW) and two rearing systems (GIL-R, reared with gilts or SOW-R, reared with multiparous sows). Average daily gain (ADG), feed intake and feed efficiency were controlled and blood sampled at 14, 28, 40, 60, 90, 116, and 142 d of age to analyse the concentration of Pig-MAP, an acute-phase protein used as biomarker of health status. At the end of the trial pigs born from GIL ate less feed (1592 vs 1436 g/d; $P < 0.01$) and grew less (605 vs 669 g/d; $P < 0.001$) than pigs born from SOW. Also, pigs GIL-R grew less (621 vs 653 g/d; $P < 0.05$) and were less efficient (2.63 vs 2.39 g/g; $P < 0.001$) than pigs SOW-R. An interesting interaction occurred for ADG from 88 to 116 d of life; GIL-R pigs grew less than SOW-R

($P < 0.01$) only if they came from GIL. At 146 d of age BW was higher for SOW than for GIL pigs (87.0 vs 79.1 kg; $P > 0.001$) and for SOW-R than for GIL-R pigs (85.1 vs 81.0 kg; $P < 0.05$). During the fattening period mortality was higher for GIL-R pigs (9.2 vs 2.1%; $P < 0.05$) suggesting that the quality of the colostrum ingested influences health status. In association with these results, Pig-MAP serum concentration was higher in GIL-R pigs (0.70 vs 0.86 mg/ml; $P < 0.05$). An interaction was found at 116 d of life for this biomarker; GIL-R pigs from GIL had higher serum levels than the others ($P = 0.09$). We conclude that both age of the sow and type of rearing after birth affect weaning performance and mortality during the whole rearing period.

Key Words: Pig, Primiparous, Performance

400 Effect of mixing pigs or maintaining pen integrity on the response to grow-finish space allocation. R. Goodband¹, M. Brumm*², L. Johnston³, and K. Stalder⁴, ¹*Kansas State University, Manhattan*, ²*University of Nebraska, Lincoln*, ³*University of Minnesota, St. Paul*, ⁴*Iowa State University, Ames*.

Recent NCR-89 data (JAS, 79:1967-1972) indicated that when pigs are mixed into new social groups following the nursery phase, space restrictions during the finishing phase decrease ADFI and ADG. However, in a second study, when the social group remained intact, space restrictions during finishing had no effect. Therefore, a cooperative study using 906 pigs was conducted to evaluate either mixing pigs or maintaining pen integrity during the move from nursery to finishing and its effect on finishing space allowance. Treatments were arranged in a 2×2 factorial with main effects of mixing or maintaining pen integrity as pigs were moved to finishing facilities (BW 24.9 kg) and providing either 0.56 or 0.74 m² per pig. There were 8 pens per block and 7 blocks. In 2 pens, pen integrity was maintained and pens were allocated to either 0.56 or 0.74 m² per pig. For mixed treatments, pigs from 3 pens were mixed into 3 new pens and assigned to 0.56 m² per pig. Likewise, 3 more pens were mixed and assigned to 0.74 m² per pig. Individual pen was the experimental unit. From d 0 to 14, no treatment effects were observed ($P = 0.07$). For the overall data, there was no interaction between maintaining pen integrity or not and space allocation ($P = 0.13$) for ADG or ADFI. Maintaining pen integrity did not affect ADG or ADFI compared with mixing pigs (0.87 and 2.37 vs. 0.87 and 2.36 kg/d, respectively). However, pigs provided 0.56 m² had decreased ADG and ADFI compared with those provided 0.74 m² (0.86 and 2.34 vs. 0.88 and 2.39 kg/d, respectively). When providing 0.56 m² per pig, mixed pigs had better G:F compared to unmixed pens, but poorer G:F than unmixed pens when 0.74 m² per pig was provided (interaction, $P = 0.04$). These results confirm expected reductions in growth and feed intake of pigs restricted in space. In this study, maintaining pen integrity when moving pigs from nursery to finishing facilities had no beneficial effect on pig performance.

Key Words: Mixing, Pigs, Space

401 Influence of thymol on coliform bacteria, VFA, and methane production from pull-plug swine manure pits. V. H. Varela* and J. E. Wells, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE*.

This study was conducted in swine manure pits to determine the influence of thymol addition on pathogen, odor, and methane emission. Two experiments were conducted in 2 pull-plug pits (34,000 L each) which had partially slotted floors with 6 pens (16 sows per pen) over

each pit. One pit served as the control and the other pit was amended with approximately 1.5 and 3.0 g of thymol/L in experiment 1 and 2, respectively. Each experiment lasted 18 d, during which time five to six 200 ml samples were withdrawn from underneath each pen and analyzed for DM, thymol, VFA, and coliform bacteria. At the end of each experiment, 50 g samples, 6 from each pit, were placed in 200 ml serum bottles and gas volume and composition were determined periodically for 28 d. The slurry DM was not affected by thymol treatment in either experiment. Compared to the control pit, VFA production was reduced 1.28 and 1.71 mmol/L d⁻¹ (65 and 100%) for thymol amendments of 1.5 and 3.0 g/L, respectively ($P < 0.01$).

Coliform and *Escherichia coli* viable cells were reduced 1.55 and 1.76 log₁₀ CFU/g slurry for the 1.5 g of thymol/L treatment, respectively; and 2.73 and 2.94 log₁₀ CFU/g slurry for the 3.0 g of thymol/L treatment, respectively. Total gas production from the serum bottles was reduced 64 and 76% for thymol amendments of 1.5 and 3.0 g/L, respectively ($P < 0.01$); and methane production was reduced 77 and 93%, respectively ($P < 0.01$). These results suggest that thymol may be useful in swine production facilities equipped with slotted floor manure pits to reduce pathogens, odor, and greenhouse gas.

Key Words: Swine manure, Odor, Pathogens

Ruminant Nutrition: Fat Feeding, Metabolism & Composition

402 Artificial neural networks to model the rumen fermentation pattern in dairy cattle. M. Craninx, B. Vlaeminck, and V. Fievez*, *Ghent University, Melle, Belgium*.

The aim of this study is a preliminary evaluation of the use of an artificial neural network (ANN) to predict rumen molar proportions of volatile fatty acids from milk fatty acids. The current study combined data from ten experiments with rumen fistulated dairy cows, resulting in a dataset of 138 observations, which were split into a training (n=93), a validation (n=10) and a test (n=35) set, with the former used to iteratively train the model until the minimal mean square prediction error of the validation set was reached and the latter to independently test the model. A similar distribution of the input and output variables in both data sets was ensured. Essential data-input pre-processing prior to ANN model development included normalisation in the [-1 1] interval and reduction of the number of variables by selecting mutual uncorrelated milk fatty acids, based on correlation and principal component analysis and by excluding milk fatty acids of dietary (e.g. C18:2n-6 and C18:3n-3) or multiple origin (e.g. cis 9 C18:1), based on background physiological knowledge. Different types of ANN architecture and training algorithms were evaluated and the final neural network was characterised by 1 hidden layer with 12 neurons and a Scaled Conjugate Gradient training algorithm. The selected input variables included the milk odd and branched-chain fatty acids, which are directly derived from rumen microbes and biohydrogenation intermediates, which accumulate to a different extent according to rumen conditions. The regression between the observed and predicted values showed similar results for training and test data, suggesting no overfitting. The evaluation on the test data showed determination coefficients of 0.801, 0.686 and 0.541 and a relative root mean square prediction error of 2.64%, 9.47 % and 8.64% of the observed mean for acetate, propionate and butyrate, respectively. The results suggest that ANN is a potential method to predict molar proportions of volatile fatty acids in the rumen.

Key Words: Modelling, Rumen fermentation, Milk fatty acids

403 ¹³C Enrichment of conjugated linoleic acids and other fatty acids in cultures of ruminal microorganisms dosed with a stable isotope of linoleic acid. C. Thompson, J. Mulz, M. Reynolds, E. Thies, and T. Jenkins*, *Clemson University, Clemson, SC*.

Most published accounts of linoleic acid biohydrogenation by ruminal microorganisms account for only a single C18:2 intermediate, namely the *cis*-9, *trans*-11 conjugated linoleic acid (CLA) isomer, prior to its

complete hydrogenation to stearic acid. The purpose of this study was to determine the full range of C18:2 intermediates arising from the biohydrogenation of linoleic acid. Six rumen in vitro cultures were run, with half of the cultures receiving 25 mg of unlabelled linoleic acid in 1 mL of ethanol and the other half receiving 25 mg U-¹³C-linoleic acid in ethanol injected at the start of incubation. Samples were taken from each flask at 0, 6, 24, and 48 hours. Methyl esters of fatty acids were separated on a 100-m CP-Sil 88 column and abundances of the quasimolecular ion (M) and M+18 ion were determined by mass spectroscopy in positive chemical ionization mode. Enrichment (M+18/M minus background) data greater than zero were determined by t-test when $P > 0.05$, and time effects were analyzed by ANOVA. Enrichment of linoleic acid in the culture contents at 0 h was 0.32, which increased to 1.29 ($P < 0.05$) by 48 h. Enrichments at 48 h were 0.06, 0.08 and 0.22 for stearic acid, *trans*-11 C18:1, and *cis*-9, *trans*-11 CLA, respectively. Higher enrichments were observed for the *trans*-10, *cis*-12 CLA (1.33) and *trans*-9, *trans*-11 CLA (1.12) isomers by 48 h. Two additional peaks in the CLA region were enriched (0.99 and 0.87) but not identified. The increasing enrichment of linoleic acid over time suggests preferential utilization of the unlabelled compound for biohydrogenation, which was consistent with low enrichment for stearic acid. High enrichments that increase over time, such as those seen for several CLA, might indicate conversion from the labeled linoleic acid via a nonenzymatic isomerization process.

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Key Words: Biohydrogenation, Linoleic acid, Rumen

404 The effect of fish oil supplementation on ruminal C18 PUFA metabolism in beef steers offered either grass or red clover silage. M. R. F. Lee*¹, K. J. Shingfield², and N. D. Scollan¹, ¹*Institute of Grassland and Environmental Research, Aberystwyth, Ceredigion, UK*, ²*MTT Agrifood Research, Jokioinen, Finland*.

Red clover and fish oil have been shown to alter ruminal lipid metabolism increasing PUFA and conjugated linoleic acid (CLA), respectively, in ruminant products. This study investigated the additive effect of these two feeds on C18 PUFA metabolism in beef steers. Eight Hereford × Friesian steers prepared with rumen and duodenal cannulae were offered either grass or red clover silage at 90% ad libitum with one of three levels of fish oil 0, 1, 2, or 3 % DMI. The experimental design consisted of four 2 × 2 Latin squares within each

oil level with an extra period. Flows of fatty acids at the duodenum were assessed using the dual phase-indigestible-marker technique. DMI was significantly ($P < 0.001$) higher for red clover silage (5.98) than grass silage (5.09 kg/d). Oil level had no effect on DMI with the exception of red clover at 3% oil which was significantly ($P < 0.01$) lower. C18:2 n-6 and C18:3 n-3 intakes averaged 13.2 and 25.1 for grass silage and 17.9 and 36.2 g/d for red clover silage, respectively. Biohydrogenation of C18:2 n-6 and C18:3 n-3 were significantly lower ($P < 0.001$) on red clover silage than grass silage with oil level increasing the extent of biohydrogenation in both diets ($P < 0.05$; 0.81 and 0.85 to 0.91 and 0.92 for grass silage and 0.76 and 0.73 to 0.87 and 0.83 for red clover silage at 0 and 3 % oil, respectively). C18:1 trans was significantly increased by oil level for both diets (4.6 to 15.0 and 9.4 to 22.5 for grass and red clover silage at 0 and 3 % oil, respectively). Oil level increased the proportion of C18:1 trans 11 in the duodenal digesta in both diets from 0.47 and 0.31 with no oil to 0.52 and 0.51 at 3 % oil for grass silage and red clover silage, respectively. CLA was also significantly increased on both diets by oil level (0.21 and 0.27 to 0.48 and 0.57 g/d for grass and red clover silage at 0 and 3 % oil, respectively). The results of this study show that red clover and fish oil have the potential to beneficially alter the fatty acid profile of ruminant products.

Key Words: Red clover, Fish oil, Biohydrogenation

405 Characterization of the acute lactation response to *trans*-10, *cis*-12 conjugated linoleic acid (CLA). K. J. Harvatine*, D. A. Dwyer, and D. E. Bauman, *Cornell University, Ithaca, NY.*

Trans-10, *cis*-12 CLA is a potent inhibitor of milk fat synthesis and the decrease in milk fat yield reaches a nadir after 4-5 d of abomasal infusion. Acute responses to *t*-10, *c*-12 CLA were evaluated using 4 cows in a cross-over design. Cows were milked with the aid of oxytocin every 4 h from d -1 to d 3 and every 6 h on d 4 relative to abomasal CLA infusion. An initial priming dose of 7.5 g of CLA was given at time-zero followed by steady state infusion of 2.5 g every 4 h for 3 d. Data were analyzed using a mixed model with repeated measures in time. Milk *t*-10, *c*-12 CLA concentration peaked at 6 h and reached steady state by 22 h. At termination of the infusion, the decrease in milk *t*-10, *c*-12 CLA concentration best fit a reciprocal-linear function with an average slope of 0.381 ($R^2 > 0.98$, $P < 0.001$). Rate of milk synthesis was not affected by treatment. Milk fat percent decreased progressively after the priming dose, with the decrease being a trend at 6 h and significant by 10 h. Rate of milk fat synthesis also progressively decreased from time 0, with the decrease being a trend by 18 h and significant at 34 h. Yields of fatty acids > 16 carbons and de novo fatty acids decreased progressively from 0 h, were significant at 22 h and reached a nadir at 62 h. The milk fatty acid profile was initially unchanged, but about 14 h after the CLA dose was initiated, proportions of fatty acids began to progressively shift (increase in fatty acids > C16 and decrease in those < C16) and reached significance by 38-46 h. In contrast, changes in the desaturase indexes were immediate with a significant decrease by 6 h and a nadir by 14 h for most desaturase pairs. Thus, the desaturase enzyme must be more acutely responsive to *t*-10, *c*-12 CLA than other enzymes in milk fat synthesis. Overall, at the *t*-10, *c*-12 CLA dose utilized the initial decrease in milk fat synthesis involved an equal depression of short and long-chain fatty acid pathways and was followed thereafter by a more pronounced decrease in the synthesis of de novo fatty acids.

Key Words: *Trans*-10, *cis*-12 CLA, Milk fat depression

406 *Trans*-10, *cis*-12 conjugated linoleic acid reduces milk fat synthesis in lactating goats. M. Rovai*¹, A. L. Lock², T. A. Gipson¹, A. L. Goetsch¹, and D. E. Bauman², ¹*E (Kika) de la Garza American Institute for Goat Research, Langston, OK*, ²*Cornell University, Ithaca, NY.*

The efficacy of *trans*-10, *cis*-12 conjugated linoleic acid (CLA) in reducing milk fat synthesis in dairy cows and sheep has been well documented. However, recent examinations of the effects of *trans*-10, *cis*-12 CLA on milk fat synthesis in lactating goats have proved inconclusive. The current study was therefore designed to determine if a lipid-encapsulated *trans*-10, *cis*-12 CLA supplement (LE-CLA; BASF AG, Ludwigshafen, Germany) would inhibit milk fat synthesis in lactating goats. Thirty multiparous Alpine dairy goats (50 ± 7.4 kg) in late lactation were randomly assigned in a 3 x 3 Latin square experiment. Goats were fed a bermuda grass hay, alfalfa pellet, concentrate diet (20:20:60) either A) unsupplemented (Control), B) supplemented with 30 g/d LE-CLA (low-dose; LLE), or C) supplemented with 60 g/d LE-CLA (high-dose; HLE). The LE-CLA supplement supplied 3 and 6 g/d of *trans*-10, *cis*-12 CLA for the LLE and HLE treatments, respectively. Treatment periods were 14 d in length with a 14 d washout interval. Milk yield, DMI, and milk protein content and yield were unaffected by treatment ($P > 0.05$). Compared with Control, milk fat yield was reduced 8.1% by the LLE treatment and 21.2% by the HLE treatment ($P < 0.001$), with milk fat content reduced 4.4 and 16.0% by the LLE and HLE treatments, respectively ($P < 0.001$). In conclusion, the results of the present study demonstrate that *trans*-10, *cis*-12 CLA reduces milk fat synthesis in lactating goats in a manner similar to that observed in lactating dairy cows and sheep. However, dose-response comparisons suggest that the degree of reduction in milk fat synthesis is less in goats compared with other lactating ruminant species studied. Further studies are required to verify and extend these results and to elucidate the mechanism of action for the effects observed with *trans*-10, *cis*-12 CLA supplementation.

Key Words: Goat, Milk fat, CLA

407 Comprehensive two-dimensional gas chromatography (GC×GC) for the analysis of fatty acids (FA) in milk. B. Vlaeminck*¹, J. Harynuk², K. Korkiasaari³, V. Fievez¹, and P.J. Marriott², ¹*Ghent University, Belgium*, ²*RMIT University, Australia*, ³*University of Turku, Finland.*

GC×GC is a novel technique, rapidly gaining importance for the analysis of complex samples. Here we evaluate the potential of GC×GC for the analysis of the FA-profile of milk from dairy cows fed either a control diet or the control diet supplemented with marine algae. FA methyl esters were separated using a BPX80-column (30m×0.25mm×0.25µm) coupled to a BPX35 (0.25m×0.10mm×0.10µm). Modulation (6s) was performed using a LMCS II with liquid CO₂ as the cryogen. This modulator traps compounds eluting from the first dimension (¹D) column by means of a cold spot. By moving the modulator to a position upstream of the cold spot, the solutes are exposed to the oven temperature and are re-injected on the second dimension (²D) column resulting in sharp peaks and higher sensitivity. The trap then returns to its original position and the process repeats throughout the analysis. Due to the difference in separation mechanism of the two columns, GC×GC results in an improved separation compared with analysis on the same column set without the use of the modulator (1-D GC). Thus whereas branched-chain C17-FA normally co-elute with C16:1-isomers using 1-D GC, GC×GC resulted in separation of these FA on the ²D column.

Similarly, C18:1-isomers and conjugated linoleic acids were well resolved from C19:0 and C20:1-isomers, respectively. Displaying the peaks in a 2-D contour plot showed a well-ordered structure of FA according to their chemical properties, facilitating identification. ²D retention times provided information on the number of double bonds whereas retention in the ¹D column was closely related with double bond position (n-3 vs. n-6). In conclusion, this experiment suggests GC×GC to be a powerful technique for the analysis of FA. Nevertheless, further research is needed to achieve improved separation of trans and cis C18:1-isomers, which may require a longer ¹D column.

Key Words: Comprehensive two-dimensional gas chromatography, Fatty acids

408 Whey protein gel composites of soybean and linseed oils used as a dietary method to modify the unsaturated fatty acid composition of milk lipids. J. M. Heguy*, S. O. Juchem, E. J. DePeters, M. Rosenberg, J. E. P. Santos, and S. J. Taylor, *University of California, Davis*.

Dairy products are an important source of nutrients in the Western diet. One criticism of milk fat relates to its low content of polyunsaturated fatty acids (PUFA) in particular the omega-3 fatty acids. Various methods to protect unsaturated fatty acids from rumen biohydrogenation have been developed. The most promising method employs formaldehyde, a carcinogen, and thus of limited use in the United States. A novel gel based on only whey protein, water, and oil (U.S. Patent Application 20040058003 A1 [Pending]; U.S. Patent Application 20050089550 A1 [Pending]) was developed at the University of California, Davis. The objective was to determine the efficacy a whey protein gel composite as a dietary method to increase the PUFA in milk lipids. Four primiparous Holstein cows were used in a 4x4 Latin square. The supplement lipid was a 1:1 (w:w) mixture of soybean:linseed oils (S/L) added to a total mixed ration. The S/L was fed in one of 4 chemical forms: (1) oil (O) where S/L was added directly to the diet unmodified, (2) calcium salts (CaS) of S/L, (3) whey protein concentrate (WPC) gel composite of S/L and (4) whey protein isolate (WPI) gel composite of S/L. Each diet provided a similar amount of total FA. Dietary treatment had no effect on dry matter intake, milk yield, and milk fat percentage. Milk triacylglycerol (TG) composition of linoleic acid averaged 2.77, 3.53, 3.59, and 6.35 g/100g fat and α -linolenic averaged 0.97, 1.33, 1.73, and 4.09 g/100g fat for O, CaS, WPC, and WPI. Total C18:1 *trans* FA decreased from 4.01 g/100g fat for O to 2.50 g/100 g fat for WPI. Similar changes in PUFA content of milk phospholipids were observed. The lower *trans* FA and higher PUFA in milk fat support a reduction in rumen biohydrogenation of PUFA. Feeding a whey protein gel composite successfully increased the PUFA of milk lipids.

Key Words: Unsaturated fatty acids, Milk fat, Whey protein gel

409 Feed intake, milk production and milk composition of dairy cows fed extruded linseed. M. C. Fuentes*¹, S. Calsamiglia¹, C. Sanchez², A. Gonzalez³, J. E. Santos⁴, J. R. Newbold⁵, and J. Fontecha⁶, ¹*Universidad Autonoma de Barcelona, Bellaterra, Spain*, ²*Tauste Ganadera, Zaragoza, Spain*, ³*Nutral, SA, Madrid, Spain*, ⁴*University of California, Davis*, ⁵*PROVIMI, Brussels, Belgium*, ⁶*CSIC, Madrid, Spain*.

Four hundred early lactation multiparous Holstein cows were used in a randomised complete block design to determine the effects of extruded linseed on feed intake, milk yield and milk composition

between weeks 4 and 20 of lactation. Forty of these cows were used to study the effects of extruded linseed on milk fatty acid (FA) profile and on individual feed intake. Cows were fed a 40:60 forage to concentrate ratio diet (17.7% CP, 27.7% FND and 6.03% EE) ad libitum that was identical in composition between treatments except for the treatment supplement that was control (CTR: 4.9% extruded soybean, 3.7% extruded corn, 1% calcium soaps and 0.02% Mepron) and linseed (LIN: 5.5% extruded linseed, 7.9% extruded corn, 4.1% extruded barley and 0.02% Mepron). Individual feed intake measured at 40 (23 kg DM) and 100 days in milk (24.2 kg DM) was not affected by treatment. Milk production (45 kg/d) was not affected by treatment, but the lower (P<0.05) milk fat percentage in cows fed LIN (2.65%) compared with CTR (2.86%) resulted in lower (P<0.05) fat-corrected milk yield for cows fed LIN (35.4 kg/d) compared with CTR (37.7 kg/d). Milk protein content was higher (P<0.05) in LIN (3.04%) than in CTR (3.00%). Total saturated FA were 4% lower (P<0.05) in milk fat from LIN cows compared with CTR cows (55.6 vs. 59.7 %) at 100 d of treatment. However, monounsaturated FA (35.7 vs. 33.3%) and polyunsaturated FA (8.6 vs. 6.8%) were 2.5% and 2% higher (P<0.05), respectively, in cows fed LIN compared with CTR cows. Linseed supplementation also increased (P<0.05) vaccenic acid, total CLA and n-3 FA (2.0, 1.5 and 1.7 fold, respectively). In general, linseed increased milk protein percentage, reduced milk fat percentage and enhanced the content of healthy FA in milk without modifying DM intake and milk yield.

Key Words: Linseed, Milk fatty acids, Milk production

410 Effects of dietary addition of unsaturated fat, vitamin E, and sorbitol on performance of dairy cows and fatty acid concentrations in milk. A. Todd*, M. L. Eastridge, C. V. D. M. Ribeiro, J. Engel, and B. Mathew, *The Ohio State University, Columbus*.

Dietary addition of soybean oil will increase conjugated linoleic acid (CLA) in milk but not to the extent that results from feeding fish oil. Data are limited on CLA in milk from feeding a combination of soybean and fish oils to provide different sources of fatty acids (FA). There is some evidence that increasing dietary concentration of vitamin E may affect milk CLA when feeding unsaturated fat. Sorbitol is being used in commercial feed, but limited published data are available. Eight lactating dairy cows (4 Holstein and 4 Jersey) were used in a Latin square design. Each period consisted of 3 wk, with wk 3 being used for data analyses. Rumen samples were taken from the Holstein cows (one with rumen cannula and via stomach tube for the other 3 cows). Diets consisted of 44% forage (80% corn silage and 20% alfalfa hay), were mixed once daily as TMR, and fed twice daily. The cows were fed 4 diets: 1) control diet (CNTL; 500 IU vitamin E), 2) 2% fish oil, 0.5% soybean oil, and 500 IU of vitamin E (FSO), 3) 2% fish oil, 0.5% soybean oil, and 2000 IU of vitamin E (FSOE), and 4) 1% sorbitol (SORB, dry form; 500 IU vitamin E). Diets with oil reduced DMI (18.8 versus 22.7 kg/d), but DMI was similar between CNTL and SORB. Milk yield (31.7 kg/d) and MUN (17.0 mg/dl) were similar among diets. Diets with oil reduced milk fat and protein percentages (3.87, 2.50, 2.58, and 3.96%; 3.38, 3.09, 3.16, and 3.32% for CNTL, FSO, FSOE, and SORB, respectively). Rumen VFA were similar among diets. Concentrations of vaccenic acid (3.49, 8.03, 11.8, and 1.96% of FA, respectively) and CLA (0.63, 1.28, 2.00, and 0.39%, respectively) in milk were increased with the diets containing oil; concentrations of vaccenic acid tended to be higher and CLA was higher for FSOE versus FSO. Both breeds responded similarly to the dietary treatments with respect to performance and individual milk FA. Addition of soybean and fish oils increased CLA in milk, but the

higher concentration of vitamin E in combination with the oils further increased milk CLA. Feeding the sorbitol resulted in similar responses as to feeding the CNTL diet.

Key Words: Fish oil, Sorbitol, Vitamin E

411 Effects of flaxseed processing on the recovery of A-linolenic acid in milk. G. Thangavelu¹, M. Oba¹, M. Dehghan-banadaky¹, D. J. Ambrose², and E. Okine¹, ¹University of Alberta, Edmonton, AB, Canada, ²Alberta Agriculture Food and Rural Development, Edmonton, AB, Canada.

Effects of flaxseed processing on the recovery of α -linolenic acid in milk were evaluated using ten primiparous Holstein cows (153 ± 30.7 DIM; mean \pm SD) in a crossover design with 14 d per period. We hypothesized that feeding unprocessed flaxseed is as effective as dry-rolled flaxseed at increasing α -linolenic acid concentration in milk fat. Experimental diets contained either whole (WH) or dry-rolled (DR) flaxseed at 10.1% of dietary DM. Dietary concentrations of NDF, CP, ether extract, and α -linolenic acid were 39.1, 17.6, 7.0, and 2.7%, respectively (DM basis). Dry matter intake, milk yield, and concentrations of milk fat, protein, and lactose were not affected by treatments, and averaged 17.5 kg/d, 27.5 kg/d, 3.60%, 3.00%, 4.73%, respectively. Apparent total tract digestibility of ether extract was lower for WH compared with DR (48.6 vs. 62.4 %; $P < 0.01$). Moreover, excretion of α -linolenic acid in feces was greater for WH compared with DR treatment (259 vs. 129 g/d; $P < 0.001$). However, α -linolenic acid concentration in milk was not affected by treatments (0.83 and 0.86 % for WH and DR, respectively), and both treatments had three times as much α -linolenic acid concentration as the period prior to the experiment (0.26%), during which sunflower seed was fed in place of flaxseed. These data indicate that both WH and DR treatments increased the absorption of α -linolenic acid to a similar extent despite the lower digestibility for WH treatment, which can be attributed to less lipolysis or fatty acid biohydrogenation for WH compared with DR. This speculation is supported by that WH treatment decreased concentration of vaccenic acid, a fatty acid intermediate during biohydrogenation, in milk fat compared with DR (1.9 vs. 3.0 %; $P < 0.01$). Dry-rolling flaxseed does not necessarily improve the absorption of α -linolenic acid probably because processing increases the extent of biohydrogenation in the rumen as well as digestibility.

Key Words: Flaxseed processing, α -linolenic acid, Biohydrogenation

412 The effect of bypass fat in the diet of dairy ewes on milk production. R. M. S. Emediato*, E. R. Siqueira, M. M. Stradiotto, S. A. Maestá, and A. Piccinin, São Paulo State University, Botucatu, São Paulo, Brazil.

Little is known in Brazil about milk production of ewes. As wool and meat production have become important activities in the country, an increasing interest in milk production is observed. Thus, the objective of the present work is to evaluate the effect of the use of bypass fat in the diet of Bergamasca dairy ewes on milk production. Eighty ewes were divided into 2 blocks according to parturition and age. Within each block, half of the animals received either one of two treatments: A – balanced diet (concentrate + corn silage) without bypass fat; and B – same diet as in A with added bypass fat (35g/ewe/day). In both blocks, the lambs were kept with their mothers in pasture during daytime and were separated at night. The lambs were returned to their mothers after the morning milking and were weaned at 45 days of age. The ewes were machine-milked starting 48 hours after parturition, once a day,

at 7h A.M., for 60 days. Diets were isoenergetic and isonitrogenous, containing 22% CP and 66% TDN on a dry-matter basis. The statistical analysis was performed by means of SAEG 9.0 (System for Statistical and Genetic Analyses). Statistical differences were not observed ($P > .05$) between treatments for average daily milk production until 45 days; however, after 45 days, treatment B showed a higher ($P < .05$) milk yield in comparison to A (540 vs 502 g/ewe/day). This result may be attributed to the use of diet with bypass fat, which supposedly provided better absorption of unsaturated fatty acids in the small intestine.

Key Words: Unsaturated fatty acids, Dairy sheep, Milk yield

413 The effect of feed delivery time on dairy cattle production. C. J. Furedi*, A. D. Kennedy, and J. C. Plaizier, University of Manitoba, Winnipeg, MB, Canada.

Changing the delivery of fresh feed from the morning to the evening has shown improvement in average daily gain as well as in feed:gain ratio in beef cattle. This could be due to reduced heat stress in the summer and reduced cold stress in the winter with PM feeding. However, research in a thermal neutral environment demonstrated a trend towards higher milk fat in dairy cows fed fresh total mixed ration (TMR) at 9 pm compared to cows fed at 9 am. To confirm this result, a 6 wk feeding trial with two groups of 14 lactating Holstein cows was conducted using a randomized complete block design. Cows received fresh TMR (97% DM, 18% DM CP, 36% DM NDF) at 9 am or 9 pm for ad libitum feeding allowing between 5 and 10% orts. Subcutaneous fat (back & hip) measurements were made using ultrasound at the beginning and end of the trial. Dry matter intake (24.36 kg/d), milk yield (42.9 kg/d), milk fat percentage (2.2%), milk protein percentage (3.3%), BW (645 kg), BCS (2.9) averaged across weeks and treatments were not affected by time of feed delivery. By the end of the trial, subcutaneous fat level of PM fed cows (1.53 ± 0.35 mm) was 2 times that of AM fed cows (0.77 ± 0.35 mm) but the treatment effect was significant only at $P = 0.18$. A significant effect might be found with a larger number of cows and a longer treatment duration since subcutaneous fat variation was large. The above results suggest a possible improved efficiency of energy utilization with PM feeding since the PM fed cows tended to lay down more subcutaneous fat while producing the same amount of milk fat as the AM fed cows. Milk fat percentage decreased from 2.5% to 1.7% from wk 1 to wk 6, even though the composition of the TMR was constant. The milk fat results suggest that the cows were sorting the TMR which had a high dry matter content. Also, the absence of a milk fat response to PM feeding might relate to the milk fat depression that occurred during the study.

Key Words: Time of feeding, Milk production, Subcutaneous fat

414 Impact of providing total mixed ration at evening vs. morning on feed intake, rumen pH, and productivity of lactating Holsteins. A. Nikkhah*, J. C. Plaizier, C. Furedi, and A. D. Kennedy, University of Manitoba, Winnipeg, MB, Canada.

The impacts of providing fresh total mixed ration (TMR) either at 0900 or at 2100 h on lactation performance were studied using four multiparous (645 ± 75 kg BW; 90 ± 33 days in milk) and four primiparous (576 ± 46 kg BW; 77 ± 25) Holstein cows. A cross-over design with two 6-week periods was used. The first 3-week of each period were for adaptation and the last 3-week for data collection. The TMR contained a 50% concentrate on a dry matter basis. Rumen fluid

was sampled at 0000 and 1200 h at day-5 of week-5 via rumen cannula from four cannulated cows (3 primi- and 1 multiparous) and using oral probe from four non-cannulated cows. Cows were milked twice daily at 0430 and 1630 h. Nutrient digestibility was measured using total fecal collection technique during week-4. Results were analyzed with SAS (v. 9.1) as a linear mixed model including the fixed effects of time of feeding, parity, and time of feeding \times parity; and the random effects of cow within parity and period. Provision of fresh TMR at 2100 h instead of 0900 h enhanced dry matter intake in primiparous cows (20.7 vs. 18.5 ± 0.96 kg/d, $P < 0.05$) but not in multiparous cows (20.6 vs. 21.0 kg/d), and improved the apparent total tract digestibility of dry matter (63.4 vs. $60.6 \pm 0.63\%$, $P < 0.01$), NDF (50 vs. $45 \pm 0.6\%$, $P < 0.001$), and ADF (45 vs. $41 \pm 1.3\%$, $P < 0.05$) in all cows. Time of

feed delivery did not affect milk yield, milk protein yield, and rumen pH. Milk fat yield tended to increase (1.1 vs. 0.96 ± 0.05 kg/d, $P = 0.07$) when cows were fed at 2100 h instead of 0900 h. Rumen pH was lower at 3 h postfeeding than at 15 h postfeeding (6.21 vs. 6.40, $P = 0.01$). No interactions were found between the time of feed delivery and time of rumen sampling on rumen pH. Results suggest that evening rather than morning provision of fresh TMR can improve feed intake, milk fat, and nutrient digestibility. Parity appears to affect the impact of time of feeding on cow performance, notably feed intake and milk protein.

Key Words: Time of feeding, Productivity, Lactating Holsteins

415 Beef cattle diets and forage optimization strategies on western

Ruminant Nutrition: Identifying Opportunities for Maximizing Forage Utilization?

rangelands. T. DelCurto*, *Oregon State University, Union.*

Beef cattle distribution and use patterns are a continual challenge for livestock and land managers in the western US. Designing grazing management plans that optimize animal performance while maintaining or improving native vegetation are critical goals of land managers. To achieve these goals, the manager needs to understand how biotic (cow age, breed, stage of production, experience, etc) and abiotic (slope, aspect, vegetation type, soil depth, etc.) factors influence grazing distribution and diet selection. Pasture distribution and diet selection of beef cattle are influenced by the animal's nutritional requirements and the availability, palatability, and nutritional quality of the vegetation. The availability of water and the diurnal pattern of grazing relative to water location clearly illustrate the importance of water and associated vegetation in beef cattle thermal regulation and grazing distribution. However, the role of vegetation quality (CP, NDF, ADF, IVDMD, and DM), in predicting beef cattle distribution and use patterns, is less clear. In comparison to other herbivores, cattle have strong preferences for herbaceous vegetation even when woody vegetation is superior in nutrient density. Changes in vegetation are a function of landscape characteristics and, as a result, are often confounded with attributes such as elevation, topography, aspect, slope, and surface water. Past research has documented grazing behavior differences due to breed, age, and lactation status, suggesting that beef cattle nutrient requirements also influence grazing distribution and use patterns.

Key Words: Beef cattle, Rangelands, Diet quality

416 Nutritional management strategies for efficient utilization of forage resources. F. T. McCollum*, *Texas A&M University, College Station.*

The descriptors efficient and sustainable are used in the narrative describing this symposium. Efficiency and sustainability can be discussed in both biological and economical terms. Because of the inter- and intra-year fluctuations in climate, the quantity and quality of forage and the environmental stressors on grazing cattle are never identical from one year to the next. Hence it is a complex and difficult task to optimize efficiency. Perhaps a more important objective is to manage production risk so that actual production outcomes may approximate projections and over time the business enterprise is economically sustainable. Nutritional management is a key part of a production risk management program in beef cattle systems that

rely upon grazed forage. Supplemental feeding is the most common means of managing risk associated with variations in forage quality and availability. Strategic supplementation decisions should address quantity and quality of available forage, timing of supplementation within the year to achieve the greatest response, method of delivery, and herd management to reduce supplement inputs. In addition, efficient use of the forage resource may also address landscape utilization issues. Placement and delivery of supplements can be used to influence grazing patterns and therefore efficient landscape use. With increased land values, labor, equipment and fuel costs, cattle producers must begin to address nutritional management with more year-to-year flexibility in order to attempt to optimize their programs based on a landscape.

Key Words: Nutrition, Beef, Forage

417 Nutritional wisdom revisited: From instinct to experience with implications for use of forages by herbivores. F. D. Provenza*, *Utah State University, Logan.*

During the past century, the notion of nutritional wisdom – referred to as “genetic programming” of ingestive behavior and as the “subconscious but irresistible desire” to restore biochemical equilibrium – was discounted when researchers found lactating dairy cows did not instinctively ingest recommended levels of calcium and phosphorus when offered dicalcium phosphate, sheep did not rectify a phosphorus deficit by consuming supplemental dicalcium phosphate, and dairy cows offered choices did not consistently select appropriate minerals and vitamins, though the cows fed different diets did not perform differently during 16-week trials. Finally, when lambs did not eat sufficient amounts of minerals, and because they tended to over-consume some minerals, researchers recommended feeding a complete ration, or if that is not possible, to offer free choice a complete mineral mix. Collectively, these studies fostered the notion that domestication had erased “nutritional wisdom” and the “innate ability” to select needed nutrients, a trait that through evolution still confers survival value to wild herbivores. These conclusions should be reconsidered in light of current understanding of how nutritional wisdom is likely to be manifest. It is unlikely several million years of evolution have been erased by a few thousand years of domestication. Acquiring nutrients and avoiding toxins is as important as breathing, which has not changed due to domestication. Indeed, mechanisms for detecting and correcting

amino acid imbalances appear to be conserved in animals ranging from single cell-organisms such as yeast, to invertebrates, to humans. To understand nutritional wisdom, and its implications for maximizing forage use in cattle diets, we must consider how animals learn flavor-feedback associations, including the roles of past experience and the familiar-novel dichotomy, discrimination and generalization, initial conditions, and the many dynamic contingencies that apply when animals learn flavor-feedback associations.

Key Words: Nutritional wisdom, Learning, Foraging

418 Forage intake, digestion and milk production by dairy cows.

R. Shaver*, *University of Wisconsin, Madison.*

Intake by dairy cows is influenced by NDF content and in vitro NDF digestibility (NDFD, % of NDF). Data from the literature suggest that a one-percentage unit increase in NDFD at the same NDF content will increase DMI 0.12 to 0.17 kg/d. Neither NDF content nor NDFD are included in the Dairy NRC (2001) intake prediction equations. The Dairy NRC (2001) summative energy equations are based on fiber digestibility calculated using lignin, but in vitro NDFD measurements can be used directly also. Data from the literature suggest that at production levels of intake, NDFD has minimal impact on net energy content, but impacts net energy intake primarily through effects on DMI. Inclusion of NDFD in nutritional models will thus require a dynamic modeling approach. In vitro NDFD values are highly variable among and within forage types, and this variation will be reviewed. Introduction of low-lignin, brown midrib hybrids for production of corn and sorghum silages has widened the range for NDFD in these forage types. Data from the literature show milk production responses from varying forage NDFD, but trials were conducted primarily with corn or sorghum silages. There have been some recent trials conducted with wheat straw or alfalfa hays that report conflicting lactation

performance results. Intake, digestion and milk production responses to NDFD among and within forage types will be reviewed.

Key Words: Forage, NDFD, Dairy cows

419 Forage feeding in relation to animal and human health. T. R. Dhiman*, *Utah State University, Logan.*

The current strategies of feeding high starch, low forage diets to maximize milk production and yields of milk components in dairy cows have led to higher cull rates, lower reproductive efficiency, lower milk components, and higher veterinary costs. On most dairy farms annual culling rates exceed 30-35% of the herd. About 85% of the cows are culled due to reproduction problems, disease or injury, mastitis or udder problems, feet and legs, or death. High quality forages are the key to achieving a healthy and productive cow. The objective of this presentation is to review the importance of feeding high quality forages or fibrous feeds on animal's life time production, health, reproductive performance and nutritional quality of milk and meat. Milk and meat from animals raised on forages has been shown to have high levels of vitamin E, beta-carotene, conjugated linoleic acid, omega fatty acids and have higher proportions of unsaturated fatty acids compared with milk and meat from animals raised on high grains. The effect of nutritional quality of milk and meat on human health will also be discussed. Consequences of feeding high forage diets on animal productivity will be compared with feeding high grain diets. Feeding strategies to maximize the use of forages while maintaining milk production and milk and meat quality will be suggested based on the review of literature.

Key Words: Forage, Cow, Milk

Teaching/Undergraduate and Graduate Education: Student Engagement: The Classroom and Beyond

420 Using the National Survey of Student Engagement to understand students' experiences in the agricultural and related sciences. T. Nelson Laird*, *Indiana University, Bloomington.*

After defining student engagement and explaining why it is important for undergraduate education, this presentation will draw on data collected through the National Survey of Student Engagement (NSSE) to better understand student engagement in the agricultural and related sciences and how it compares to student engagement in other fields of study. NSSE results suggest that on average agriculture students participate in active and collaborative learning experiences less than students in other fields and that their coursework emphasizes high-order thinking skills (e.g., analyzing and synthesizing course material) less than the coursework of students in other fields. However, agriculture students tend to report slightly greater levels of student-faculty interaction and a greater sense of support from the campus environment. The presentation will conclude with a discussion of implications from the NSSE findings and suggestions for improving student engagement

in agriculture that draws on examples and "best practices" collected from campuses across the country.

Key Words: Student engagement, National Survey of Student Engagement, Disciplinary comparisons

421 Active and collaborative learning. J. Swanson* and J. McClaskey, *Kansas State University, Manhattan.*

Two types of teaching have traditionally dominated the agricultural sciences. The first is learning for the purpose of accumulating knowledge typically measured by student recall of teacher-presented information. The second type of teaching often takes place in a laboratory and is best described as learning by doing. In recent years there has been a revolution in college teaching spawned by discoveries made in the cognitive and neurosciences about learning. The primary pedagogical shift is from the language of teaching students to that of student learning. The development of active and collaborative learning

methodology is a result of understanding the nature of how students perceive and process information. Active learning includes the analysis, judgment, synthesis, and application of knowledge. While active learning builds skill in the use of knowledge, collaborative learning also requires students to learn from each other. Collaborative learning includes problem solving, team work, caring, and interpersonal skills. Both methods can be successfully employed in small or large classes to enhance student learning. We will give examples of how both approaches to learning have been used in an animal science and a professional ethics course.

Key Words: Learning, Active, Collaborative

422 Strategies for engaging students in large classes. W. E. Beal*, *Virginia Polytechnic Institute and State University, Blacksburg, VA.*

Connecting with students, especially freshmen, in a large class (>100) is critical for achieving teaching/learning success. Courses with recitations or labs allow more direct contact between teachers and students and make bonding easier. Developing a bond between the students and the faculty in Introductory Animal and Poultry Science has depended on five strategies: 1) learning students' names; 2) employing undergraduate students as teaching assistants (TA); 3) including weekend field trips; 4) inviting parents to class and 5) incorporating tips on how to succeed at college. Learning names is an obvious method of personalizing a course. Having the faculty and TAs compete in a "naming game" at the beginning of each class period early in the semester also makes the process entertaining to the students. Including undergraduate TAs (2/lab) as teachers allows the lab sections to be divided into multiple learning stations with instruction of small groups simultaneously. Undergraduate TAs also provide an approachable source of assistance. Faculty interaction with students is enhanced by increased familiarity among the students. Overnight field trips to farms, industries and livestock sales events funded by livestock producer groups provide students with an opportunity to become more familiar with their fellow students and to enhance their knowledge. Inviting parents at the annual Parents Weekend to participate in a "mock lab" where the students teach their parents livestock handling skills provides the parents with a link to their son's or daughter's college experience. Taking time from fact-filled lectures to introduce concepts such as: "what to call your professor," or "how and when to dispute grading of an exam" provides students with tips that may make their transition to college more successful. No one strategy is the key. The combined effect of all strategies makes the faculty member more open and engaging to the students.

Key Words: Teaching, Student engagement, Class size

423 Student engagement at a distance using virtual teaching assistants in the classroom and beyond. M. Latour* and K. Orvis, *Purdue University, West Lafayette, IN.*

The way to teach at a distance may include a wide range of media platforms and this can vary depending on the audience. More specifically, our studies suggest that young undergraduates (less than 20 years of age) respond poorly to instruction via teleconference and/or direct Internet instruction, coupled with go-at-your-own-pace. Conversely, the acceptance of teleconference instruction for graduate students is much higher. In order to improve online undergraduate instruction, we implemented the use of Virtual Teaching assistance and for the past 3-years, the response has been outstanding. Therefore, the purpose of this talk will be on the discussion, interaction, comfort

level, perspectives, motivation, and overall satisfaction between students in Virtual Introduction to Animal Science 101 (ANSC101V) versus a traditional face-to-face Introduction to Animal Science 102 (ANSC102) utilizing traditional and virtual teaching assistants. In general, students in ANSC101V rated questions pertaining to discussion, comfort level, student perspectives, and motivation higher when compared to students in ANSC102. However, the level of satisfaction was determined to be not different between the two classes. Because of the high rating and responses by online students, it was determined that virtual teaching assistants contributed greatly to the level of comfort and outcome in the ANSC101V course.

Key Words: Distance, Internet, Teaching

424 Enriching the educational experience through co-curricular activities. T. Klopfenstein*, *University of Nebraska, Lincoln.*

It has been my observation that student success and involvement in co-curricular activities are highly correlated. (Note this is a personal observation and therefore no r is reported.) Further a close relationship with at least one faculty member is related to student success and the overall "college experience". All humans (at least most) desire interaction with small groups of other individuals. One reason given for young people belonging to "gangs" is that it provides them a small group to be a part of. Co-curricular activities are important in providing for that need for college students. Important activities include some of the obvious — clubs and judging teams. However, four other very important activities are internships, undergraduate research projects, jobs within the department and undergraduate teaching assistants. Internships that include some class meetings increase the learning experience, develop group relationships, and develop student-faculty relationships. Most undergraduate research projects are done in a team approach with graduate students, technicians, other undergraduates and faculty which provides important relationships discussed previously. Undergraduate jobs provide similar benefits. Better to hire three students to weigh feed for cattle than to spend the money on an automated feeding system. The opportunity to experience teaching (mentoring) as an upper level student is especially beneficial. So with student success and co-curricular activities, what is cause and what is effect? Are successful students more involved or are they successful because they are involved? Our job is to get them involved.

Key Words: Students, Success, Co-curricular activities

425 The role of academic advising in student engagement. L. C. Martin*, *Oklahoma State University, Stillwater.*

Academic advising provides a unique opportunity to actively engage students in setting academic goals, identifying leadership opportunities, exploring strategies for personal and professional growth, and investigating career options. Traditionally, student engagement has focused on the classroom (active and collaborative learning, analysis and synthesis of course material, and making connections across courses and disciplines). Academic advising, however, has the potential to engage students beyond the boundaries of the traditional classroom environment and can influence the extent to which students participate in enriching educational experiences. Quality advising has been linked to a number of measures of student success including retention, GPA, student involvement, connection to the campus community and to the major, and student satisfaction. While a number of advising models exist (faculty advising, centralized advising ...), some are more effective than others in enhancing student engagement. The impact of academic

advising is further dependent upon whether the advising is prescriptive (advisor-centered) or developmental (student-centered). Students differ in the type of advising they prefer; gender, class rank and major have been shown to influence preference. Too often, the impact of advising has been undervalued and the opportunities to engage students

through advising efforts, underestimated. Effective academic advising strategies should focus on maximizing impact and should result in enriching each student's educational experience.

Key Words: Academic advising, Student engagement

Wednesday, July 12, 2006

POSTER PRESENTATIONS

Animal Behavior and Well-Being

W1 Analysis of the association of change in average daily gain of finisher pigs remaining after pulling out heavier pigs with the change in allometric space allowance. L. Anil*, S. S. Anil, and J. Deen, *University of Minnesota, St. Paul.*

The association of change in average daily gain (Δ ADG) of finisher pigs remaining after the removal of heavier pigs from pens at market BW, with change in k value (Δ k) and actual k experienced (k-EXP) was assessed. Barrows of 30kg (30.56 ± 0.15) were randomly allocated to 4 floor space treatments based on 4 values of k (0.037, 0.034, 0.031 and 0.027) calculated for the final anticipated BW of 116kg and maintained up to a market weight of 116kg. The four final space allowance treatments based on k for the anticipated 116kg BW were 0.88, 0.81, 0.74 and 0.64 m² per pig respectively. The group composition treatments included uniform (pigs of BW above 25 and below 75 percentiles) or varying BW (pigs of BW below 25 and above 75 percentiles) and the group sizes were kept constant as 19 pigs per pen. The trial was conducted in a commercial farm in Minnesota with fully slatted floor, following a 4x2 factorial design across 32 pens. All pigs had ad libitum access to feed and water and were fed Paylean (ractopamine HCl, 9g/ton of feed) during 14th wk of the trial. The k-EXP at different time periods was calculated based on weekly BW and pen area. Pigs were individually weighed at the start, bi-weekly up to 6 wk and weekly thereafter up to 17th wk of the trial. ADG was determined from weekly BW. Heavier pigs were removed from different pens at 15th, 16th and 17th wk once the respective pen average reached 116kg. The association of Δ ADG of pigs remained after removal of heavier pigs with Δ k (with respect to 14th wk) and k-EXP in the pen after 14th wk was analyzed using linear regression analysis. The association of Δ ADG with Δ k and k-EXP in the wk after the first removal of pigs (15th wk) was not significant ($P \geq 0.05$). Regression equations for Δ ADG for second (16th wk) and third removal (17th wk) of pigs were Δ ADG = $1.0668 + 32.858$ k-EXP + 30.665Δ k ($R^2=0.21$, $P \leq 0.05$) and Δ ADG = $1.0888 + 34.574$ k-EXP + 25.556Δ k ($R^2=0.37$, $P \leq 0.01$) respectively. It may be possible to determine benefit in terms of ADG while taking decision to pull out pigs if the k values at market weight are known.

Key Words: Daily gain, Space, Finisher pig

W2 The effects of different frequencies of weekly human interaction on handling responses in market hogs. J. A. Brown*¹, E. L. Toth¹, A. L. Stanton¹, T. M. Widowski¹, and P. Lawlis², ¹*University of Guelph, Guelph, Ontario, Canada,* ²*Ontario Ministry of Agriculture and Food, Guelph, Ontario, Canada.*

The effects of different amounts of human interaction on responses to humans, handling during loading and behavior pre-slaughter were studied in 1900 market hogs from two commercial operations. Pens of 15 to 24 pigs were walked once, twice or three times per week, or not at all, during the final 12 weeks of finishing. Walking the pens involved a handler with a pig board entering and walking purposefully through the pen, spending an average of 40 (± 0.39) seconds there. Responses towards humans were monitored in the home pen weekly. Handling behavior and time to load were monitored on the day of shipping and behavior in the crowd pen and chute were monitored at the packing plant. At both farms, walking the pens had a significant effect on behavior. All treatments showed a significant reduction in escape behavior over time. After eleven weeks, pigs walked twice or three times per week showed significantly less escape behavior than those walked only once per week ($P < 0.05$). The percentage of animals showing escape behavior at eleven weeks were 31.25 ± 7.8 , 12.5 ± 4.7 and 12.5 ± 4.7 (mean, \pm SE) for pens walked once, twice and three times per week, respectively. During handling at loading no significant treatment effects were observed. The truck level that pigs were loaded on had a significant effect on loading time, with pigs loaded on the top deck requiring almost twice as long to load as those on middle or bottom decks ($P < 0.05$). At the packing plant, different treatment effects were found for each farm. Handled pigs from farm 1 showed a significant reduction in jamming at the chute entrance, while handled pigs from farm 2 took less time to move through the crowd pen. We conclude that regular human interaction during the finishing period has a significant effect on behavioral responses towards humans. Walking the pens two or three times per week during the last 12 weeks before shipping had the greatest effect on behavior on-farm in the home pen, while walking pens as little as once per week showed a positive effect on handling at the packing plant.

Key Words: Pigs, Handling, Behaviour

W3 Impact of animal management and transportation factors on transport losses in market weight pigs at the packing plant. M. J. Ritter*¹, M. Ellis¹, C. R. Bertelsen¹, R. Bowman², J. Brinkmann², J. M. DeDecker¹, O. Mendoza¹, C. M. Murphy¹, B. A. Peterson¹, A. Rojo¹, J. M. Schlipf¹, and B. F. Wolter², ¹University of Illinois, Urbana, ²The Maschhoffs, Inc., Carlyle, IL.

Two studies were carried out to evaluate the effect of animal management and transport factors on transport losses. Study 1 used 35 trailer loads of pigs in a split-split-plot design with a 2 × 3 factorial arrangement of treatments: 1) time off-feed prior to loading (0 vs. 24 h) and 2) transport floor space (0.39 vs. 0.46 vs. 0.54 m²/pig). Study 2 used 37 loads in a split-plot design with a 2 × 3 factorial arrangement of treatments: 1) mixing during transport (unmixed vs. mixed) and 2) transport floor space (0.39 vs. 0.46 vs. 0.54 m²/pig). Pigs from the same farm were transported in either February-March or August-September. Floor space treatments were compared in the front three compartments on each deck of the same design of straight, double-deck trailers. Pigs were loaded using standard commercial procedures and were transported ~140 km to a commercial packing plant. Data for transport losses were not normally distributed, were transformed using the Rank procedure of SAS, and were analyzed using PROC Mixed. Time off-feed and mixing during transport had no effect on transport losses. Therefore, data from studies 1 and 2 were combined to evaluate the effects of transport floor space on transport losses. The combined data showed that transporting pigs at 0.39 m²/pig compared to 0.46 and 0.54 m²/pig increased ($P < 0.05$) non-ambulatory pigs (0.39 vs. 0.12 vs. 0.14 ± 0.09%, respectively), but did not affect deads on arrival or non-ambulatory, injured pigs at the plant. Floor space effects on the incidence of non-ambulatory, non-injured pigs and total losses at the plant varied depending on the time of year. For loads transported in February-March, there was no effect of floor space, however, for loads in August-September, pigs with 0.39 m²/pig had higher ($P < 0.05$) incidences of non-ambulatory, non-injured pigs (0.38 vs. 0.00 vs. 0.00 ± 0.08%, respectively) and total losses (0.72 vs. 0.16 vs. 0.00 ± 0.13%, respectively) than pigs with 0.46 and 0.54 m²/pig. These results confirm that floor space on the trailer has a major impact on transport losses, but suggest that the effect is dependent upon transport conditions.

Key Words: Pig, Transport, Feed withdrawal

W4 Maternal stress: Behavior and endocrine response of the progeny. J. N. Landgrebe*, N. C. Burdick, and J. C. Laurenz, *Texas A&M University, Kingsville.*

This study examined the effects of maternal stress on offspring behavior in relationship to changes in the stress response. Pregnant sows were assigned by parity to one of two treatments and managed either per current industry standards (Control; n=2) or subjected to a daily 5 min acute restraint stress from d 85 to 110 of gestation (Stressed; n=2). After farrowing, pigs (n= 12 from control sows; MC; and n=17 from stressed sows; MS) were weighed, tattooed for identification and managed similarly throughout the study. On d 18 of age, pigs were subjected to a social confrontation test by placing 3 MC and 3 MS pigs in a 1.5 x 1.5 m open field. Each pig was numbered and the test was videotaped. The behavioral elements measured per pig included: (1) sniffing; (2) threat; (3) biting; (4) fighting; (5) chasing; (6) fleeing; and (7) withdrawal. An aggression score (AS) was calculated as the sum of elements 2 through 5. To assess pig stress response, pigs were subjected to an acute restraint test and blood samples collected at 1.5, 3 and 6 min. Plasma was analyzed for cortisol (C), epinephrine

(E), norepinephrine (NE), and dopamine (D). All data was subjected to ANOVA using split-plot design. Sources of variation included treatment, time of bleed, and individual interactions. MS pigs displayed more ($P < 0.05$) sniffing than MC pigs. MS pigs had decreased ($P < 0.05$) incidents of biting and fighting, and increased ($P < 0.05$) incidents of fleeing. The AS score for MS pigs was lower ($P = 0.03$) than MC (10.9 ± 2.3 vs. 23.8 ± 6.2, respectively). The MS pigs had similar ($P > 0.05$) plasma concentrations of C, but had lower ($P < 0.05$) E, NE, D than MC pigs. For both MC and MS pigs there was a positive correlation between AS and E ($r=0.76$; $P < 0.01$), but no ($P > 0.05$) correlation between AS and NE and D. MC pigs showed a positive correlation between AS and C ($r=0.78$; $P < 0.01$). In contrast, in MS pigs there was a negative relationship between AS and C ($r=-0.61$; $P < 0.01$). Collectively, these data indicate that maternal stress reduces the normal aggressive behavior of pigs. In addition, the results suggest that the role of C in normal aggression in the pig is dependent upon concentrations of the E.

Key Words: Behavior, Maternal stress, Pig

W5 Analysis of the association of shoulder lesions during lactation with sow-level factors. S. S. Anil*, L. Anil, and J. Deen, *University of Minnesota, St. Paul.*

A study involving 162 sows was conducted to analyze the association of sow level factors with the presence or absence of shoulder lesions during lactation. The sows were housed in 4 different farms during gestation and were transported to a single facility for farrowing on 109-112d of gestation. The sow level factors considered were parity, farrowing performance (number of piglets born alive and presence or absence of stillborn and mummies), lactation length, body condition score, and lameness observed while in the farrowing crate (lame or non-lame). Body condition of all the sows was visually assessed between 110-114d of gestation on a scale of 1-5. Shoulder lesions were assessed immediately before weaning. The data were analyzed using logistic regression model. For the analysis, parity of sows was categorized into parities 1 and 2, 3 to 5 and ≥ 6 and body condition into ≤ 2 or >2. The number of piglets born alive and lactation length were included in the model as continuous variables. Since the sows were housed in 4 different farms during gestation, farm was included in the model as a random factor using Glimmix macro of SAS (v 9.1). Of the 162 sows, 54 had shoulder lesions, including 31 sows with bi-lateral lesions. Among the sows, 19 showed lameness while in the farrowing crate and 67 had body condition score ≤ 2. The average lactation length was 18 ± 0.44 days. The odds ratio (OR) indicated that the likelihood of shoulder lesions increased ($P ≤ 0.05$) by 16% with one day increase in lactation length. Sows with body condition score ≤ 2 had higher ($P ≤ 0.05$) likelihood of shoulder lesions than sows with score >2. Non-lame sows had 73% lower ($P ≤ 0.05$) likelihood of shoulder lesions. The study indicated that lameness, poor body condition and longer lactation periods are risk factors associated with the development of shoulder lesions in sows during lactation.

Key Words: Shoulder lesions, Sow, Lameness

W6 Decreasing feed tossing behavior in dairy cows by emplacing a cable in front of manger. F. Farivar*¹ and F. Kafilzadeh², ¹Gorgan University, Gonbad, Gorgan, Iran, ²Razi University, Kermanshah, Kermanshah, Iran.

This experiment was conducted to evaluate a method for decreasing feed tossing by dairy cows. Forty five lactating dairy cows were

randomly allocated to three treatments: two groups had a cable in front of their manger which was located 40 cm away from feeding fence and with either 80 or 70 cm above the standing floor of cows. The third group had no cable above their manger (control). One week after fixing the cables, feed tossing behavior of cows was directly observed during the morning feeding of a TMR ration for 10 days. Backward and forward tossing behaviors were recorded for each cow in each group. There was a highly significant difference ($P < 0.01$) between groups in both backward and forward tossing behaviors. Both groups with cables above their mangers showed lower feed tossing behavior (22 and 20 vs. 52 times backward feed tossing; and 9.2 and 4.2 vs. 25.4 forward tossing for groups with 80 cm and 70 cm height above their manger and the control respectively). Height of cable (80 or 70 cm) had no significant ($P > 0.05$) effect on the tossing behaviors.

Key Words: Dairy cow, Feed tossing, Behavior

W7 Behavioral patterns change when primiparous cows are mixed with multiparous cows. C. Iglesias^{*1}, A. Bach^{2,3}, M. Devant³, X. Manteca⁴, S. Calsamiglia⁴, and A. Ferret⁴, ¹SEMEGA, Spain, ²ICREA, Spain, ³IRTA-Unitat de Remugants, Spain, ⁴Universitat Autònoma de Barcelona, UAB, Spain.

Forty six multiparous and 80 primiparous cows (PPC) were used over a 5-mo period to evaluate the effects of grouping strategy of PPC on behavioral patterns. On average, the number of lactating cows across the study was 100, evenly distributed according to DIM and production in 2 symmetrical pens, maintaining a ratio of cows to feeding places of 1.78. One pen was composed exclusively of PPC (PP) whereas the other (PM) included 30% PPC and 70% multiparous cows. All cows on each pen were observed twice daily (from 1100 to 1300 and from 1600 to 1730) by the same person from an observing platform every 10 d and the occurrence of drinking, fighting, licking, self grooming, ruminating, sleeping, and walking behaviors of PPC were recorded (total hours of observation was 59.5 h). A Poisson regression model including treatment, and DIM as fixed effects, day as a repeated measure, and cow as a random effect assuming an equal-correlation variance-covariance structure was used. The incidence rate ratios (IRR) were calculated to describe the probability of occurrence of a particular behavior in the PP group relative to the PM group ([incidence rate in PP] / [incidence rate in PM]). The incidences of fighting (0.95%), licking (0.95%), and self grooming (5.0%) behaviors were not different in PP than in PM. Also, proportion of observations corresponding to walking (3.7%) or sleeping (5.1%) activities were similar in both PP and PM cows. However, in the PM group, 1.8% of the total observations of PPC corresponded to drinking activities, whereas in the PP group the figure was 3.4%, which resulted in an IRR for the drinking behavior of 2.0 ± 0.56 ($P < 0.05$). Similarly, in the PM group, 43.8% of the total observations of PPC corresponded to ruminating activity, with an IRR for ruminating behavior of 1.16 ± 0.06 ($P < 0.01$). It is concluded that separating PPC from multiparous cows resulted in increased drinking and ruminating activities with no changes in self grooming or aversive behaviors.

Key Words: Cattle, Behavior, Grouping

W8 The impact of machine milking on milk production traits and blood cortisol in primiparous dairy ewes. S. P. G. Rassu¹, E. A. Cannas², P. Nicolussi², P. Bonelli², and G. Pulina^{*1}, ¹Dipartimento di Scienze Zootecniche - University of Sassari, Sassari, Italy, ²Istituto Zooprofilattico sperimentale per la Sardegna, Sassari, Italy.

In Sardinian dairy flocks, machine milking starts at about 30 days post-partum, after lamb weaning. This is a stress factor, especially in primiparous ewes that are exposed to this practice for the first time. The objective of the trial was to evaluate the effect of milking parlour training before weaning on milk production traits. One week before weaning, six ewes (group A) and their lambs were introduced into the milking parlour and hand-milked once a day, to adapt them to the new environment and noise of the milking machine. Seven ewes (group B) were hand-milked once a day outside the milking parlour until weaning. Milk yield was recorded and milk samples were collected at each milking for the first 10 days of machine milking for fat, protein and somatic cells count (SCC) analysis. Blood samples were collected every day soon afterwards the morning machine milking and analyzed for cortisol levels. Data were analyzed using group and sampling as fixed factors and ewes within group as random factor. No differences between groups were observed in all evaluated parameters. Nevertheless, milk yield, milk fat content and yield, and SCC tended to be lower in group A than in group B. Significant interactions between group and sampling date were observed for all milk traits. Blood cortisol levels were not affected by the treatments during the first 10 DIM. The results suggest that a week of training in the machine parlour did not allow to reduce the stress caused by machine milking and weaning in primiparous ewes. Funded by the BenOLat (MiPAF) project.

Table 1. Milk production traits and blood cortisol levels (mean±se).

	Milk yield g/d	fat %	fat yield g/d	CP %	CP yield g/d	SCC *1000/ml	cortisol ng/ml
Group A	1755±175	4.4±0.2	75±8	4.7±0.2	81±8	77±1	29±2
Group B	1946±162	4.7±0.2	91±7	4.5±0.1	88±8	93±1	29±2
Significance							
Group	ns	ns	ns	ns	ns	ns	ns
Sampling	**	**	**	ns	**	**	ns
Group x Sampling	**	**	**	**	**	**	ns

CP = crude protein; SCC = somatic cells count; ns = not significant; ** significant at $P < 0.01$

Key Words: Animal welfare, Sheep management, Dairy sheep

W9 Regional differences in sweat rate response of steers to short-term heat stress. D. E. Spiers^{*1}, L. E. Wax¹, B. Scharf¹, and G. E. Aiken², ¹Univeristy of Missouri, Columbia, ²USDA-ARS, Forage-Animal Production Research Unit, Lexington, KY.

A preliminary study was performed to determine the sweat rate response to short-term heat stress using a new portable detector. Six angus steers (319.5 avg bw) were placed in two chambers maintained at 16.5 – 18.8C air temperature (T_a) within the Brody Environmental Center at the University of Missouri. Cold chamber T_a was lowered to 8.1C and T_a within the hot chamber was increased to 32.7C over a 24h period. Measurements at selected time periods included air and rectal temperatures, along with respiration rate, as indicators of thermal strain. Skin temperature was measured at shoulder and rump locations with determination of sweat rate using a Vapometer (Delfin Technologies Ltd, Finland). Rectal temperature did not change in cold or hot

locations due to a known lag in this response, and to effectiveness of thermoeffector mechanisms. Respiration rate nearly doubled in the heat ($P < 0.05$) to maintain this core temperature. Best fit for this relationship was a fourth-order polynomial relationship ($R^2 = 0.87$; $P < 0.0001$). This increase occurred at a T_a above 24°C. Skin temperatures at the two locations were highly correlated with each other and with T_a . In contrast, sweat rate was different at rump and shoulder sites, and affected by T_a . Sweat rate of the rump exhibited only a small increase with T_a , and showed no signs of a sharp increase. However, sweat rate at the shoulder increased more than 4-fold at T_a and shoulder temperatures above 27 and 36°C, respectively. Increased sweat rate in this region is supported by an earlier report of a higher density of sweat glands in the shoulder compared to rump regions. Sweat rate was correlated with several thermal measurements to determine the most likely predictor and stimulus for this response. Fourth-order polynomial expressions for rectal, shoulder and air temperatures produced R^2 values of 0.37, 0.72, and 0.97, respectively. This suggests that thermal inputs, other than rectal or shoulder temperatures, drive the sweat response in the shoulder.

Key Words: Cattle, Heat stress, Sweat

W10 Blood indicators of stress are not affected when primiparous cows are mixed with multiparous cows. C. Iglesias^{*1}, A. Bach^{2,3}, M. Devant³, X. Manteca⁴, S. Calsamiglia⁴, and A. Ferret⁴, ¹SEMEGA, Girona, Spain, ²ICREA, Barcelona, Spain, ³Unitat de Remugants-IRTA, Barcelona, Spain, ⁴Universitat Autònoma de Barcelona (UAB), Barcelona, Spain.

A total of 142 lactating Holstein cows (52 multiparous and 90 primiparous) were used over a 10-mo period to evaluate the effects of grouping strategy of primiparous cows (PPC) on potential stress indicators in blood. On average, the number of lactating cows across the study was 100, evenly distributed according to DIM and production in 2 symmetrical pens, maintaining a ratio of cows to feeding places of 1.78. One pen was composed exclusively of PPC (PP) whereas the other included 30% PPC and 70% multiparous cows (PM). All PPC were blood and milk sampled at 3, 10, 24 DIM and monthly afterwards, to determine cortisol, serum amyloid A (SAA), haptoglobin, and NEFA in plasma, and amyloid A in milk. Milk production and DMI were monitored daily. Data of PPC were analyzed using an unbalanced (PP = 67; PM = 23) mixed-effects model with repeated measures. Milk production (25.9 vs 25.6 ± 0.8 kg/d) and DMI (18.7 vs 18.1 ± 0.9 kg/d) were similar in both PM and PP, respectively. Plasma NEFA, cortisol, and SAA concentrations were similar in PP and in PM (0.18 ± 0.01 mM, 16.83 ± 1.41 ng/ml, and 35.63 ± 1.11 µg/ml, respectively). However, NEFA concentrations were highest (0.34 ± 0.02 mM) during the first 24 DIM, and SAA during the first 95 DIM (45.15 ± 1.22 µg/ml) than in later stages of lactation (0.13 ± 0.02 mM and 27.93 ± 1.21 µg/ml, respectively). Plasma cortisol concentrations did not change with lactation stage. Plasma haptoglobin concentrations were not affected by grouping strategy but were highest (0.31 ± 0.13 mg/ml; $P < 0.01$) during the first 95 DIM in both PP and PM. Milk amyloid A concentration was positively correlated with SAA although the correlation was not strong ($r^2 = 0.34$, $P < 0.001$). It is concluded that either the grouping strategy had no effect on stress of PPC as production and intake were not affected, or if stress was present, the studied blood parameters were not useful indicators of it.

Key Words: Stress, Social behavior, Cattle

W11 Automatic monitoring of lying, standing and walking behavior in dairy cattle. L. Munksgaard¹, C. G. Reenen², and R. Boyce^{*3}, ¹Danish Institute of Agricultural Sciences, Research Centre Foulum, Denmark, ²Animal Sciences Group of Wageningen University and Research Centre, Lelystad, The Netherlands, ³IceRobotics, Roslin BioCentre, Scotland.

Management and housing can have important impact on locomotor activity and lying behavior in cattle, and this can affect the welfare of the animals. However, large scale as well as long-term studies have been limited since both direct observations and analysis of video recordings are very time consuming. The aim of the present study was therefore to validate the use of a new device (IceTag[®] (IceRobotics, Edinburgh, UK)) for automatic monitoring of lying, standing and walking in cows. The device is attached to the hind leg of the cow and by use of a special USB cable data can be downloaded to the IceTagAnalyser[®] software on a PC. There was a high correspondence between data recorded from different loggers attached to the left and right hind leg on the same cow ($n=6$); correlations were 0.99 for lying and standing, 0.89 for activity and 0.84 for number of steps. Lying down and getting up were recorded both by direct visual observation and by the device in two groups of six cows. Fourteen events of getting up and fifteen events of lying down were recorded by direct observation. These events were also recorded automatically. Regression analysis showed that duration of lying bouts obtained by direct observation could be reliably predicted by duration of lying bouts recorded automatically. In a third experiment 90 bouts of standing and 89 bouts of walking were recorded by direct observation of five cows which had the device attached to the hind leg. The estimated bout length from the automatically recorded data predicted the duration of bouts of walking and standing recorded by direct observation. In conclusion, the results demonstrate that the device can be used for estimating duration and frequency of lying, standing and walking in cows with high accuracy.

Key Words: Automatic monitoring, Lying, Activity

W12 The effect of stocking rate, parity, and lameness on the short-term behavior of dairy cattle. C. T. Hill^{*1}, R. J. Grant¹, H. M. Dann¹, C. S. Ballard¹, and R. C. Hovey², ¹William H. Miner Agricultural Research Institute, Chazy, NY, ²University of Vermont, Burlington.

The objectives of the study were (1) to evaluate the effect of stocking rate (SR) on the behavior of freestall-housed dairy cattle and to identify the effect of (2) parity and (3) lameness on behavioral responses to changes in SR. Lactating Holstein cattle ($n=136$) were divided into four pens of 34 cows [11 primiparous (PP), 23 multiparous (MP)]. Each pen was assigned randomly to a SR (100, 113, 131, or 142%) in a 4×4 Latin Square design with 7-d periods. The SR was adjusted by altering access to stalls and headlocks. Six focal animals per pen (2 sound, PP; 2 sound, MP; and 2 lame, MP) were used to compare behavioral responses. Sound cows scored <3 and lame cows scored 3 or 4 on a 5-point gait-scoring scale. Observations were recorded at 10-min intervals over the last 48 h of each period. Data from one lame cow were excluded due to severe mastitis affecting her behavior during one period. Overall, lying time tended ($P=0.14$) to decrease from 51.1 to 47.4% of 24 h as SR increased from 100 to 142%. Time feeding (20.6% of 24 h) was unaffected ($P=0.99$) by SR, but meals per day increased ($P=0.01$) as SR increased. Although total time ruminating (35.0% of 24 h) was not affected ($P=0.19$) by SR, ruminating while standing in the alley increased ($P=0.03$) from 2.1 to 4.4% of 24 h at

the expense of ruminating while lying ($P=0.12$). Time spent standing in the alley without ruminating increased ($P=0.03$) from 5.6 to 8.2% of 24 h as SR increased from 100 to 142%. Parity and lameness had little effect on behavioral responses to changes in SR. However, lame cows tended ($P=0.09$) to spend less time ruminating than sound cows when SR increased. In summary, focal animals tended to spend less time lying, less time ruminating while lying, and more time standing in alleys as SR increased. The interaction of parity or lameness with SR had minimal effect on short-term behavior except for a tendency for lame cows to ruminate less than sound cows as SR increased.

Key Words: Stocking rate, Behavior, Lameness

W13 Age at transport effects on behavioral responses in dairy calves to novel stimuli. S. D. Eicher*¹, T. A. Johnson^{1,2}, and J. N. Marchant-Forde¹, ¹USDA-ARS, West Lafayette, IN, ²Purdue University, West Lafayette, IN.

This study evaluated the effects of age at transport on behavioral response to novel stimuli within a test environment. Eighteen Holstein calves were randomly assigned to treatments according to age at d of transport; 2 to 3-d-old (young, Y), 4 to 5-d-old (moderate, M), or 6 to 8-d-old (old, O). Each calf was transported for 6 h (d 0). Then calves were placed in outdoor hutches until d 39 when they were moved to the USDA-ARS Livestock Behavior Research Unit for behavioral testing on d 43 (6 wk after transport). A 21.3 m corridor was designed with several novel objects spaced approximately 2.4 m apart; including an entry, red bucket, black mat, translucent plastic curtain, horizontal striped plank, darkened space, silver gates, reflecting metal, and open red gate to finish. Force was measured by 1=yelling; 2=moving into flight path; 3=pats; or 4=pushing to pass the obstacle. Calves went through the corridor once on d 43, then 3 times on d 44, 45, and 46. Data for the first experience with the corridor were reported previously, in which the Y calves tended to take longer to cross the first corner with a bucket than O calves and less force was needed to pass the second corner, for Y compared to M calves. All time data were analyzed using Mixed procedure and force data were analyzed using the Fisher's exact test in the Frequency procedure of SAS. Run time decreased with replication for the curtain, grate, dark and reflective metal ($P<0.05$). The silver gate and reflective metal were passed more quickly by the M than the Y or O calves ($P<0.05$). Force required to enter the corridor on d 44 was greatest for the Y calves on replicates 1 and 2 ($P=0.01$). Only on the 3rd run on d 46 did the Y calves require more force to pass the curtain than the M calves ($P<0.05$). On d 45 run 3, the O calves required more force ($P=0.04$) to pass the final gate than the M calves. These data show that age at transport affects behavioral responses up to 6 wk after transport.

Key Words: Calves, Behavior, Transport

W14 Effects of age and milk allowance on responses to abrupt weaning in dairy calves. K. Ito, T. J. DeVries*, M. A. G. von Keyserlingk, and D. M. Weary, *Animal Welfare Program, The University of British Columbia, Vancouver, Canada.*

Much recent interest has focused on alternative feeding programs for milk-fed calves, but little is known about how these calves can best be weaned. The objectives of this study were to quantify the effects of age and milk allowance on responses to abrupt weaning. Thirty-six Holstein calves were randomly assigned to either ad libitum or restricted (10% BW) access to milk and weaned at either 4 or 8 wks of age. Calves were reared in a group pen with milk provided by a computer-controlled

feeder. Grain and water were provided ad libitum. Time standing and number of visits to the milk feeder were monitored from 1 wk before weaning until 3 d after weaning. Body weight was recorded automatically each time calves visited the feeder. An average of the pre-weaning values was used as a baseline in comparing responses post weaning. All calves showed strong behavioral responses to weaning, including an increase in standing time (9.5 ± 0.2 vs. 6.9 ± 0.2 h/d; $P < 0.001$) and a dramatic increase in feeder visits (61.7 ± 3.8 vs. 13.9 ± 3.7 visits/d; $P < 0.001$) during the 24 h after weaning. The restricted-fed calves tended ($P < 0.1$) to return to baseline values for these behaviors faster than the ad libitum-fed calves, but weaning age had little effect. Calves weaned at 8 wks of age from the restricted ration gained 0.74 ± 0.23 kg/d before weaning and actually tended to gain more (1.12 ± 0.15 kg/d; $P = 0.06$) during the week after weaning. However, all calves fed ad libitum and all calves weaned at 4 wks experienced a growth check at weaning. The growth rate of these calves decreased ($P < 0.05$), on average, from 0.82 ± 0.08 kg/d before weaning to 0.18 ± 0.09 kg/d during the week after weaning. In conclusion, all calves showed a distress response to abrupt weaning, but calves weaned early and from higher milk rations show increased behavioral responses and the greatest reductions in ADG in the days after weaning. These results illustrate the need for alternative weaning practices to accompany new milk-feeding methods.

Key Words: Milk allowance, Weaning, Dairy calves

W15 Use of recycled paper (news/office) and straw as bedding and their effects on heifer cleanliness and behavior. J. E. Wohl*¹, D. B. Imwalle, and L. S. Katz, *Rutgers University, New Brunswick, NJ.*

Recycled paper products were compared with straw (STR) as bedding in two 4 wk trials with Holstein heifers in a loose housing system. Pens consisted of a scrape alley (3.0 x 3.6 m) and bedded pack (3.6 x 4.6 m). In Trial 1, eight pens of 5 heifers (average weight 320 kg) were bedded with STR or hammer-milled newspaper (HNP; 2.54 cm screen). In Trial 2, six pens of 38 heifers (6-7 animals/pen; average weight 211 kg) were bedded with STR, shredded newspaper (SNP), or shredded office paper (SOP). Initial bedding provided a 5.08 cm cushion for a lying heifer. Moisture content of bedded pack was recorded daily using an 81.3 cm Farmex[®] probe and clean bedding added if moisture exceeded 30%. Heifer cleanliness (scale 1 clean to 5 dirty) was recorded on Days 0, 7, 14, 21, and 28. Heifer behavior was recorded once daily as location (scrape alley, bedded pack) and position (lying, standing). Bedded packs were sampled on Day 28 for nutrient content. Data were analyzed using repeated measures or ANOVA using NCSS[®] software. Moisture content of bedded packs increased with day ($P < 0.05$) but did not differ with bedding type (Trial 1: 37.6%; Trial 2: 42.6 - 43.5%). Amount of bedding used per pen differed ($P < 0.05$) with bedding type (Trial 1: STR 164 kg, HNP 179 kg; Trial 2: STR 443 kg, SNP 464 kg, SOP 334 kg) due to density. Cleanliness scores increased ($P < 0.05$) with Day in Trial 1, but decreased ($P < 0.05$) in Trial 2. Bedding type influenced ($P < 0.05$) cleanliness score (Trial 1: STR 1.7, HNP 1.6; Trial 2: STR 2.8, SNP 2.3, SOP 2.5). Ammonia-N content of bedded pack differed ($P < 0.05$) with bedding type in Trial 2 (STR 0.098%, SOP 0.017%, SNP 1.96%). The pH content of clean bedding (STR 6.8, SNP 7.7, SOP 9.9) was a factor. Bedding type did not affect heifer behavior ($P < 0.05$). These experiments suggest that use of paper products compared to STR result in cleaner animals; however, amounts used and waste content can vary with bedding type or processing of paper product.

Key Words: Heifer, Bedding, Cleanliness

W16 Hair whorls locations of dairy heifers affects their growth, but not behavior. J. Broucek^{*1}, S. Mihina¹, M. Uhrincat¹, C. W. Arave², P. Kisac¹, and A. Hanus¹, ¹Research Institute of Animal Production, Nitra, Slovakia, ²Utah State University, Logan.

We tested hypothesis that growth, time solving the maze (TSM) and number of grid crossings (GC) in open-field tests (OFT) are affected by the height location of facial whorl in heifers. 58 Holstein heifers were used. They originated from 2 sires. Differences between sire lineage's were not significant in any trait. Whorl placement was recorded by one person as each heifer entered the scale as hair whorl (HW) high (if the whorl was above the top of eyes), middle (if the whorl center was located between the top of the eyes and the bottom of the eyes) and low (if the center was located below the bottom of the eyes). Heifers were kept in hutches and fed 6 kg milk replacer (0.6 kg powder) per d until 8 wks. After weaning all heifers were kept in loose housing pens according to age and size, regardless the HW positions. Equal conditions of nutrition were ensured. Experimental conditions were as follows: The maze tests were performed in the indoor space at the age of 15 wks. Animals were deprived of concentrate prior to maze tests. A bucket with 1 kg of concentrate was placed at the exit. The heifers had to solve 2 tasks on two consecutive days. On the first day, the passage was open on the left side, and on the right side on the second day. Before the first test was one training run. Each day, the heifers were tested 4 times, TSM was measured from video tape. OFTs (one 5-min test, morning) were conducted at 16 wks and 18 months in an inside arena, visually and acoustically isolated from other animals. Number of GC were recorded. The data were analyzed using a GLM/ANOVA. We did not find any significant differences in behaviors. Heifers with a high hair whorl were the fastest during the maze tests and they had the highest GC at the both ages. Heifers with a high HW had the highest BW at days 360 ($P < 0.05$) and 540 ($P < 0.01$) and ADG from birth to 21 months ($P < 0.001$) and from the 6th to 21st months ($P < 0.01$) of age. We found that the growth was influenced in dairy cattle by height of their facial whorl, but the time of solving the maze and the locomotive activity in open-field testing was not.

Key Words: Dairy heifers, Hair whorl, Growth

W17 Effect of transport for up to 24 hours followed by twenty-four hours recovery on liveweight, physiological and hematological responses of bulls. B. Earley^{*}, D. J. Prendiville, and E. G. O' Riordan, Teagasc, Grange, Beef Research Centre, Dunsany, Co. Meath, Ireland.

The objective of the study was to investigate the effect of road transport on liveweight, physiological and hematological responses of bulls after journeys of 0, 6, 9, 12, 18 and 24h. Eighty-four continental x bulls (mean weight (s.d.) 367 (35) kg) were randomly assigned to one of six journey (J) times of 0 (0km), 6 (280km), 9 (435km), 12 (582km), 18 (902km) and 24h (1192km) at a spatial allowance of 1.02m²/bull. Blood samples were collected by jugular venipuncture before, immediately after and at 1, 2, 4, 6, 8, 12 and 24h. Bulls were weighed before, immediately after, and at 4, 12 and 24h. Blood samples collected into heparinized tubes were centrifuged and the plasma separated for subsequent analysis of: globulin, albumin, total protein, and creatine kinase. The hematological variables including red blood cell number (RBC), hemoglobin (Hb), hematocrit (packed cell volume (PCV)), mean cell volume (MCV), white blood cell (WBC) count, number of lymphocytes and neutrophils were determined for unclotted (K₃EDTA) whole blood. There were no differences ($P \geq 0.05$) in rectal body temperature, pre- and post-transport, or liveweight among treatments on days 0 (pre-transport). Bulls traveling for 6, 9, 12, 18 and 24h lost 4.7, 4.5, 5.7, 6.6 and 7.5 percentage liveweight compared with the -24h baseline. There was no change ($P \geq 0.05$) in globulin, albumin, total protein, or creatine kinase concentrations before or after transport. Neutrophil numbers (mean \pm s.d) were greater ($P \leq 0.01$) in all transported animals post-transport (J6, 55 \pm 6.7; J9, 60 \pm 10.1; J12, 48 \pm 16.8; J18, 46 \pm 10.9, J24, 48 \pm 6.9) and counts returned to baseline by 24 hours for the J6 (30 \pm 15.0), J12 (34 \pm 9.3), J18 (36 \pm 12.1) and J24 (43 \pm 11.3) treatments. Control animals had greater ($P \leq 0.01$) neutrophil numbers at the 6, 8, 12, and 24h sampling time periods as transported animals. Transport of bulls from 6 to 24h did not impact negatively on animal welfare. In conclusion, liveweight, physiological and hematological responses of bulls returned to pre-transport levels within 24h with animals having had access to feed and water.

Key Words: Transport, Physiology, Immune response

Animal Health III

W18 Maternal stress: Effect on the stress response and immune function of the progeny. M. Reyna^{*1}, S. Martinez¹, T. H. Welsh, Jr.², J. A. Carroll³, and J. C. Laurenz¹, ¹Texas A&M University, Kingsville, ²Texas A&M University and Texas Agriculture Experiment Station, College Station, ³USDA-ARS Livestock Issues Research Unit, Lubbock, TX.

This study examined the effects of maternal stress on the stress response and immune function of the pig. Pregnant sows were assigned by parity to one of two treatments and either managed per current industry standards (Control; n=4) or subjected to a daily 5 min acute restraint stress from d 85 to 110 of gestation (Stressed; n=4). Following farrowing, pigs (n=37 from Control sows; MC; and n=31 from Stressed sows; MS) were weighed and tattooed. Pigs were subsequently reweighed at weekly intervals and average daily gain (ADG) calculated. At day 21, pigs were weaned and allowed 14 days to adapt to the new environment. Pigs were subjected to an acute restraint stress (3 min) and blood samples collected. Plasma concentrations of cortisol (C), epinephrine (E), norepinephrine (NE), and dopamine (D) were determined. To assess immune function, pigs were immunized against

keyhole limpet hemocyanin (KLH) and serum samples obtained prior to immunization (d=0), and at 3, 7, 14, 21, 28, and 35 d post-immunization. Total immunoglobulin G (IgG) and KLH-specific IgG were determined. ADG during the pre-weaning period (d 1 to 21) was lower ($P < 0.05$) in MS vs. MC pigs (222 \pm 8 vs. 247 \pm 7 g/d, respectively). Gender affected C, with female pigs having greater ($P < 0.05$) C than male pigs (72 \pm 6 vs. 50 \pm 4 ng/mL) during an acute restraint stress. There was a maternal treatment by gender interaction, with male MS pigs having C concentrations lower than MC males and similar ($P > 0.05$) to female pigs. Regardless of gender, MS pigs had lower ($P < 0.05$) levels of E, NE and D. Immunization against KLH resulted in time-dependent increases ($P < 0.05$) in both total and KLH-specific IgG, with peak concentrations occurring at d 21 and 28 post-immunization, respectively. Although not affecting the temporal pattern, MS pigs had reduced ($P < 0.05$) total and KLH specific-IgG in response to immunization. These results indicate that maternal stress can dramatically impact the stress response of the progeny with an associated detrimental effect on immune function.

Key Words: Maternal stress, Immune function, Pig

W19 Maternal stress modulates the acute stress response and immune function of the pig. N. C. Burdick^{*1}, T. H. Welsh, Jr.², J. A. Carroll³, and J. C. Laurenz¹, ¹Texas A&M University, Kingsville, ²Texas A&M University, College Station, ³USDA-ARS Livestock Issues Research Unit, Lubbock, TX.

This study examined the effects of maternal stress on the response of the pig to acute restraint stress and in vitro measures of immune function. Pregnant sows were assigned by parity to one of two treatments and managed per current industry standards (Control; n=2) or subjected to a daily 5 min acute restraint stress from d 85 to 110 of gestation (Stressed; n=2). After farrowing, pigs (n= 12 from control sows; MC; and n=15 from stressed sows; MS) were weighed and tattooed for permanent identification and managed similarly throughout the remainder of the study. At 35 d of age, pigs were restrained and blood collected initially (t = 1.5 ± 0.1 min), and at 3 and 6 min. Plasma was collected and analyzed for cortisol (C), epinephrine (E), norepinephrine (NE) and dopamine (D). To assess immune function, lymphocytes were isolated using density gradient centrifugation. Cells were plated in DME/F12 media containing Concanavalin A (ConA; 0 to 10 µg/mL) and cultures incubated for 96 hours (37C and 5% CO₂). Following incubation, IgM production and the extent of proliferation were determined. Plasma C did not differ (P > 0.05) between MS and MC pigs, and increased (P < 0.01) with duration of restraint (40±5 vs. 75±5 ng/mL for 1.5 vs. 6 min). Plasma E and NE increased with duration of restraint, (P < 0.05) and MS pigs had lower (P < 0.05) E and NE than MC pigs. In MC pigs, D increased (P < 0.05) with duration of restraint. In contrast, in MS pigs D was not affected (P > 0.05) by restraint, and D was lower in MS relative to MC (1.6 ± 0.2 vs. 2.9 ± 0.3, respectively). ConA induced dose-dependent increases (P < 0.01) in lymphocyte proliferation and IgM production. The extent of proliferation was not affected (P > 0.05) by duration of restraint. In contrast, IgM production by cultures decreased (P < 0.05) with increasing time of restraint. Regardless of duration of restraint, cultures established from MS pigs had a reduced (P < 0.05) proliferative and IgM response to ConA than MC pigs. These results indicate that maternal stress affects the stress response of the progeny which may have a negative impact on immune function.

Key Words: Acute restraint stress, Immune function, Reprogramming

W20 Non-nutrient additives alter the weaned pig's stress response to a *Mycoplasma hyopneumoniae* vaccination. J. Carroll^{*1} and K. Haydon², ¹Livestock Issues Research Unit, Agricultural Research Service-USDA, Lubbock, TX, ²Prince Agri Products, Inc., Quincy, IL.

Previously we demonstrated that the acute phase response of weaned pigs following a lipopolysaccharide challenge can be altered with non-nutrient additives. The current objective was to evaluate three non-nutrient additives as potential modulators of the stress and immune responses of pigs following vaccination for *Mycoplasma hyopneumoniae*. Pigs (n=32; 6.3 ± 0.1 Kg) were weaned at 21.4 ± 0.3 d and moved to an off-site nursery where they were weighed, blocked by BW, and assigned to one of four treatment groups: 1) Control pigs (Cont; n=8) fed a non-medicated starter ration, 2) Pigs supplemented with 0.4% of experimental blend B (Exp B, n=8), 3) Pigs supplemented with 0.4% of experimental blend C (Exp C, n=8), and 4) Pigs supplemented with 0.4% NeutroMAX (NM, n=8). NM is a proprietary blend (patent pending) with proven immune enhancing properties. Exp B and Exp C are experimental 'next generation' NM blends. Pigs were

individually housed and fed *ad libitum* for 10 d. Feed intake and BW were collected on d 5 and 10. On d 10, all pigs were non-surgically fitted with an indwelling jugular catheter. On d 11, all pigs received an i.m. dose (2 mL) of a *Mycoplasma hyopneumoniae* vaccine (RESPISURE-ONE[®]) at time 0 and blood samples collected at 30-min intervals from -2 h until 6 h, and then at 24 h. Catheters were removed and the pigs maintained on their respective diets for an additional 13 d. Blood samples were collected on d 7 and 14 post-vaccination via venipuncture. Whole blood samples were utilized for hematological measurements and serum samples were analyzed for cortisol. ADG prior to vaccination was greater (P < 0.04) in the NM and Exp B groups compared to the Cont group. However, post-vaccination, growth was similar in all groups. Prior to vaccination, lymphocyte (P < 0.08) and neutrophil (P < 0.01) cell counts were higher in the Exp B and Exp C groups compared to the Cont group. During the first 24 h post-vaccination, serum cortisol was greater (P < 0.02) in the Cont group compared to all other groups. These data suggest that non-nutrient additives can alter the stress response associated with a *Mycoplasma hyopneumoniae* vaccination.

Key Words: Pig, Stress response

W21 Three strategies to counteract the negative impact of mycotoxins on piglets. U. Hofstetter^{*1}, D. Schatzmayr¹, G. Schatzmayr¹, and E. M. Binder², ¹Biomim GmbH, Herzogenburg, Austria, ²Erber AG, Herzogenburg, Austria.

Mycotoxins are toxic chemical products formed by fungi species that colonize crops and pose a potential threat to human and animal health as many of these toxins are acutely toxic, immunosuppressive, genotoxic, and show estrogenic effects. The purpose of this study was to investigate the impact of deoxynivalenol (DON) and zearalenone (ZON) on growth performance, blood biochemistry and immune response of pigs and the alleviating effects of a detoxifying feed additive (Mycofix Plus) based on the following three different strategies. A strictly anaerobic bacterium belonging to *Eubacterium sp.* (BBSH 797) is capable of detoxifying trichothecenes by enzymatic reduction of the toxic 12,13-epoxy-group and the newly discovered yeast strain *T. mycotoxinivorans* detoxifies ochratoxins and zearalenone. As all mycotoxins are known to damage the liver and to cause immunosuppression in animals, plant and algae extracts were selected to overcome these negative influences. A total of 48 weaning piglets were randomized allotted to four treatments including a negative control group which got neither mycotoxins nor feed additive, a toxin group (1 mg/kg DON and 250 µg/kg ZON), a trial group (1 mg/kg DON, 250 µg/kg ZON and 1.5 kg/t feed additive) and a positive control group which received the feed additive alone for 6 weeks with two replicates per treatment. The results of different evaluated parameters including growth performance, serum biochemistry parameters, alveolar macrophages activity, antibody titers for PR vaccine and cytokines secretion profile showed that DON and ZON caused an impairment in piglets after 6 weeks of exposure. Histopathological findings and blood biochemistry suggest that the combination of DON and ZON causes a multi-organ toxicity in pigs. All these detrimental effects were overcome by addition of the new feed additive. This study also suggests that levels below the critical value of DON and ZON for farm animals published by BML (1 mg/kg DON and 250 µg/kg ZON in starting and finishing pig diets) still have adverse and toxic effects.

Key Words: Deoxynivalenol (DON), Zearalenone (ZON), Immune function

W22 Successful detoxification of ochratoxin A in weaning piglets.

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Mycotoxins are secondary metabolites produced by fungi in certain stress periods. They can cause insidious losses, ill thrift and reduced disease resistance. While the use of products based on aluminosilicates gave good results in counteracting aflatoxins the adsorptive deactivation of other toxins failed under field conditions. A novel yeast strain with the capability of degrading ochratoxin A (OTA) was isolated and characterized. A trial with weaning piglets was conducted to prove the efficacy of the feed additive *T. mycotoxinivorans* in pig diets contaminated with ochratoxin A. 48 weaning piglets were randomly assigned to 4 groups. A positive control group (no product, no toxin), a negative control group (no toxin but 1×10^5 CFU *T. mycotoxinivorans* /g feed), a toxin group (500 ppb OTA, no product) and a trial group (500 ppb OTA and 1×10^5 CFU *T. mycotoxinivorans* /g feed). At the end of week 2 all animals showed mild symptoms of diarrhea for 2 days. The animals were weighed separately on day 1, 14 and 42. Analysis of the data revealed differences between the negative control group and the toxin group, which could be improved by the addition of *T. mycotoxinivorans* so that the difference between toxin group and trial group was improved about +10.2%. For daily weight gain the same results could be obtained as for live weight. Daily weight gain was significantly reduced in the toxin group compared to both control groups. With the addition of *T. mycotoxinivorans* daily weight gain could be improved. Feed intake was reduced clearly in the toxin group and was improved in the trial group. Feed conversion rate (FCR) was much higher in the toxin group compared to all other groups. Feedstuff with 500 ppb OTA caused a clear depression in performance in the toxin group. *T. mycotoxinivorans* could compensate these effects and increase daily weight gain, improve feed consumption and thus improve feed conversion in rearing piglets.

Key Words: Mycotoxins, Biotransformation, Growth performance

W23 The effect of butyrate on cytokine production and proliferation by porcine monocytes.

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Although butyrate modulates the immune system in some species, the role of butyrate as a regulator of immune function in the pig has not been studied. Therefore, the primary objective of this study was to determine whether butyrate influences the proliferation, cytokine secretion and mRNA expression by porcine immune cells in vitro. For experiments using peripheral blood mononuclear cells (PBMC), blood was collected from healthy pigs (n = 6), and PBMC were isolated to test the effect of sodium butyrate (0, 0.2, or 2.0 mM) on the blastogenic response to concanavalin A (Con A; 5 µg/mL) and cytokine expression and secretion. Cytokine mRNA abundance was determined using real-time reverse transcriptase PCR, and cytokine secretion was measured via enzyme-linked immunoassay (ELISA). Butyrate at 2.0 mM, but not 0.2 mM, suppressed ($P < 0.05$) Con A-induced PBMC proliferation and led to a paradoxical increase ($P < 0.05$) in interleukin-2 (IL-2) mRNA expression. The secretion and mRNA expression of interferon-γ (IFN-γ) by Con A-activated PBMC was increased several-fold ($P < 0.05$) by butyrate at 2.0 mM. Treating activated PBMC with butyrate at 2.0 mM decreased ($P < 0.05$) the secretion of IL-10. In contrast, butyrate at 0.2 mM increased ($P <$

0.05) both IL-10 secretion and mRNA expression. To test the effect of butyrate on cytokine expression by porcine macrophages, cells from a porcine monocyte-derived macrophage cell-line were cultured with *E. coli* lipopolysaccharide (LPS; 10 µg/mL) in the presence or absence of sodium butyrate (2.0 mM). Activating the macrophages with LPS increased ($P < 0.05$) the mRNA expression of tumor necrosis factor-α (TNF-α) at 2 h post treatment and IL-6 at 2 h and 4 h post treatment. Treating the activated-macrophages with sodium butyrate tended ($P < 0.07$) to decrease the expression of TNF-α at 2 h and partially reversed ($P < 0.05$) the induction of IL-6 by LPS at 4 h post treatment. These data indicate that the effect of butyrate on proliferation and cytokine production by porcine PBMC is dose-dependent, and provide evidence that butyrate decreases the expression of inflammatory cytokines by porcine macrophages.

Key Words: Butyrate, Pig, Immune system

W24 Expression of an active Colicin E1 in the yeast pichia pastoris.

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Escherichia coli infections, causing post-weaning diarrhea or edema disease, are one of the most commonly reported disease problems in young pigs in this country, causing substantial losses to the swine industry due to both mortality and morbidity. With worldwide concern over the use of prophylactic antibiotics in animal agriculture, the development of new products to protect swine from *E. coli* infections is urgently needed. We have previously shown that Colicin E1 is highly effective against the *E. coli* strains (F4 and F18) responsible for post-weaning diarrhea and edema disease in pigs. In order to make a colicin product more cost-effective for use in swine diets, we recombinantly expressed Colicin E1 in the yeast *Pichia pastoris*. The Colicin E1 gene was amplified by PCR and ligated into a yeast expression vector, pPICZαC, under control of the methanol inducible AOX1 promoter. The construct was then chromosomally integrated into *P. pastoris* X33 by electroporation. Transformants were selected by Zeocin resistance. Both the supernatant and cell extract of the transformed yeast were screened for colicin activity by spot testing onto lawns of *E. coli* DH5α. Yeasts demonstrating the highest colicin activity were selected for batch fermentation studies. Time course studies demonstrated that maximum Colicin E1 levels were obtained in the cell extract after 4d of methanol induction. No detectable colicin activity was found in the supernatant. The level of expression obtained in the yeast was comparable to that obtained with Mitomycin C induction of the native Colicin E1 producing *E. coli*, approximately 100U/mL of culture. Expressing an active Colicin E1 as an intracellular protein in *P. pastoris* is advantageous because both purification and processing costs would be dramatically reduced because the yeast may be directly fed to the piglets post-weaning. The production of Colicin E1 by a yeast system holds promise as an alternative to conventional antibiotics for the treatment/prevention of *E. coli* disease in pigs.

Key Words: Swine, Diarrhea, Yeast

W25 Polymorphisms within the lactoferrin gene promoter in various cattle breeds.

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Lactoferrin is an iron binding glycoprotein known for its antimicrobial properties. It is expressed in a species-, tissue- and cell type-specific

manner. In milk, this protein provides protection to infant mammals and plays a key role in defence of the maternal mammary gland against infection. The aim of this study was to increase our knowledge of polymorphic variation in the bovine *lactoferrin* promoter. Oligonucleotide primers were designed to amplify and sequence this region in a total of 58 cattle from 5 different cattle breeds (Holstein Friesian, New Zealand Holstein, Montebéliard, Normande and Norwegian Red). In total 15 different single nucleotide polymorphisms (SNP) were identified, 9 of which were novel and located at positions -765, -610, -599, -585, -457, -271, -255, -190 and -132 respectively. In general, the identified SNPs were widespread throughout the various breeds. However, 3 of the novel SNPs only occurred in a Montebéliard at positions -457, -255 and -132 and one was only present in a Normande at position -765. The most frequently encountered polymorphism (52%), found in all breeds was at position -28, which is immediately proximal to the TATA box of the promoter. The most variable base position was -131, which included three heterozygote and three homozygote variants. This polymorphism occurs in a putative transcription factor binding site, for the Nuclear factor of activated T cells. Norwegian Red cattle, which have been selected for mastitis resistance, displayed fewer polymorphisms than other breeds with most nucleotide changes occurring at positions -190, -156, -131 and -28. These unique SNP profiles may contribute to their low somatic cell count averages and/or their inherent resistance to udder pathogens. Individual SNPs or SNP combinations may result in the identification of stronger *lactoferrin* promoters. Higher levels of Lactoferrin could contribute to improved health of the mammary gland by lowering the severity and/or incidence of mastitis.

Key Words: Bovine, Lactoferrin

W26 Using microarray analysis to decipher gene expression in mastitis causing *Escherichia coli* exposed to bovine whey. M. Worku*, J. Bowman-Simpson, and P. Matterson, *North Carolina Agricultural and Technical State University, Greensboro.*

Escherichia coli cause mastitis upon entry into the mammary gland where exposure to milk components such as whey, occurs. Infection with *Escherichia coli*, release of endotoxin and the resulting inflammation is associated with changes in milk composition, loss of production and has consequences for animal health. Exposure to immune factors in whey are important in combating infection through immunomodulation and can impact bacterial pathogenesis. The objective of this study was to evaluate the effect of host immune factors in whey on gene expression in *E. coli* using microarray analysis. A mid-log culture of *E. coli* isolated from an acute case of clinical mastitis was grown. Whey samples were prepared from clinically healthy cows. The samples were heat inactivated (56°C, 30 min.). Six samples of *E. coli* (109) were incubated in RNase free Phosphate Buffered Saline (PBS) as negative controls. Six samples were incubated with a 1:1 dilution of the inactivated whey (10 min., 37°C). RNA from control and treated samples was isolated using the RNeasy (Qiagen) kits. The integrity and size distribution of total purified RNA was checked on ethidium bromide stained denaturing agarose gels and using a bioanalyzer. Two *E. coli* K12 Starter V2 array chips consisting of 2 identical grids with a total of 192 spots (MWG Biotech, High Point) were used for expression profiling of *E. coli*. Data were analyzed using MicroArray Genome Imaging and Clustering Tool (MAGIC Tool) Version 1.0 an open source program. Exposure of *E. coli* cultures to whey components resulted in transcriptional up regulation of all heat shock related *E. coli* genes when compared to samples maintained in PBS. Following log transformation three genes were markedly

up-regulated as indicated by values greater than 3 for the expression ratio. The gene encoding 2-oxoglutarate dehydrogenase was down regulated (-2). The differential expression of these genes may serve to identify pathways for the control of *E. coli* mastitis and indicate targets for intervention.

Key Words: *E. coli*, Microarray, Whey

W27 Microarray analysis of bovine blood neutrophils exposed to *E. coli* endotoxin. M. Worku*, P. Matterson, and Z. Li, *North Carolina Agricultural and Technical State University, Greensboro.*

Polymorphonuclear leukocytes (PMNs) are key players in the inflammatory response to bacterial products such as endotoxin (LPS). Endotoxins are components of the outer cell wall of gram negative bacteria. Few studies have addressed the effects of LPS on global gene expression in bovine blood PMNs. This study aims to explore the utility of microarray analysis for evaluation of the effects of LPS on global gene expression in bovine PMN. Blood PMN (8 million) isolated from a clinically healthy cow were exposed to LPS (10 ng/million cells). Total RNA was isolated from control and treated samples. RNA quality and quantity were evaluated using a Bioanalyzer. RNA was provided to Paradigm Array labs (Icoria) where following quality and quantity assessment cRNA was produced labeled and hybridized to GeneChip bovine arrays with approximately 23,000 bovine transcripts (Affymetrix). Comparison expression analysis compared the cell intensity data of the LPS treated samples to a baseline GeneChip® expression probe array (of control samples). This comparison analysis identified the relative change in the expression level of each transcript represented on the probe array. The procedure for selecting robust changes between control and experimental GeneChip probe arrays was based upon Affymetrix GCOS guidelines, using default parameters for probe detection, comparison analysis between experimental and baseline arrays, and signal log ratios. The final dataset resulted in all probe sets with at least either a two-fold increase or two-fold decrease in expression. Thus, in the LPS treated sample 12,874 genes were detected. In the control sample 13,263 genes were detected. Changes in gene expression were observed in 540 genes. At least a two fold increase in expression was observed in 111 genes. A two fold decrease in expression was observed in 429 genes. The types of transcripts impacted are being characterized. Global gene expression in bovine PMN was differentially impacted by exposure to LPS. Microarray analysis proved to be a useful tool for evaluation of the effects of LPS on global gene expression in bovine PMN.

Key Words: Neutrophil, Endotoxin (LPS), Microarray

W28 Increased pulmonary arterial pressure (PAP) and maternal undernutrition induces differential gene expression in right ventricle of steers. B. Berg*¹, B. Hess¹, S. P. Ford¹, K. McInnerney², W. Means¹, T. Hansen³, and H. Han¹, ¹*University of Wyoming, Laramie*, ²*Montana State University, Bozeman*, ³*Colorado State University, Fort Collins.*

Brisket disease, characterized by elevated pulmonary arterial pressure (PAP) and right ventricular hypertrophy, is primarily observed at altitudes over 1500m, and is due to decreased levels of atmospheric oxygen. We hypothesized that maternal undernutrition programs right ventricular gene expression and sensitivity to high altitude stress (2200m). Forty AngusXGelbvieh cows were grouped by BW from 30 to 125 days of gestation. On day 30 of gestation, cows were divided in equal numbers and fed either to meet NRC requirements (control; C) to

gain weight (average = +4.25% BW) or fed below NRC requirements (nutrient restricted; NR) to lose weight (average = -6.8% BW) from day 30-125 of gestation. On day 126 of gestation NR cows were realimented so as to achieve the same BW and BCS as controls as d250 of gestation. Parturition occurred naturally. Pulmonary arterial pressure of 15-mo-old steers from C or NR cows were measured before slaughter (values ranged from 40-114 mmHg). Hearts were collected from steers, separated into right and left ventricles, atria, and septa and weighed. Ventricle thickness was recorded. Right ventricle mRNA from high PAP (n=4; 2 C and 2 NR) and low PAP (n=4; 2 C and 2 NR) were used for Affymetrix bovine gene chips (contains 25mer probes per gene) screening. Gene chip data was analyzed by two-way ANOVA. Right ventricular weight (corrected by total body weight;

$r^2=0.76$; $P < 0.05$) and thickness ($r^2=0.53$) were correlated with increased PAP. Screening of steer right ventricles from low PAP and high PAP control fed steers revealed that 177 genes were differentially expressed. Right ventricles from NR low PAP steers revealed 42 differentially expressed genes (≥ 2 fold) when compared to C steers. Our study suggests that maternal NR programs gene expression in the fetal heart possibly affecting sensitivity of the steer heart to stress by 15 months of age. Differential programming of right ventricular gene expression in the fetus during early gestation may be detrimental to animal health, particularly at high altitude. Supported by NIH INBRE 1P20RR16474.

Key Words: Brisket disease, Gene expression, Undernutrition

W29 - See abstract number 77.

Dairy Foods: Cheese, Products, and Processing

W30 Probiotic properties of the *Candida kefir* isolated from kefir. S. J. You¹, J. K. Cho¹, C. G. Ha², C. H. Kim¹, and K. C. Heo^{*1}, ¹Hankyong National University, Anseong, Gyonggi, Republic of Korea, ²Hanyang University, Ansan, Gyonggi, Republic of Korea.

In this study, *Candida* sp. was isolated from Kefir grains and tested as a potential probiotic. The isolated strain was identified as *Candida kefir* with 99.8% identity to the species of *C. kefir* by a sugar fermentation test kit. The yeast strain was higher in amylase activity compared with its phytase, cellulase and xylanase activities. The growth curve of the isolated strain reached a peak at 30h incubation with 1.4×10^{10} CFU/ml. Because probiotic organisms should be acid and bile tolerant, qualitative analyses were carried out using the isolated strain. After exposure to acidic condition (pH2), the strain was able to grow in PD medium up to 1×10^8 CFU/ml compared with 8×10^9 CFU/ml at pH 5. Irrespective of the presence of bile acid, growth was observed in the strain cultured in medium containing 1.0% bile salt. Especially, *C. kefir* showed high heat stability in which the microbial counts of the strain was 37.5% at 60°C incubation compared with those at 30°C incubation. *Candida kefir* was grown in PD medium containing 13 antibiotics with 5 different addition levels and it was mostly not inhibited by 11 antibiotic agents which belong to tetracycline groups. The results indicated that the isolated *C. kefir* from Kefir grains could be a useful probiotic for animal production due to its strong resistance in acid and thermal conditions and antibiotics.

Key Words: Kefir, *Candida Kefir*, Probiotics

W31 Volatile fraction of Sicilian Pecorino cheese: Comparison of raw and pasteurized milk cheese. T. Rapisarda¹, S. Carpino^{*1}, G. Azzaro¹, and G. Licitra^{1,2}, ¹CoRFiLaC, Regione Siciliana, Ragusa, Italy, ²D.A.C.P.A. Catania University, Catania, Italy.

SPME coupled to gas chromatography/mass spectrometry/olfactometry was used to identify and compare the relative amounts of the volatile compounds of raw (RM) and pasteurized Pecorino (PM) cheese from animal on pasture. Cheese samples were analyzed at 4 days, 1, 3, 6, 9 and 12 months of ripening. The majority of volatile compounds were more abundant in RM cheeses. Volatile compounds related to the families of free fatty acids, fatty acid esters, aldehydes, alcohols, ketones and sulfur compounds were detected in RM and PM Pecorino cheese profiles. Acetic acid and hexanoic acid, 2-butanol, 2,3-butanediol and ethoxy propanol, diethyl acetal, phenyl ethyl alcohol and

ethyl dimethyl thiazole, hexanoic acid 1-methylpropyl ester and methyl nonanoate, 1-octen-3-one, diethyl methyl pyrazine and sulfur compounds like thiophene and dimethyl trisulfide were exclusively detected in RM cheeses likely due to the pasture diet and to the wild microbial communities presented in raw milk. Only a few exclusive compounds were detected in PM cheeses: benzaldehyde, benzaldehyde-4-methoxy, 2-undecanone, showing that milk pasteurization might determine lower levels of volatile compounds. Other relevant volatile compounds: (E)-2-nonenal, (Z)-2-nonenal and decadanal derived from oxidation of unsaturated fatty acids in plants and monoterpenes: (Z)-linalool oxide, nerol oxide, (E)-limonene oxide and isogeraniol derived from secondary plant metabolites, were detected only in RM cheeses. The greater presence of these volatile compounds in RM cheeses suggests that the influence of pasture and indigenous microflora of milk was reduced by the pasteurization process. In general, raw and pasteurized Pecorino cheeses volatile profiles increased for intensity and number of compounds with aging, with RM cheeses always showing richest volatile profiles at all different ages. Peculiar odor notes for raw milk Pecorino cheeses were green, hay, mushroom, nutty, garlic and floral, produced, respectively, by aldehydes, ketone, pyrazine, sulfur compound and terpene.

Key Words: Pecorino cheese, Raw/pasteurized milk, Volatile compounds

W32 Characteristics of reduced fat milks as influenced by the incorporation of folic acid. K. Achanta, C. A. Boeneke*, and K. J. Aryana, Louisiana State University Agricultural Center, Baton Rouge.

Milk and milk products serve as a beneficial source for folic acid fortification due to the presence of folate binding proteins which seem to be involved in folate bioavailability. Folic acid fortification plays an important role in the prevention of neural tube defects such as spina bifida and anencephaly, heart defects, facial clefts, urinary abnormalities and limb deficiencies. Though milk is not a good source of folic acid, fortification could help in the prevention of the above mentioned defects. The objective of this study was to examine the physico-chemical characteristics of reduced fat milks fortified with folic acid. Reduced fat milks were prepared using 25, 50, 75 and 100% of the recommended dietary allowance of 400 micrograms of folic acid. Treatments included addition of folic acid at these levels before and after pasteurization. Color, pH, fat, protein, viscosity, folic

acid concentration, folate binding protein concentration, folate binding protein profile, standard plate count and coliform count were determined on days 1, 7, 14 and 21. A consumer acceptance test was conducted on day 7. Data were analyzed using the General Linear Model with repeated measures in time by the Statistical Analysis System. Significant differences were determined at $P < 0.05$ using Tukey's Studentized Range Test. There were no differences in the electrophoretic mobility of folate binding protein in samples. The concentration of folic acid was significantly higher in reduced fat milks fortified with folic acid after pasteurization. The consumer panelists found no significant differences in flavor, appearance and texture of folic acid fortified reduced fat milks compared to control. Fortification of reduced fat milks with folic acid can be accomplished without adversely affecting product characteristics.

Key Words: Milk, Folic acid, Folate binding protein

W33 Removal of cholesterol from Blue cheese by crosslinked β -cyclodextrin. H. Y. Kim, H. Y. Bae, S. Y. Kim, J. Ahn, and H. S. Kwak*, *Sejong University, Seoul, Korea.*

This study was carried out to determine the cholesterol removal rate and resulting changes in sensory aspects and fatty acid and amino acid productions in reduced-cholesterol Blue cheese, made by cream separation followed by 10% crosslinked β -cyclodextrin (β -CD) treatment, ripened for 8 weeks at 10°C, and stored for 4 weeks at 4°C. The cholesterol removal from the cheese was 92.8%. The TBA value was significantly increased up to 6 week ripening and maintained thereafter in both treatments. The production of short-chain fatty acids (FFAs) significantly increased during the ripening and storage periods up to 10 weeks and slightly decreased thereafter in both control and β -CD-treated cheeses. During ripening and storage periods, the production of total amino acids increased significantly. The quantity of short-chain FFAs and total amino acids released between treatments during ripening was not different. In rheological properties, brittleness score was significantly different between control and cholesterol-reduced cheese at 8 and 12 week ripening and storage. In sensory analysis, appearance, flavor, taste and texture properties were not significantly different between control and cholesterol-reduced Blue cheese after 8 week ripening and 4 week storage periods. In addition, overall acceptability in the cholesterol-reduced cheese was closely similar to that in control. On the basis of our results, we conclude that the crosslinked β -CD-treated cream Blue cheese showed a sufficient cholesterol removal rate and no adverse changes in sensory characteristics.

Key Words: Blue cheese, Crosslinked β -cyclodextrin, Cholesterol removal

W34 Effect of crosslinked β -cyclodextrin treatment on cholesterol removal and chemical and sensory properties in Feta cheese. H. Y. Bae, H. Y. Kim, T. H. Jung, J. Ahn, and H. S. Kwak*, *Sejong University, Seoul, Korea.*

This study was designed to examine the cholesterol removal rate and resulting changes in chemical, rheological and sensory characteristics in reduced-cholesterol Feta cheese. For cholesterol removal, separated cream was treated with 10% crosslinked β -cyclodextrin (β -CD) at 1,400 rpm, then blended with remaining skim milk and homogenized with 500 psi at 50°C. After 12 weeks of storage at 4°C, the cholesterol removal from the cheese was 90.2%. The TBA value was significantly

lower in reduced-cholesterol cheese after 6 weeks of storage and thereafter, compared with that in control. The production of short-chain fatty acids (FFAs) significantly decreased during 12 weeks of storage and was markedly higher than control in reduced-cholesterol cheese in all periods. Most of rheological scores including cohesiveness, gumminess and brittleness were significantly higher in reduced-cholesterol cheese than those in control from 4 weeks until 12 weeks of storage. In sensory analysis, appearance, flavor, taste and texture properties were not significantly different between control and cholesterol-reduced Feta cheese during 12 weeks of storage. In addition, overall acceptability in the cholesterol-reduced cheese was highly similar to that of control in all periods. Therefore, the present study indicated that the crosslinked β -CD-treated Feta cheese showed over 90% cholesterol removal rate and no significantly adverse changes in chemical and sensory characteristics.

Key Words: Feta cheese, Crosslinked β -cyclodextrin, Cholesterol removal

W35 Changes of physicochemical and sensory properties of freeze-concentrated milk treated by ozone during storage. J. H. Hwang, S. J. Lee, S. H. Kim, J. Ahn, and H. S. Kwak*, *Sejong University, Seoul, Korea.*

The present study examined the physicochemical and sensory properties freeze-concentrated milk treated with ozone treatment during storage. After the freeze-concentrated milk containing 27% of total solids was treated with 150 ppm of ozone for 5 min, 99% of microflora was eliminated, and the activities of protease, lipase and phosphatase were decreased to 93.3, 96.2 and 96.2%, respectively. When the freeze-concentrated milk was stored at 4°C for 18 days after ozone treatment, total bacteria count was initially 4.0×10^3 CFU/mL and reached 1.8×10^4 CFU/mL at 12th day, and increased up to 2.1×10^5 CFU/mL at 18th day. TBA absorbance of the freeze-concentrated milk was significantly lower than that of the evaporated milk at every storage period and increased proportionally to the storage periods. The production of individual free amino acids was similar to that of the evaporated milk samples. The amount of water soluble vitamins decreased proportionally to the storage periods and the higher amounts of vitamins were lost in the evaporated milk than in the freeze-concentrated milk. In sensory analysis, longer storage resulted in undesirable cooked flavor and color scores. Those scores were lower in the freeze-concentrated milk than in the evaporated milk. Overall acceptability was evaluated better with the freeze-concentrated sample than with the evaporated milk. Based on the above results, ozone treatment of the freeze-concentrated milk appeared to be an adequate process for pasteurization and enzyme inactivation with minimizing nutrient loss and keeping sensory quality during storage.

Key Words: Freeze-concentrated milk, Ozone treatment, Storage

W36 Effects of microencapsulated isoflavone and minerals in milk on serum and urinary calcium metabolism in ovariectomized rats. B. J. Jeon, N. C. Kim, K. H. Seon, H. S. Park, and H. S. Kwak*, *Sejong University, Seoul, Korea.*

This study was carried out to investigate the effects of microencapsulated water-soluble isoflavone and/or calcium and vitamin supplementation in milk on bone metabolism in ovariectomized rats. Thirty Sprague-Dawley rats of 6 week-old were divided into 2 groups (sham-operated and ovariectomized) and ovariectomized group was subdivided into 4

subgroups: 1) Sham, sham-operated and fed diet without supplement, 2) OVX1, ovariectomized and fed diet without supplement, 3) OVX2, ovariectomized and fed microencapsulated isoflavone added diet, 4) OVX3, ovariectomized and fed microencapsulated isoflavone, calcium, and vitamin D and K supplements added, and 5) OVX4, ovariectomized and fed calcium and vitamin D and K supplements added. Above supplements were consumed by dissolving in 1 mL milk. After 19 wk feeding, body weight gain and food intake efficiency ratio were significantly lower in Sham group than those in 4 OVX groups ($p < 0.05$). In blood analysis, the ratio of BALP (bone alkaline phosphatase) to TALP (total alkaline phosphatase) concentration was the lowest in OVX1 group (52.1%) and was the highest in OVX3 group (73.5%), which was supplemented with isoflavone, calcium, vitamin D and K. In addition, serum osteocalcin was the highest in OVX3 but not significantly different among OVX groups ($p > 0.05$). Serum calcium was higher in Sham group and OVX3 group such as 11.6 and 11.7 mg/dL compared with those in others ($p < 0.05$), while serum phosphorus concentration was not different among groups. In urine analysis, urinary deoxypyridinoline (Dpd) was relatively but not significantly lower in OVX3 group compared with those in other OVX groups. These results may indicate that isoflavone supplementation with calcium and vitamin D and K in milk enhances both bone forming and bone resorption processes in ovariectomized rats.

Key Words: Microencapsulated isoflavone in milk, Serum and urinary calcium metabolism, Bone forming process

W37 Effects of isoflavone fortified milk on bone mineral metabolism in ovariectomized rats. B. J. Jeon, N. C. Kim, K. H. Seon, H. S. Park, and H. S. Kwak*, *Sejong University, Seoul, Korea.*

This study was conducted to investigate the effects of microencapsulated water-soluble isoflavone and/or calcium, vitamin D and L supplementation in milk on bone loss in ovariectomized rats. Thirty Sprague-Dawley rats of 6 week-old were divided into 2 groups (sham-operated and ovariectomized) and ovariectomized group was subdivided into 4 subgroups: 1) Sham, sham-operated and fed diet without supplement, 2) OVX1, ovariectomized and fed diet without supplement, 3) OVX2, ovariectomized and fed microencapsulated isoflavone added diet, 4) OVX3, ovariectomized and fed microencapsulated isoflavone, calcium, and vitamin D and K supplements added, and 5) OVX4, ovariectomized and fed calcium and vitamin D and K supplements added. After 19 wk feeding, body weight gain and food intake efficiency ratio were significantly lower in Sham group than those in 4 OVX groups ($p < 0.05$). The lengths of femur and tibia were not significantly different among all groups, however, femoral weight was slightly but not significantly higher in OVX groups supplemented with isoflavone and/or calcium, vitamin D and K. Femoral BMD (bone mineral density) appeared to be greater in Sham and OVX3, which supplemented with microencapsulated isoflavone, calcium, vitamin D and K than those in other groups. BMD/body weight showed the similar trend to that of BMD. Among groups, no difference was found in bone strength including maximum energy and stiffness ($p > 0.05$). Trabecular bone areas (%) in tibia were slightly higher in Sham and OVX3 group. In histological bone tissue examination, Sham group showed that normal structure of bone tissue. On the other hand, OVX1 group, which was ovariectomized and no supplementation showed the reduced thickness, interconnection or number of trabecula and the destroyed bone matrix. Meanwhile, OVX2, 3, 4 groups increased thickness, number of trabecula compared to OVX1 group. The present study indicated that microencapsulated isoflavone and/or calcium, vitamin D and K supplementation in milk might have a potential role

for preventing bone loss and enhancing bone sparing effects in ovariectomized rats.

Key Words: Isoflavone fortified milk, Bone mineral metabolism, Preventing bone loss

W38 Compositional differences between industrial sources of salty whey and sweet whey. K. Blaschek*, W. Wendorff, and S. Rankin, *University of Wisconsin, Madison.*

Salty whey is currently underutilized in the dairy industry because of high salt content and increased processing costs. Salty whey accounts for 2-5% of the whey generated during cheese manufacture. Since relatively little information is available on the composition of salty whey, this study was conducted to determine the range of analyses from commercial cheese plants. Gross compositional differences in percent protein, salt, solids, and fat between sweet whey and salty whey from various dry-salted cheeses from 8 commercial plants were determined. Differences between individual whey protein compositions were also determined using SDS-PAGE. Total solids, fat, and salt content were significantly greater in the salty whey as compared to the corresponding sweet whey. True protein was significantly reduced in salty whey. Individual whey proteins analyzed include lactoferrin (LF), bovine serum albumin (BSA), immunoglobulin G (IgG), β -lactoglobulin (β -LG), and α -lactalbumin (α -LA). Salty whey showed an increase in LF content and a decrease in α -LA and β -LG content when compared to sweet whey. Salty whey may be a source of LF, potentially increasing its value to whey processors. However, the compositional assessments show that salty whey is a highly variable waste stream from the commercial cheesemaking process.

Key Words: Salty whey, Lactoferrin, Whey proteins

W39 Effect of protein-to-fat ratio of cheese milk on the composition and yields of Cheddar cheese. T. Guinee*, E. Mulholland, J. Kelly, and D. O'Callaghan, *Moorepark Food Research Centre, Teagasc, Fermoy, Co. Cork, Ireland.*

The effect of protein-to-fat ratio (PFR) of cheese milk on the composition and yield of Cheddar cheese was investigated. Six cheese-making trials, each with 4 different milk PFRs randomly selected from 24 target values in the range 0.70 to 1.15, were undertaken. The mean protein content of the cheese milks was $3.66 \pm 0.1\%$ (w/w). Cheese manufacture was standardized for starter-to-protein ratio (0.38 kg/kg protein), rennet-to-protein ratio (317 chymosin unit/kg protein), firmness of gel at cut (40 Pa), pH at set (6.55-6.6), pH at whey drainage (6.15) and pH at curd salting (5.25). The PFR values were divided into three groups (low, LPFR: 0.7 to 0.85; medium, MPFR: 0.88 to 1.0; and high, HPFR: 1.0 to 1.15) for statistical analysis using one-way analysis of variance (ANOVA). Linear regression analysis of the data was used to establish potentially significant relationships between the PFR of the cheese milk and the response variables such as cheese moisture and yield. Increasing the PFR significantly ($P < 0.05$) increased the levels of cheese moisture, protein, Ca and P, but significantly reduced the levels of moisture-in-non-fat substances, fat-in-dry matter and salt-in-moisture. The actual yield (Y_A) of the LPF cheese (11.73 kg/100 kg cheese milk) was significantly higher than the yield of the MPF (10.78 kg/100 kg) or HPF (10.33 kg/100 kg) cheeses. Y_A decreased linearly with PFR at a rate of - 0.49 kg/100 kg cheese milk for every 0.1 unit increase in PFR. Cheese yield was also expressed as normalized yield, Y_{AFPRM} , which was defined as kg cheese per 100 kg milk with reference levels of fat (4.1%, w/w) and

protein (3.7 %, w/w). In contrast to actual yield, Y_{AFPRM} increased significantly with PFR by 0.14 kg/100 kg milk for every 0.1 unit increase in PFR. The mean Y_{AFPRM} for the LPF cheese (10.74 kg/100 kg milk) was significantly lower than for the MPF cheese (10.91 kg/100 kg milk) which in turn was lower than for the HPF cheese (11.19 kg/100 kg milk). Consistent with the trend for Y_{AFPRM} , the mean percentage milk fat recovered in the HPF cheese (88.3) was significantly higher than for the MPF (87.7) or LPF (86.5) cheeses.

Key Words: Protein-to-fat ratio, Milk, Cheddar cheese

W40 Utilization of lactoperoxidase system and/or microfiltration for manufacture of Cheddar cheese from raw milk. Y. Amornkul* and D. Henning, *South Dakota State University, Brookings.*

The objective of this study was to evaluate the application of microfiltration (MF) and/or the raw milk lactoperoxidase system (LP) to improve the safety of raw milk cheeses. For this purpose, *Escherichia coli* K12 was selected to be added to raw milk for studying survival as a nonpathogenic surrogate organism for pathogenic *E. coli* and *Salmonella* spp. Five replications of 6 treatments of Cheddar cheese were manufactured. Each replication involved separation of skim and cream and microfiltration of a portion of the skim with 1.4 μ m pore size. Cheese milks were then prepared by blending skim and cream portions and proceeding with the treatments. The 6 treatments included: cheeses made from pasteurized milk, raw milk, raw milk inoculated with *E. coli* K12, raw milk inoculated with *E. coli* K12 + LP activation, raw milk inoculated with *E. coli* K12 + MF, and raw milk inoculated with *E. coli* K12 + MF + LP activation. *E. coli* counts were done at 1, 14, 30, 60, 90, and 120 days of ripening time. Results indicate that there was a significant ($P < 0.05$) decrease in *E. coli* populations in all cheeses during ripening. However there was a large variation in the counts among replications during ripening. In addition, no significant ($P > 0.05$) effect of treatments on *E. coli* populations in cheeses during ripening was observed. Also results based on the percent decrease of *E. coli* K12 during ripening, the decrease in *E. coli* population was similar among treatments. These results suggest that survival of *E. coli* K12 present in cheeses depends on the microenvironment (pH, aw) rather than the treatments given to the milk used for manufacturing cheese. Hence it is inferred that if we can lower the *E. coli* counts in the cheese milk, we will lower the number of *E. coli* in the cheese. Application of MF, LP and MF+LP led to an average percent reduction in *E. coli* counts by 75, 85, and 95% respectively. Hence, utilization of MF in combination with LP activation can be an effective technique in reducing the counts of *E. coli* in raw milk cheeses.

Key Words: Raw milk cheese, Microfiltration, Lactoperoxidase

W41 Characterization of Queso Fresco cheeses manufactured in Mexico and the United States. D. L. Van Hekken*¹, M. H. Tunick¹, J. A. Renye¹, B. Vallejo-Cordoba², and A. F. Gonzalez-Cordova², ¹USDA, ARS, ERRC, Wyndmoor, PA, ²CIAD, A.C., Hermosillo, Sonora, México.

Queso Fresco is a fresh, high moisture, white, rennet-set cheese that is the most popular Hispanic-style cheese in the US and Mexico. Traditionally, Mexican Queso Fresco is made with raw milk although the use of pasteurized milk is slowly replacing this practice. In the US, the FDA mandates that cheeses, such as Queso Fresco, sold less than 60 d after manufacture must be made with pasteurized milk. Queso Fresco has not been studied extensively and it is not known if the

pasteurized milk cheeses are different from the raw milk originals. In this study, the compositional (moisture, fat, protein, and salt) and physical properties (whiteness value, water activity, and pH) of Queso Fresco from 6 commercial cheese plants in Sonora, Mexico (4 using raw milk and 2 using pasteurized milk) were characterized and compared to 8 commercial US-made cheeses. In composition, raw milk cheeses were higher in moisture (58-60%), and lower in fat (20-24%) and protein (15-17%) than the pasteurized milk cheeses from Mexico and the US (47-52% moisture, 23-36% fat, and 18-24% protein); the US-made cheeses contained more salt than the Mexican-made cheeses (1.2-1.9% and 0.7-1.2%, respectively). In physical properties, all cheeses were bright white (whiteness L^* values of 92-93) whereas raw milk cheeses had higher water activities (0.980 to 0.998) than the pasteurized cheeses (clustered near 0.975). The pH values of Mexican-made cheeses ranged from 4.8 to 6.0 whereas the pH values of US-made cheeses were above 6. The differences in manufacturing techniques, the unique microflora presence in the raw milk, and the excessive acid production in some of the cheeses contributed to the differences noted in composition and physical properties of the Queso Frescos. Establishing the basic chemical and physical properties of Queso Fresco is the first step in understanding the unique quality traits of this cheese and identifies traits that need to be maintained in pasteurized versions.

Key Words: Hispanic, Cheese, Queso fresco

W42 Manufacture of fresh soft cheese (Domiaty-type) from camel milk using ultrafiltration process. M. A. Mehaia*, *Qassim University, Buriedah, Qassim, Saudi Arabia.*

Manufacturing procedures and composition of fresh soft cheese (Domiaty-type) manufactured from camel milk using ultrafiltration (UF) and traditional processes were investigated. Cheese yield, recovery of protein, fat and total solids, and sensory characteristics of the cheese manufactured with two starter cultures were also evaluated. UF process showed reduction rates of 88.5, 83.3, 88.4 and 85.9% in salt, calcium chloride, starter culture and rennet added, and 80% in processing time and 77% in milk used in processing, respectively. The cheese manufactured by UF process was higher in pH and moisture contents, whereas the protein and fat contents were lower in cheese manufactured by the traditional method. Increment rates achieved by UF process were 45% in cheese yield, 40% in protein recovery, 42% in fat recovery and 40% in total solids recovery. For sensory characteristics, the mean scores for appearance, texture, flavour and overall acceptability of the cheese manufactured by UF process were significantly higher ($P < 0.05$) than those scores recorded by the cheese manufactured by the traditional method. The UF process investigated in soft cheese has the potentiality for developing a cheese with good yield and acceptability from camel milk.

Key Words: Ultrafiltration, Domiaty cheese, Camel milk

W43 Modifying the functionality of reduced-fat Mozzarella cheese by reduction of calcium level or by the addition of emulsifying salts during curd plasticization. J. A. O'Mahony, E. O. Mulholland, and T. P. Guinee*, *Moorepark Food Research Centre, Teagasc, Fermoy, Co. Cork, Ireland.*

The objective was to simulate the characteristics of low-calcium (18.8 mg calcium/g protein) reduced-fat Mozzarella cheese by blending emulsifying salts (ES) with hot plasticized curd containing a normal

level of calcium (28.8 mg calcium/g protein). Reduced-fat Mozzarella (RFM) with normal (NC) or low (LC) calcium levels were made on two separate occasions using chemical acidification of the cheese milk and plasticizing the curds (NC at pH ~ 6.0, and LC at pH 5.65) in hot water (80°C) to a curd temperature of ~ 59°C. Following plasticization, the hot molten NC Mozzarella curd was immediately blended with either trisodium citrate (TSC) or disodium phosphate (DSP) for 8 min at 59°C. TSC was added at levels (% w/w) of 0 (NC), 0.5 (NCTSC0.5) or 1 (NCTSC1.0), and DSP at levels (% w/w) of 0.5 (NCDSP0.5) or 1 (NCDSP1.0). The pH values of the ES-treated curds were reduced to that of the NC curd by the addition of lactic acid. The cheeses were evaluated after 12 d storage at 4°C. The mean moisture (% w/w) and pH values of the LC and NC cheeses were 61.7 and 5.9, and 49.7 and 5.95, respectively. The addition of TSC or DSP did not affect the composition of the cheeses. The mean level of water-soluble N, as % total N, in the NCDSP1.0 cheese (9%) was notably higher than that in the other cheeses (1 – 3.6%). The mean firmness (force at 70% compression) of the cheeses decreased in the following order: NCTSC1.0 ≈ NC > NCTSC0.5 > NCDSP0.5 > NCDSP1.0 >> LC. The mean flowability of the heated cheeses, as measured by modified Olson and Price and Schreiber methods, increased in the following order: NC ≈ NCTSC0.5 < NCTSC1.0 ≈ NCDSP0.5 << NCDSP1.0 ≈ LC. The stretchability of the heated cheese, as measured by uniaxial extension at a fixed velocity, increased in the order NC ≈ NCTSC0.5 ≈ NCTSC1.0 ≈ NCDSP0.5 < NCDSP1.0 <<< LC. The results show that the functionality of low calcium RFM cheese could be partly imitated by blending 1% DSP with hot plasticized curd containing a normal calcium level.

Key Words: Reduced-fat Mozzarella, Calcium level, Emulsifying salts

W44 Impact of exopolysaccharide-containing base cheese on characteristics of reduced fat process cheese. S. Awad, A. N. Hassan*, and V. Mistry, *MN-SD Dairy Foods Research Center, Dairy Science Department, Brookings, SD.*

Fat reduction in cheese is associated with many textural and functional defects. The quality attributes of process cheese are greatly influenced by the composition and nature of base cheeses. The objective of this study was to evaluate textural, viscoelastic and functional characteristics of reduced fat process cheese made from exopolysaccharide (EPS)-containing Cheddar cheese. Reduced fat process cheeses were manufactured using a 50/50 mixture of young (2 days) and aged (6 months) reduced fat Cheddar cheeses made with EPS-producing or non-producing cultures. In addition, a full fat process cheese made with no EPS was also employed in this study. Moisture and fat were standardized to 40 and 32.5% for full fat cheese and 49 and 21% for reduced fat cheese respectively. Reduced fat process cheeses made from Cheddar cheese containing no EPS were firmer, and more chewy and gummy than those made from EPS-positive Cheddar cheese. Reduced fat process cheese manufactured from EPS-positive Cheddar cheese had lower viscoelastic moduli and increased meltability. Creep/recovery test showed that EPS-positive process cheese was more deformable and did not recover its original structure as much as the EPS-negative one did. Sensory results correlated well with instrumental data. The highest sensory scores were obtained when both young and aged cheeses contained EPS. Full fat cheese was harder, chewier, gummier and less deformable than reduced fat cheeses, which might be due to the lower moisture content in the former cheese. In

conclusion, EPS-containing base cheese could be used to improve texture and functionality of reduced fat process cheese.

Key Words: Reduced fat process cheese, Exopolysaccharides, Texture and functionality

W45 Substituting aged cheese with exopolysaccharide-containing base cheese in making process cheese. S. Awad, A. N. Hassan*, and V. Mistry, *MN-SD Dairy Foods Research Center, Dairy Science Department, Brookings, SD.*

Young Cheddar cheese is characterized by excessive firmness, curdy and rubbery texture, poor meltability and lack of flavor. In a previous study, exopolysaccharide (EPS)-producing cultures improved melting, viscoelastic and textural properties of young reduced fat Cheddar cheese (Hassan et al., *JDS* 88: 4221-4227; Awad et al., *JDS* 88: 4204-4213). Since base cheese has a direct impact on the characteristics of process cheese, we hypothesized that the use of EPS-producing cultures in making base Cheddar cheese would allow the utilization of more young cheeses in making process cheese. Reduced fat process cheeses were manufactured using young (2-day) or 1-month old reduced fat Cheddar cheese made with EPS-producing or non-producing cultures. Moisture and fat of process cheese were standardized to 49 and 21%, respectively. Enzyme modified cheese (EMC) was incorporated to provide flavor of aged cheese. Exopolysaccharide-positive process cheese was softer, less chewy and gummy, and more deformable than the EPS-negative cheeses. Process cheese manufactured from EPS-containing Cheddar cheese exhibited lower viscoelastic moduli and softening temperature. The hardness, chewiness and viscoelastic moduli were lower in process cheese made from 1-month old Cheddar cheese than those in process cheese made from 2-day old cheese. Larger differences were observed between process cheeses made from 1-month old EPS-positive and negative base cheeses than those between process cheeses made from the corresponding young base cheeses. This could be because of more extensive proteolysis in the EPS-positive Cheddar cheeses than in the EPS-negative cheeses due to their higher moisture content. Sensory scores for texture of EPS-positive process cheeses were higher than those of the EPS-negative ones.

Key Words: Reduced fat process cheese, Exopolysaccharides, Texture and functionality

W46 Evaluation of isolated starter lactic acid bacteria in Ras cheese ripening and flavour development. S. Awad*, N. Ahmed, and M. El-Soda, *Department of Dairy Science, Faculty of Agriculture, Alexandria University, Egypt.*

Twenty six cultures of starter lactic acid bacteria isolated from Egyptian dairy products with or without added adjunct cultures of lactobacilli and micrococci were evaluated in experimental Ras cheese for flavour development. Chemical compositions of experimental cheeses were within the legal limit for Ras cheese in Egypt. All cultures used in this study had no effect on chemical composition of Ras cheese during ripening. Very significant variations in free amino acids, free fatty acids and sensory evaluations have been found among the cultures used in Ras cheesemaking. The levels of free amino acids and free fatty acids were correlated well with flavour development in Ras cheese. Six of the tested cultures produced acceptable flavour and texture of Ras cheese. The highest overall score of flavour intensity, flavour and texture acceptability were in cheese made using thermophilic lactic

culture in addition to adjunct culture of *Lactobacillus helveticus*, *Lactobacillus paracasei* subsp *paracasei* and *Lactobacillus delbrueckii* subsp *lactis*. This culture can be recommended for Ras cheese manufacture using pasteurized milk.

Key Words: Ras cheese, Lactic acid bacteria, Adjunct culture

W47 Utilization of lactoperoxidase system and/or microfiltration for manufacture of Cheddar cheese from raw milk: Proteolysis and sensory characteristics. Y. Amornkul* and D. Henning, *South Dakota State University, Brookings.*

The objective of this study was to evaluate the influence of microfiltration (MF) and/or the raw milk lactoperoxidase system (LP) on the proteolysis and sensory characteristics of raw milk cheeses. Five replications of 6 treatments of Cheddar cheese were manufactured. Each replication involved separation of skim and cream and microfiltration of a portion of the skim with 1.4 µm pore size. Cheese milks were then prepared by blending skim and cream portions and proceeding with the treatments. The 6 treatments included: cheeses made from pasteurized milk, raw milk, raw milk inoculated with *E. coli* K12, raw milk inoculated with *E. coli* K12 + LP activation, raw milk inoculated with *E. coli* K12 + MF, and raw milk inoculated with *E. coli* K12 + MF + LP activation. The cheeses were analyzed for changes in pH 4.6 soluble nitrogen (N), starter and non-starter lactic acid bacteria (NSLAB) populations from 1 day to 120 days of ripening. Starter and NSLAB populations were determined on M17 and acidified (pH 5.4) MRS agars respectively. Cheese samples were evaluated for sensory characteristics at 60 and 120 days by 8 trained panelists. Results of pH 4.6 soluble N (expressed as % total protein) were similar among treatments; however, it increased ($P < 0.05$) by 3 to 5 times during 120 days of ripening. While starter populations decreased ($P < 0.05$) during ripening, NSLAB populations increased ($P < 0.05$) during ripening. Rate of increase and total populations of NSLAB were influenced by treatments. Cheeses made from raw milk with/without LP had higher levels of NSLAB as compared to cheeses made from pasteurized milk, MF milk with/without LP. Sensory attributes of the cheeses indicate that cheeses did not differ in certain attributes such as acid taste, bitterness, curdiness, and mealiness. Other attributes such as sulfide and unclean, crumbliness, firmness, shortness, overall flavor, body and texture, and appearance were different among treatments. Overall sensory acceptability was higher for pasteurized or MF cheeses as compared to raw milk cheeses.

Key Words: Raw milk cheese, Sensory, Proteolysis

W48 Effect of the addition of *Lactobacillus reuteri* over the shelf life of Oaxaca-type cheese. M. Montero-Lagunes*³, E. Paz-Gamboa¹, E. Herman-Lara¹, P. Valencia-Perez¹, and H. Garcia-Galindo², ¹*Instituto Tecnológico de Tuxtepec, Tuxtepec, Oax. Mexico*, ²*Instituto Tecnológico de Veracruz, Veracruz, Ver. Mexico*, ³*Campo Experimental La Posta, Veracruz, Ver. Mexico*.

The conditions of transport and storage in Oaxaca-type cheese cause the development of pathogenic bacteria like *Salmonella* spp. For this reason and in order to increase its shelf life, *L. reuteri* as probiotic bacteria was used. The cheeses were produced in triplicate with pasteurized milk at 63°C for 30 min and cooled to 35°C. Mesophilic culture of trademark EZAL was used as starter *L. reuteri* was added by aspersion to concentrations of 7.5, 10 and 12.5% to the cheeses after

its manufacture, and a control without *L. reuteri* was produced. During the manufacture and storage of cheeses, viability of *L. reuteri* was determined. The proteolysis like biochemical change was evaluated. Physicochemical analyses were determined according to AOAC, Mexican norms were used for the microbiological analysis. Results showed that *L. reuteri* survived well in the cheeses kept at 6°C for 20 days and remained between 1.08×10^6 to 1.29×10^6 cfu/g of cheese. No significant difference was observed between cheeses produced with or without addition of *L. reuteri* for fat and protein. However significant differences in moisture, protein and proteolysis between the cheeses added with 12.5% of *L. reuteri* were observed. Presence of coliforms, *Staphylococcus aureus* and salmonella were not detected in the obtained cheeses except at the control. Amount of fungi and yeasts stayed within the permissible values by the Mexican Official Norms. The results indicate that the addition of *L. reuteri* to 7.5% showed an excellent viability during a time of storage of 20 days being able to be an alternative of production for this type of cheeses. This help to their life of shelf, overall will provide the most effective means to prevent growth of salmonella.

Key Words: Cheese, Shelf life, Probiotic

W49 Acceptability of cream cheese. M. Almena*, N. Losambe, and P. S. Kindstedt, *University of Vermont, Burlington.*

Hot-pack cream cheese is an acid-coagulated cheese that is heated and homogenized during manufacture and contains stabilizers to increase spreadability and decrease syneresis. Cream cheeses made using more traditional technologies and ingredients have been gaining in popularity in the U.S. as a result of renewed interest in artisan and organic cheeses. The goal of this study was to explore the acceptability of a variety of commercially available plain cream cheeses. Three samples of cream cheese: a hot-pack style, an organic version, and an artisanal variety made without stabilizers, were evaluated by consumers enlisted at a coffee/bagel shop and a supermarket that specializes in natural/gourmet foods. One group of consumers (91) compared the hot-pack (HP) cheese containing stabilizers vs. the organic sample which also contained stabilizers; a second group (105) compared the HP-sample vs. the sample without stabilizers. Both groups were asked to select the favorite sample and to rank the overall acceptability, appearance, texture and flavor of the 2 samples using a 9-pt hedonic scale. Demographic data and cream cheese eating habits information were also collected. Data were statistically analyzed by ANOVA and Chi-square tests using SPSS. There was a significant preference overall for the hot-pack cream cheese. The HP-sample was preferred by 74% of the individuals when compared to the organic cheese and by 75% when compared to the artisanal cheese without stabilizer. The HP-cream cheese also scored significantly ($P < .05$) higher for all the characteristics when compared to the other 2 cheeses, especially vs. the artisanal sample without stabilizers. Chalky, dry, gritty and sour were the main dislike attributes identified for the artisanal cheese, while natural, not slimy, sharper and tangy flavor were the main positive attributes. Although the artisanal cheese without stabilizers received lower acceptability scores, consumers did not dislike the cheese but took exception to its designation as cream cheese. No significant differences were found between genders in terms of preference for any of the products evaluated.

Key Words: Cream cheese, Acceptability

W50 Characteristics of Swiss cheese manufactured with adjunct *Lactobacillus* strains using low cooking temperature. N. A. Kocaoglu-Vurma*¹, W. J. Harper¹, M. A. Drake², and P. D. Courtney¹, ¹The Ohio State University, Columbus, ²North Carolina State University, Raleigh.

The use of *Lactobacillus casei* as an adjunct culture is common for Swiss-type cheese manufactured in Switzerland, however, few published reports exist on adjunct use and none exist for adjunct use in U.S.-manufactured Swiss cheese. The objective of this study was to establish the effect of nonstarter *Lactobacillus* adjunct cultures on Swiss cheese characteristics. Selected nonstarter *Lactobacillus* strains isolated from commercial cheeses were utilized as adjunct cultures for cheese manufacture. Cheeses were manufactured using a commercial starter combination and one of three previously isolated nonstarter *Lactobacillus* strains, *L. casei* A26, *L. casei* B21, and *L. rhamnosus* H2. Control cheeses lacked the adjunct culture. Cheeses were analyzed during ripening for microbial and chemical composition. The use of adjunct cultures reduced the variability in total *Lactobacillus* counts compared to cheeses manufactured without adjunct addition. There were no significant differences in protein, fat, moisture, and salt contents. The pH of the mature cheeses ranged from 5.4 to 5.5, and free amino acid concentration ranged from 5 to 7 mmol/100 g cheese. Lactic, acetic, and propionic acid contents of cheeses were not significantly different after a 90-day ripening period. Citric acid was depleted in cheeses manufactured with adjunct *L. casei* strains by the end of warm room ripening. Based on electronic nose and descriptive sensory analysis, cheeses made with adjunct *L. casei* A26 were most similar to the control cheese in development of particular flavor attributes.

Key Words: Swiss cheese, Adjunct culture, *Lactobacillus casei*

W51 Hydrolysis of caseins in Cheddar cheese: Effects of temperature and coagulants. P. J. Joseph*¹, D. J. McMahon¹, J. R. Broadbent¹, and C. J. Oberg², ¹Utah State University, Logan, ²Weber State University, Ogden, UT.

Functional attributes of Cheddar cheese used in a wide variety of food products are critical to its applications and consumer acceptance. Functionality in turn is determined largely by the extent of hydrolysis. The objective of this study was to investigate the influence of coagulants and ripening temperature on the proteolysis in cheese, particularly the hydrolysis of large and hydrophobic peptides. Triplicate 400-kg batches of Cheddar cheese were made in open vats using *Lactococcus lactis* as starter with additional Lac- *L. lactis* and *Lactobacillus helveticus* adjunct cultures. Chymosin and *Cryphonectria parasitica* rennet, individually and combined (61/39%) were used as coagulants at 1X and 4X levels. Each of the above treatments were ripened for 6 months at 40 and 55°F. Proteolysis was monitored by RP-HPLC on a C8 Brownlee column with a Beckman Gold system. Trifluoroacetic acid (0.1%) and acetonitrile (80%) were used as the mobile phase, with the concentration of acetonitrile being raised from 40 to 60% over 30 min. Peptides over 3 kDa in size, and eluting at elution times ranging between 25 and 35 min were monitored. Changes in the peptide profiles over this time range occurred between 1 week and 2 months in cheeses at both 40 and 55°F. Total peak areas reduced between 2 and 4 months, indicating that these observed peptides may have gone from being relatively hydrophobic to hydrophilic, thus loosely binding with the column and eluting earlier. Cheeses having higher level of coagulant (4X) and at 55°F had ~90% of the intact caseins and large peptides hydrolyzed in 2 months. Chymosin, *C. parasitica* rennet and their

combination did give peptide profiles that were apparently different at 2 and 4 months. These results suggest that higher levels of coagulants used in combination in cheese ripened at 55°F will hydrolyze large hydrophobic peptides that may play a role in functionality.

Key Words: Cheese ripening, Accelerated aging, Proteolysis

W52 Effect of sodium gluconate on the solubility of calcium lactate. C. Phadungath* and L. E. Metzger, MN-SD Dairy Foods Research Center, University of Minnesota, St. Paul, MN.

The typical concentration of calcium and lactate in Cheddar cheese are in excess of the solubility of calcium lactate at 4°C. Consequently, it is not surprising that calcium lactate crystals (CLC) are a common defect in Cheddar cheese. One approach in preventing CLC is to add sodium gluconate to cheese. Sodium gluconate can increase the solubility of calcium and/or lactate in the serum phase by forming metastable complexes with one or both of the calcium and lactate ions, and removing one or both of the calcium and lactate ions from being available for the formation of CLC. The solubility of anhydrous calcium lactate has been reported to be 3.38 and 6.41 g/100 g of water at 4 and 24°C, respectively, while the typical concentration of soluble calcium and lactate in the serum phase of Cheddar cheese is 1.06 g and 3.73 g/100 g water. The objective of this study was to determine if sodium gluconate could increase the solubility of calcium and/or lactate. Seven calcium lactate solutions (5.31% calcium lactate) with seven level of sodium gluconate (0, 0.5, 1, 1.5, 2, 3, and 4%) were made in triplicate. The solutions were stored at 4°C for 21 days, and then were visually inspected for CLC formation. Subsequently, they were filtered at 4°C to remove CLC and the supernatant was analyzed for lactic acid and gluconic acid by HPLC and for calcium by Atomic Absorption Spectroscopy. The visual inspection demonstrated that CLC were formed in the solution with 0% gluconate after the first day of storage and CLC continued to accumulate over time. A minute amount of CLC was also visible in the solution with 0.5% gluconate after 21 days of storage, while CLC were not visible in the other solutions. The HPLC results indicated that there was a significantly ($P < 0.05$) higher concentration of lactic acid in the filtrate from the solutions containing added gluconate. The calcium concentration was also significantly ($P < 0.05$) higher in the filtrate from the solutions containing added gluconate. Therefore, it is apparent that sodium gluconate can significantly increase the solubility of calcium lactate.

Key Words: Calcium lactate crystals, Sodium gluconate

W53 Influence of adjunct cultures and accelerated ripening on texture and melting properties of Cheddar cheese. T. C. Rasmussen*¹, D. J. McMahon¹, J. R. Broadbent¹, and C. J. Oberg², ¹Utah State University, Logan, ²Weber State University, Ogden, UT.

Changes in cheese physical properties during aging are related to proteolysis by coagulant and culture enzymes. Storage temperature also affects rate of aging. Cultures are important for flavor development, but less is understood about their role in textural and melting properties. Our objective was to make cheddar cheese using different cultures, to age it at 5 and 13°C, and measure physical properties over 6 months. Cheese was manufactured using *Lactococcus lactis* starter culture either alone or combined with one or both of lac- *Lc. lactis* or *Lactobacillus helveticus* adjunct cultures. Three replicates of cheese were made using 1500 lb milk. Cheese composition was 35.5±1.0% moisture, 52.5±2.5% FDB, 1.65±0.05% salt, and pH 5.2±0.1. All cheeses were initially stored at 5°C, then half were moved to 13°C after 21 d. Texture

profile analysis (TPA) was performed using 25% and 60% compression and melting measured using a Melimeter at 65°C. After 2 months, differences in cheese properties were observed based on cultures and storage temperature. Cultures used had more effect on hardness and cohesiveness, while storage temperature had a large impact on adhesiveness. Using 25% or 60% compression produced different TPA values, especially when the cheese fractured during compression. At 25% compression, after 2 months, the cheeses made using *Lb. helveticus* had the highest hardness (av. 2365 g versus 1853 g), while the cheese stored at 13°C had more adhesiveness (av. 18.3 versus 11.8). At 60% compression, the control cheese stored at 5°C had the highest hardness, as it was the only cheese that did not fracture during compression. Cheeses stored at 13°C melted faster (1.39 versus 1.29 mm/s) and further (82.5% versus 75.5% height reduction) than those stored at 5°C. Adding either adjunct cultures or raising the storage temperature can accelerate the aging of cheese thus changing its textural and melting properties. Loss of a fracture point during TPA using 60% compression is a characteristic of cheese ripening.

Key Words: Proteolysis, Hardness, Fracture

W54 Effects dietary supplementation of unsaturated fat, vitamin E, and sorbitol on fatty acid concentrations in milk and the properties of Cheddar cheese. F. Parada-Rabell*, M. L. Eastridge, C. J. Kuo, V. Alvarez, A. Todd, C. V. D. M. Ribeiro, and J. Engel, *The Ohio State University, Columbus.*

Feeding unsaturated fat alters the fatty acid profile of milk. Research has shown that dietary supplementation of soybean oil will alter the fatty acid profile in milk but not in the same manner as when feeding fish oil. Data are limited on fatty acid composition in milk when a combination of soybean and fish oils are fed. There is some evidence that increasing dietary concentration of vitamin E may affect fatty acid composition of milk, especially when feeding unsaturated fat. Even though sorbitol is being used in commercial feed, limited published data are available as to its effect on milk composition. Four lactating Holstein cows were used in a Latin square design for 3 wk periods, with milk collection occurring during wk 3 for composition analyses and production of cheddar cheese. Cows were fed 4 diets: 1) control diet (CNTL; 500 IU vitamin E), 2) 2% fish oil, 0.5% soybean oil, and 500 IU of vitamin E (FSO), 3) 2% fish oil, 0.5% soybean oil, and 2000 IU of vitamin E (FSOE), and 4) 1% sorbitol (SORB, dry form; 500 IU vitamin E). Cheese yield was lower for the diets containing oil (7.8% versus 9.6%). Moisture and solids concentrations were similar among the cheeses. Crude protein concentrations (40.8, 49.2, 50.2, and 43.1%, dry basis, respectively) tended to be lower for cheeses made from cows fed the control diet. Fat concentration tended to be lower in cheese from cows fed the FSOE diet (44.1, 31.2, 29.2, and 44.0%, dry basis, respectively). Regarding texture profile analysis, cheeses made from cows fed the FSOE and FSO diets were harder than those from CNTL and SORB (13.4 and 15.7, versus 5.8 and 6.6 kgf, respectively). Oil supplemented diets resulted in lower proportions of palmitic, stearic, linoleic, and saturated fatty acids and higher proportions of unsaturated fatty acids in milk. FSOE resulted in the highest proportion of unsaturated fatty acids in milk. These results suggest that milk from cows fed fish-oil diets will likely have less fat content, and thus the characteristics of the cheese, such as yield, texture, and protein-fat ratio, will be altered.

Key Words: Fish oil, Sorbitol, Cheddar cheese

W55 On-farm extraction of proteins from raw whole milk. A. Chand*^{1,2}, J. E. Swan¹, and C. J. Fee³, ¹*The University of Waikato, Hamilton, New Zealand*, ²*Dexcel Limited, Hamilton, New Zealand*, ³*University of Canterbury, Christchurch, New Zealand.*

The concept of 'on-farm processing of dairy proteins' directly from raw, whole milk was investigated. Extracting proteins from raw, whole milk is impractical due to high levels of fat (an individual cow's milk can contain up to 10% w/v fat). Producing high-value dairy proteins such as lactoferrin (LF) and lactoperoxidase (LP) generally requires extensive pre-treatment (e.g. centrifuging, precipitation, Ca²⁺ chelation, filtration etc) to remove fat and caseins, before LF and LP can be extracted by ion exchange chromatography. Raw, untreated whole milk was processed in the laboratory through a 5-cm high column packed with SP Sepharose Big Beads™ without exceeding the maximum backpressure at milk secretion temperature (35-37°C). Data indicated that more than 100 column volumes of raw milk could be loaded at 300 cm/hr before LF and LP breakthrough occurred. Laboratory single-stage stirred tank trials showed that cation exchangers could capture 90% (SP Sepharose FF™, average particle size 90 µm) or 66% (SP Sepharose Big Beads, average particle size 200 µm) of the initial LF within 30 minutes. Absorption rate was faster on Fast Flow. A Protein Fractionation Robot (PFR) prototype based on a single-stage stirred tank system was designed, built and coupled to an Automated Milking System (Dexcel Ltd, Hamilton). Freshly-obtained, raw, whole milk from 16 individual cows was diverted to the PFR for extractions. The average yields of LF and LP using Big Beads resin were 36% and 87% respectively. Economic feasibility studies showed that an on-farm system for extracting high-value proteins is viable, especially if the farmer is paid on total solids basis with a premium for specialty proteins. This technology provides opportunity for complete product traceability. It can potentially give much higher recoveries of proteins that are thermally labile and/or undergo rapid degradation when processed under standard factory conditions.

Key Words: On-farm, Protein extraction, Lactoferrin

W56 Effect of processing on the composition and structure of buttermilk and of its milk fat globule membranes. P. Morin*¹, R. Jiménez-Flores², and Y. Pouliot¹, ¹*Stela Research Group, INAF, Université Laval, Québec, Canada*, ²*Dairy Products Technology Center, Cal Poly, San Luis Obispo.*

The effect of pasteurization of the cream on the composition and microstructure of buttermilk after pasteurization, evaporation and spray drying was studied. The composition of MFGM isolated from the buttermilk samples was also characterized. Pasteurization of the cream induced a higher lipids recovery in the buttermilk. Spray-drying of buttermilk was found to have major effect on its phospholipid content and composition. Phospholipid content of buttermilk decreased in a proportion of 38.2 and 40.6% for buttermilk from raw and pasteurized cream respectively. Pasteurization of the cream induced the highest increase of whey protein recovery in MFGM isolates compared to all other processing steps applied on buttermilk. A reduction in the phospholipid content was also found in the MFGM isolates following spray drying. Transmission electron microscopy of the microstructure of buttermilks revealed extremely heterogeneous microstructures and could not reveal any effect of the treatments.

Key Words: Buttermilk, Milk fat globule membrane, Phospholipids

W57 Yogurt manufactured with an immune enhancer. C. Olga and K. J. Aryana*, *Louisiana State University Agricultural Center, Baton Rouge.*

Arabinogalactan stimulates the body's immune defense system and enhances production of natural killer cells which destroy invading microorganisms. In human studies arabinogalactan showed increased immune cell proliferation at a consumption level of 1.5 g per day. The objective was to study the effect of the immune enhancer arabinogalactan on the physico-chemical, microbiological and sensory characteristics of yogurt. Arabinogalactan was added during mix preparation at 0, 1.5, 3.0 and 4.5 g per 228 g (8 oz) cup of yogurt. Total solids in the control compared to the treatments were kept constant with nonfat dry milk. The attributes studied were apparent viscosity, syneresis, pH, L*, a*, b*, C*, h*, flavor, appearance and color, body and texture, and microbial counts. Incorporation of arabinogalactan at all levels significantly increased C*, a* and b* but significantly decreased L* and h* values. Product pH was increased by the incorporation of arabinogalactan at 4.5 g per 228 g yogurt. The incorporation of arabinogalactan at any rate in yogurts did not significantly affect flavor scores, appearance and color scores, body and texture scores, apparent viscosity, microbial counts and syneresis of the product.

Key Words: Immune, Health, Fermented

W58 Heart healthy fat free yogurt. C. Olga and K. J. Aryana*, *Louisiana State University Agricultural Center, Baton Rouge.*

Cardiovascular diseases ranks as America's No. 1 killer, claiming the lives of nearly 39 percent of more than 2.4 million Americans who die each year. The objective was to study the effect of heart healthy nutrients on yogurt characteristics. Heart healthy plain yogurts were manufactured by incorporating heart healthy nutrients namely thiamine (vitamin B1), riboflavin (vitamin B2), niacin (vitamin B3), folic acid, manganese and magnesium at 0, 30, 60 and 90% of their respective recommended dietary allowance (RDA). Fiber was incorporated at a constant rate of 2.2% w/w mix in all the treatments since the amount of fiber would directly affect characteristics, such as viscosity, flavor and syneresis. The total solids in the control (no fiber, vitamins or minerals) were kept equal with the other yogurts by adding non fat dry milk. Viscosity, syneresis, pH, color, microbial counts of the yogurts were determined and the sensory (flavor, body and texture, appearance and color) evaluation was conducted at days 1, 7, 21 and 34 after yogurt manufacture. Incorporation of the heart healthy nutrients at the 30, 60 and 90 % significantly decreased syneresis, pH, L*, a* values but significantly increased b* and C* values. Product viscosity was significantly increased by the incorporation of the nutrients at 60% of their respective RDA's. The incorporation of heart healthy nutrients at any rate in yogurts did not significantly affect flavor, appearance, body and texture, microbial counts and h* values of the product. Incorporation of heart healthy nutrients affected some characteristics of fat free yogurts.

Key Words: Heart, Health, Fermented

W59 Yogurt manufactured using a novel dietary fiber with several health benefits. B. Trammell, K. J. Aryana*, and C. Boeneke, *Louisiana State University Agricultural Center, Baton Rouge.*

A novel fiber is being marketed as a dietary fiber with excellent physiological functions. It combines the advantages of the water-insoluble dietary fiber (microcrystalline cellulose) namely; improvement in

bowel movements, increase in amount of feces, prevention of colon cancer and the advantages of the water-soluble dietary fiber (resistant maltodextrin) namely; lowering level of serum cholesterol, improving glucose tolerance and improving intestinal flora. The objective was to study the effect of this novel fiber on the physico-chemical, microbiological and sensory characteristics of yogurt. The novel dietary fiber namely Ceolus™ Fiber DF-17 was incorporated at the rate of 0, 0.5, 1, 1.5%w/v yogurt mix. Product manufacture was replicated three times. The apparent viscosities of the control and yogurt with 0.5% fiber were not significantly different from each other but had significantly lower viscosities compared to yogurts with 1 and 1.5% fiber incorporated. The control had significantly higher syneresis than the treatments. Within the treatments as the amount of the fiber increased the syneresis significantly decreased. The control had a significantly higher lightness (L*) value and significantly lower a* value compared to yogurts with fiber incorporated at the rate of 1 and 1.5%. There was no significant treatment effect for flavor (p=0.6630) and appearance (p=0.7398). There was a treatment effect for body and texture (p=0.0083). The control was significantly lower than the 1 and 1.5% indicating that increase in fiber to 1.5% favors body and texture of the product. Incorporation of Ceolus™ Fiber DF-17 did not adversely affect the flavor and appearance of the product. Ceolus™ Fiber DF-17 addition favorably affected the viscosity, syneresis, body and texture of the product. Ceolus™ Fiber DF-17 can be recommended for incorporation to as high as 1.5% w/v in yogurts. It is possible to enjoy the health benefits of Ceolus™ Fiber DF-17 in yogurt.

Key Words: Fiber, Yogurt, Dairy

W60 Gross composition and nutrient profiles of Chinese yak (Maiwa) milk. J. Li*¹, Q. Sheng², M. Alam¹, X. Fang², and M. Guo¹, ¹*University of Vermont, Burlington,* ²*Sanlu Group Co., Ltd., Shijiazhuang, Hebei Province, P.R. China.*

Yaks are a major source of livelihood for the high landers where agriculture does not exist. This multipurpose animal has remained a subject of studies since the second half of 18th century. However, there is limited data available on the chemistry of yak milk in China. The objective of this study was to analyze the chemical composition and nutrient profiles of Chinese yak milk. Fresh milk samples from 7 mid-lactating yaks (Maiwa breed) in Hongyuan county of Sichuan Province in China were collected, pooled, lyophilized and stored at -20 °C before use. Gross composition (total solids, protein, fat, ash, and lactose), minerals, and profiles of fatty acids, amino acids and proteins of the milk samples were examined. The average values of gross composition were 14.35% total solids, 3.51% protein, 5.80% fat, 3.90% lactose, and 0.58% ash in the yak milk. The levels of Ca, Na, K, Mg, Zn, and Fe were 1149.4, 276.8, 1066.1, 105.3, 6.9, and 1.5 mg/L, respectively. Gas liquid chromatography analysis of milk fat showed that major fatty acids in yak milk were C_{16:0}, C_{18:1}, C_{18:0}, and C_{14:0}. There was a small amount (2.68 mg/g fat) of conjugated linoleic acid in yak milk. Results of amino acid analysis indicated that glutamic acid (183.79 mg/g protein) was the most abundant amino acid in yak milk. The mean values of lysine and methionine were 81.01 and 30.61 mg/g protein, respectively. The total essential amino acid percentage is 46.36% which suggests that the yak milk may be a good supply of essential amino acids. SDS-PAGE and densitometry results demonstrated that, similar to cow's milk, the major proteins in yak milk are caseins, which accounts for over 60% relative percentage of total proteins. The relative percentage of α -lactalbumin in yak milk was significantly lower ($P < 0.05$) compared to bovine milk. As information about yak milk chemistry is limited, especially in

China, more systematic studies in this area are needed in order to utilize this valuable resource.

Key Words: Chinese yak milk, Gross composition, Nutrient profile

W61 Development of a software program for goal oriented functional food formulation. Y. Yang*, S. Gokavi, X. Wu, and M. Guo, *University of Vermont, Burlington.*

Development of formulated functional foods is a complicated process that involves meeting many goals. Some of these goals may include matching the flavor and texture of other products of the same type, meeting regulatory requirements and compositional restrictions for appropriate quality and shelf-life, and meeting cost constraints. This process is referred to as goal oriented formulation. The objective of this study was to develop and test a computer program that uses a linear programming approach to aid in new product formulation to achieve required compositional goals. A computer program was designed to facilitate goal oriented formulation. The developed software has both formula and ingredient storage components. The entire USDA food composition database is available. The user entered formula specifications, such as amount of nutrients to be present in a particular formulation and the list of ingredients to be used in formulation. The user can also prepare a concise print out of the formulation that lists the amount of each ingredient to use plus any corresponding information and instructions. The software developed uses USDA data base for ingredients and their nutrient composition and can give several different recipes for one single product. One recipe can be selected based on its sensory qualities and cost of formulation. The developed software was found to be effective in determining the best recipe for a formulation, time saving, and easy to operate.

Key Words: Functional foods, Formulation, Software

W62 Organic butter and cheese: Preference, acceptability and consumer attitudes. M. Almena* and A. Howard, *University of Vermont, Burlington.*

Food acceptability is highly dependent by the sensory quality of the food, as well as social, cultural and economic conditions of the consumer. Consumers are willing to pay more for organic foods based on a number of preferences; however, the role of the sensory component is unclear. This study evaluated consumer sensory preference and acceptability of organic butter and cheeses (cheddar and cream cheese) comparing to their non-organic version. For each of the three products evaluated, two commercial samples (organic and non-organic) were tested using a face-to-face survey with consumers. A total of 85 individuals evaluated the butter samples and 91 evaluated the cheeses. Consumers were enlisted at a local coffee/bagel shop, as well as students from the University of Vermont. Overall acceptability and flavor of the products were evaluated using an increasing intensity 9-pt scale. In addition, the group of consumers evaluating cheese also scored the texture and appearance of the 4 samples. All the questionnaires

included a section in which subjects were asked about demographic information and their purchase habits toward organic and dairy products. Data were statistically analyzed by paired t-tests, ANOVA and Chi-square tests using SPSS. There was a significant preference overall ($P = 0.015$) for the organic butter (65%) vs. non-organic (35%). Vermonters especially showed a greater preference for the organic product, and they also indicated to purchase organic butter more often than non-Vermonters (31% vs. 14%). For the cheese, there was a significant preference overall ($P = 0.001$) for the non-organic samples for both cheddar and cream cheeses. Only 20% of the individuals preferred the organic cheddar and 26 % the organic cream cheese. However, most of the individuals purchasing organic products noted that they rather would buy the organic cheeses even though they preferred the non-organic product. No significant differences were found between genders in terms of preference for any of the products evaluated.

Key Words: Organic dairy products, Sensory, Acceptability

W63 Sensory evaluation of a novel ingredient produced from buttermilk. S. Jinjara¹, P. Morin², A. Olabi¹, and R. Jimenez-Flores^{*1}, ¹*California Polytechnic State University, San Luis Obispo*, ²*Laval University, Quebec City, Quebec, Canada.*

Buttermilk was concentrated by microfiltration (MF) and diafiltered (DF) to half its original volume, and the resulting retentate was subjected to super critical fluid extraction (SFE). This process was applied to concentrate the phospholipids of the milk fat globule membrane. Chemical analyses were performed to determine protein, fat, lactose, solid, and ash content. Two types of models and statistical analyses were performed, first to compare four types of buttermilks with and without SFE treatment, and second, to compare the treatments (DF-SFE, MF-SFE, SFE, none) for whey buttermilk (WBM) and sweet cream buttermilk (CBM) only. For the first model, attributes generally related to defects such as cardboard, sour, rancid and salty properties were significantly different along with some appearance properties. SFE enhanced the quality of the ingredients by reducing the level of several undesirable attributes with only yellowness, viscosity and cooked aroma presenting significant differences. Lactose and ash content were significantly different with $p \leq 0.05$ and $p \leq 0.001$ respectively. As for the second model, yellow color was significantly different while several flavors were found to have more significant differences than appearance. The four treatments increased intensities of flavor attributes. MF and DF combined with SFE yielded higher mean scores over the other two treatments on cardboard flavor. Lactose was significantly different for CBM and WBM. Replicate effect was not significant for most attributes in both models. Grain, sweet, and buttery flavors were desirable factors and noted in all samples. The resulting ingredient had significant higher phospholipids, in particular sphingomyelin.

Key Words: Buttermilk, Sensory evaluation, Novel ingredient

Forages and Pastures: Grazing

W64 Effects of grazing management on pasture characteristics affecting sediment and nutrient loads in surface waters. M. Haan^{*1}, J. Russell¹, D. Morrical¹, D. Strohbahn¹, W. Powers¹, J. Lawrence¹, and J. Kovar², ¹*Iowa State University, Ames*, ²*USDA-ARS, Ames, IA.*

To evaluate cattle grazing effects on the potential for sediment and nutrient loading of surface waters, forage cover, sward height, and mass and manure cover were measured in pastures with different grazing management systems. Six 12.1-ha cool-season grass pastures were

assigned one of three treatments: continuous stocking with unrestricted stream access (CSU), continuous stocking with stream access only at a reinforced crossing (CSR), or rotational stocking (5 paddocks; RS). Pastures were stocked with 15 fall-calving Angus cows (650±72 kg) from May through October, 2005. Forage sward height, determined with a falling plate meter (4.8 kg/m²), and mass, determined by clipping a 0.25-m² area, and the proportions of bare and manure-covered ground, determined by a point line procedure over 16.1 m, were measured monthly from open and congregation sites on the stream banks and at distances of 0 to 33.5 m, 33.5 to 67 m, and greater than 67 m from the stream banks. The proportion of ground that was bare was greater ($P<0.05$) in congregation than open areas in July through October. The proportion of ground covered with manure was greater ($P<0.05$) in congregation than open areas in August through October. Forage mass was lower ($P<0.05$) in congregation than open areas in June and August through October. Pastures with CSU had greater ($P<0.05$) proportions of bare soil in October, greater ($P<0.05$) manure cover on the banks and 0 to 33.5 m from the banks, lower ($P<0.05$) sward heights on the banks in June and October and lower ($P<0.05$) forage masses on the banks and 0 to 33.5 m from the banks in October than CSR pastures. In October, RS pastures had greater ($P<0.05$) proportions of manure-covered ground and lower ($P<0.05$) forage sward heights and masses on the banks and 0 to 33.5 m from the banks than CSR pastures. Results imply that limiting access to streams to stabilized crossings or using rotational grazing may decrease the potential for sediment and nutrient loading to surface waters.

Key Words: Grazing, Water quality

W65 Milk yield from crossbred cows grazing hybrid sorghum during fall. M. L. P. Lima*, F. F. Simili, J. R. Nogueira, M. G. Pinheiro, L. El Faro, and V. L. Cardoso, *Agencia Paulista de Tecnologia dos Agronegocios, Ribeirao Preto, SP, Brazil.*

Sorghum is typically used for silage, but also can be used for grazing. Hybrid sorghum is often planted for fall pasture when the quality of tropical pasture decline. The objective of this trial was to compare the milk production of crossbred cows grazing a perennial tropical pasture composed of guineagrass (*Panicum maximum*) and sorghum x sudangrass (*Sorghum bicolor* x *Sorghum sudanense*) pastures in a rotational system during the fall. Eighteen crossbred cows (Holstein x Gir), from 30 to 90 days in milk (in each experimental period) were used during two consecutive years and two grazing cycles per year. The experimental design was a split-split plot (two cycles and two years), analysed with SAS program. The three treatments were sorghum x sudangrass only (negative control), sorghum x sudangrass plus 3 kg of concentrate/hd/d, and guineagrass plus 6 kg of concentrate/hd/d. A significant ($P<0.01$) diet effect was observed on milk yield. Cows fed sorghum x sudangrass plus 3 kg of concentrate and guineagrass plus 6 kg of concentrate showed higher milk production than cows fed with sorghum x sudangrass pasture. However there were no differences ($P>0.10$) in fat-corrected milk production. Treatments did not affect %fat, %protein, %lactose, or %total solids not fat. Year affected %fat ($P<0.001$). No parameters were affected by grazing cycles. The authors concluded that concentrate supplementation improves the milk production for cows grazing sorghum x sudangrass pastures.

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Table 1. Effect of treatments on milk yield, composition of milk

	Sorghum	Sorghum +3kg of concentrate	Guineagrass +6kg of concentrate	SEM
Milk yield, kg/day	16.01 ^b	18.29 ^a	18.41 ^a	0.84
3.5% fat corrected milk, kg/day	15.48 ^a	17.21 ^a	17.87 ^a	0.92
Fat %	3.25 ^a	3.07 ^a	3.35 ^a	0.12
Protein %	2.99 ^a	2.98 ^a	3.08 ^a	0.06
Lactose %	4.44 ^a	4.44 ^a	4.47 ^a	0.04
Total solids %	11.34 ^a	11.41 ^a	11.23 ^a	0.07

Within a row, means with different superscripts differ significantly ($P<0.05$)

Key Words: Dairy cow, Hybrid sorghum, Tropical pasture

W66 In situ dry matter degradation kinetics of the diet selected by grazing cattle in a grassland of Northern Mexico. O. Reyes-Estrada, M. Murillo-Ortiz, E. Herrera-Torres, M. Guerrero-Cervantes, G. Nevarez-Carrasco, R. Montoya-Escalante, M. A. Cerrillo-Soto*, and A. S. Juarez-Reyes, *Universidad Juárez del Estado de Durango, Durango, Dgo. Mexico.*

The study was carried out to determine the *in situ* DM degradation kinetics of the diet selected by range cattle. Four esophageal cannulated steers (350 ± 5.0 kg BW) were used to obtain extrusa samples during Spring (Apr-Jun), Summer (Jul-Sep), Autumn (Oct- Dec) and Winter (Jan-Mar). To estimate the *in situ* degradation kinetics, 10g of sample were incubated in the rumen of two fistulated heifers (375 ± 4kg BW) fed alfalfa hay *ad lib*. The bags were withdrawn from the rumen at 0, 3, 6, 9, 15, 24, 36, 48, 72 and 96h. Data were fitted to the model: $Y = a + b(1 - e^{-ct})$, where a is the intercept; b is the slowly degradable fraction; c is the rate constant of disappearance of b ; t is the time of incubation and k is the estimated rate of out flow. The potential degradability (PD) was estimated as $a + b$ and the effective degradability (ED) was calculated by: $ED = a + (b * c)/(c + k)$. The parameters a , b , c , PD and ED were analyzed using PROC GLM according to a completely randomized block design. The mean value for fraction (a) was 20.6% and no differences were registered between seasons ($P>0.05$). Regarding the fraction (b), no differences were recorded in most parts of the year (Spring, Autumn and Winter) ($P>0.05$) although higher values ($P<0.05$) were observed during the rainy months (Summer; 68.0%). Similarly, the constant rate of degradation (c) was 3.5 times higher in Summer (5.7%/h) than in the winter (1.6%/h). Values related to PD were similar between Autumn and Winter ($P>0.05$), but lower ($P<0.05$) than those obtained in Spring and Summer. The ED was also different among periods of sampling ($P<0.05$). Regarding the *in situ* DM degradability, higher values ($P<0.05$) were also obtained during the rainy months (24h; 76.1%, and 48h; 83.5%) compared with those obtained when forage in the field is dormant (Winter; 39.1%) and in the dry season (Spring; 62.8%). Results from this study indicate that the constant rate of degradation (c) and the *in situ* DM degradation at 24 and 48h, may be adequate estimations to identify variations in nutrient availability among diets consumed by range cattle throughout the year.

Table 1. *In situ* degradability parameters (%) of the forage selected by grazing cattle

Item Parameters	Seasons				Mean	sem
	Spring	Summer	Autumn	Winter		
Soluble fraction (a)	23.0 ^a	20.9 ^a	19.4 ^a	19.2 ^a	20.6	0.010
Slowly degradable fraction (b)	59.3 ^b	68.0 ^a	57.9 ^b	59.9 ^b	61.2	0.043
Constant rate of degradation (c)	4.3 ^b	5.7 ^a	2.5 ^c	1.6 ^d	3.5	0.019
Potentially degradable fraction (a+b)	82.3 ^b	88.9 ^a	77.4 ^c	79.2 ^c	81.9	0.045
Effective degradability	41.1 ^b	47.1 ^a	35.1 ^c	26.3 ^d	37.4	0.023

Means between rows with different superscripts differ ($P < 0.05$)

Key Words: Degradation kinetics, Grazing cattle, Northern Mexico

W67 Nutritional characteristics of native grasses used in a pasture system. A. Loyd*¹, S. Smith², J. D. Sampson¹, and J. N. Spain¹, ¹University of Missouri, Columbia, ²Windrush Farm, Columbia, MO.

Sustainable livestock systems are being developed that support thriving wildlife populations alongside profitable agricultural systems. Grazing systems that better utilize native grass species (to provide an appropriate habitat for wild birds as well as forages for beef cattle) may provide one answer to help achieve this delicate balance. The objective of this study is to describe the nutritional qualities of native grasses produced during the summer in Missouri. 11 native Missouri grass species were analyzed: Bluejoint (BJ), Canada Wildrye (CWR), Cluster Fescue (CIF), Compass Plant (CmpP), Cordgrass (CRD), Indian Grass (IG), Little Bluestem (LB), Prairie Dock (PrDk), Prairie Dropseed (PDRP), Sawtoothed Sunflower (SS), and Virginia Wildrye (VW). Each species was sampled every 28 days beginning May 2004. Beginning in June 2004, regrowth samples were also collected from the previously sampled forage as allowed by forage regrowth. Samples were taken manually at the height of 15.2 cm to approximate the height grazed by cattle. Dried samples were analyzed for: DM, OM, NDF, ADF, CP. Samples were incubated *in situ* in the rumens of mature steers. Incubated times were 0, 24 and 48 hours. Data for 24h DMD were analyzed as a repeated measurement using the proc mixed procedures in SAS. The main plot contained effect of forage and the subplot contained the effect of month and forage by month. Crude protein decreased as season progressed for all forages with concurrent increases in NDF and ADF. DM digestibility differed significantly by forage and over the growing season. Compass plant and PrDk had the highest average DMD (63.30% and 69.66%, respectively) compared to CRD (31.72%) and PDRP (31.54%) ($P < 0.001$). Differences in DMD was evident across the entire growing season with PrDk having the highest DMD in June (81.75%) while DMD of PDRP was 32.13%. The results of this study provide basic nutrient profiles of native grasses and digestibility values for changes over the grazing season and can be used to predict digestible forage dry matter for multicultural grazing systems.

Key Words: Native grasses, Nutrient content, Dry Matter Degradation

W68 Supplement level and stocking rate effects on stockers grazing rye-ryegrass pastures. M. Rouquette*¹ and J. Vendramini², ¹Texas A&M University Agricultural Research & Extension Center, Overton, ²Texas Cooperative Extension, Overton.

Level of supplement (SUP) has various associative effects on forage intake, total diet, and performance per animal and unit land area. The objective of this study was to quantify ADG and gain/ha of stockers grazing a mixture of 'Maton' rye and 'TAM-90' of annual ryegrass at 3 stocking rates (STK) and receiving 3 levels of SUP. Stocking rates in a fixed stocking design with two pasture replicates per treatment were 3.7, 5.2, and 7.2 hd/ha based on initial stocker weights of 270 kg/animal (half-Simmental steers and heifers). A ration containing 98% cracked corn plus Rumensin 80, salt, dicalcium phosphate, and dried molasses was group fed daily at 0 (PAS), 0.4% BW (.4BW), and 0.8% BW (.8BW). Stocking was continuous from Dec. 20 to May 17 (148 d). Average daily gain was greatest ($P < 0.01$) at 1.5 kg/d from .8 BW, and similar for 0.4 BW and PAS at 1.28 and 1.15 kg/d, respectively. The ADG were similar for calves stocked at 3.7 and 5.2 hd/d, 1.37 and 1.47 kg/d respectively, and both were higher ($P < 0.01$) than ADG of 1.05 kg/d at the highest STK of 7.2 hd/ha. The ADG among the nine treatments ranged from 0.51 kg/d from PAS when stocked at 7.2 hd/ha to 1.5 kg/d from .8 BW when stocked at 3.7 hd/ha. The .4 BW SUP level was more efficient ($P < 0.01$) at each STK compared to cattle receiving .8 BW. The SUP:extra gain ratios for .4 BW were 4.7:1, 5.4:1, and 10.6:1 when stocked at 7.2, 5.2, and 3.7 hd/ha, respectively; whereas, ratios for .8 BW were 7.2:1, 7.8:1, and 15.9:1, respectively, when stocked at 7.2, 5.2, and 3.7 hd/ha. Gain per animal efficiencies of SUP were maximized at .4 BW at both high and medium stocking rates, and were minimized at .8 BW and low stocking rate. Gain per ha of 543 kg was least on PAS and 7.2 hd/ha, and greatest from .8 BW and medium stocking rate (5.2 hd/ha) at 1083 kg/ha ($P < 0.01$). Management strategies for stocking rate and supplementation are uniquely linked to animal weight, animal prices, pasture and supplement costs, ADG, and selling margin.

Key Words: Stocking rate, Supplementation, Pasture

W69 Feeding grazing dairy cows with soybean meal, sunflower meal or canola meal in winter. M. R. Gallardo*¹, S. E. Valtorta², H. C. Castro¹, M. C. Gaggiotti¹, and C. Arakaki³, ¹EEA Rafaela - National Institute of Agricultural Technology, Rafaela, Santa Fe, Argentina, ²National Research Council (CONICET), Rafaela, Santa Fe, Argentina, ³CICV - National Institute of Agricultural Technology, Castelar, Buenos Aires, Argentina.

In Argentine grazing systems, additional supply of energy and protein is needed to balance the diet during periods of pasture shortage in winter. Three protein meal sources were evaluated, in terms of milk yield and composition, for grazing dairy cows receiving a supplementary PMR. Thirty three multiparous cows, averaging 75 ± 15 DIM, and over 7000 L/cow in previous lactations, were randomly assigned to 3 treatments: SM= soybean meal, L-SuM= sunflower meal-low-protein and CM= canola meal, in a continuous split-plot design with covariance analysis. The diets were isoenergetic (1.82 Mcal NEL) and isonitrogenous (17% CP), and were formulated (DM basis) with 17 % pasture and 83% of a PMR containing corn silage, alfalfa hay, corn grain, minerals and vitamins premix and the corresponding protein meal. The CP concentrations were 28, 35 and 41% for L-SuM, CM and SM, and represented 25, 20 and 15% total diet DM, respectively. Table 1 shows milk yield and composition for all treatments. The L-SM had the

lowest response in terms of milk yield, but the highest in milk fat percentage, thus suggesting concentration effects. On the other hand, CM produced the lowest protein concentrations, probably because of differences in dietary amino acid supply to the mammary gland. Milk urea concentration was lowest for CM.

Table 1. Milk yield and composition for grazing dairy cows receiving soybean meal (SM), sunflower meal (L-SuM), or canola meal (CM) in the diet.

Parameter	SM	L-SuM	CM	SEM	P<
Milk yield, L/cow/day	32.10 a	28.67 b	31.95 a	1.65	0.0003
Milk fat, %	3.41 a	3.59 b	3.37 a	0.35	0.0001
Milk fat yield, kg/cow/day	1.094	1.029	1.182	0.14	NS
Milk protein, %	3.62 a	3.79 a	3.08 b	0.11	0.0000
Milk protein yield, kg/cow/day	1.162	1.029	0.984	0.062	NS
Lactose, %	5.03	4.90	4.99	0.19	NS
MUN, mg%	15.83 a	14.32 a	10.03 b	3.86	0.0031

Key Words: Soybean meal, Sunflower meal, Canola meal

W70 Effect of spring grazing date and subsequent stocking rate on dairy cow performance in the mid grazing season. E. Kennedy^{1,2}, M. O'Donovan¹, J. P. Murphy¹, F. O'Mara², and L. Delaby³, ¹Dairy Production Research Centre, Teagasc Moorepark, Fermoy, Co. Cork, Ireland, ²UCD, Dublin, Ireland, ³INRA, St. Gilles, France.

Sixty-four spring calving Holstein Friesian dairy cows (32 primiparous and 32 multiparous) were randomly assigned to 4 grazing treatments (n=16). The objective was to compare the effect of initial spring grazing date and stocking rate on the production performance of spring calving cows. Two swards, early grazed (E) and late grazed (L), were created and 2 stocking rates (SR), high (H) and medium (M), were applied across them. Half of the area was grazed once between 16 February and 4 April, creating the early grazed sward. The rest of the area remained ungrazed from the previous October i.e. late grazed sward. The SRs imposed were 5.5 cows/ha (EH), 4.5 cows/ha (EM), 6.4 cows/ha (LH) and 5.5 cows/ha (LM). The study was completed over 4, 21-day rotations from 16 April to 3 July 2004. Herbage mass and sward density were measured twice weekly by taking 2 cuts per paddock with a power mower. Pre- and post-graze pasture heights were taken daily. Milk yield was recorded daily and milk composition determined weekly. All animal parameters were analysed using covariate analysis. Milk, SCM, protein, fat and lactose yield were significantly higher ($P < 0.001$) for the EM animals. There was no significant difference in liveweight or body condition score between the treatments. The results suggest that an increased level of animal performance is achievable with early grazed swards stocked at a medium SR (EM treatment).

Table 1. Effect of spring grazing date and stocking rate on milk production performance

	EH	EM	LH	LM	SED	Sig
Milk yield (kg/day)	22.7 ^b	24.5 ^a	20.9 ^c	22.4 ^b	1.03	0.001
Fat yield (g/day)	872 ^b	918 ^a	830 ^b	846 ^b	38.9	0.01
Protein yield (g/day)	744 ^b	831 ^a	670 ^c	733 ^b	32.6	0.001
Lactose yield (g/day)	1068 ^b	1159 ^a	976 ^c	1052 ^b	53.3	0.001
Solids corrected milk yield (kg/day)	20.9 ^b	22.5 ^a	19.4 ^c	20.4 ^{bc}	0.86	0.001
Grass dry matter intake (kg DM/cow/day)	16.3 ^b	17.5 ^a	15.2 ^c	16.5 ^a	0.74	0.001

^{abc}Values in the same row not sharing a common superscript are significantly different

Key Words: Grazing date, Stocking rate, Milk Production

W71 Synchronous and asynchronous concentrate supplements to lactating dairy cows on pasture. A. Konyali^{1,2}, K.-H. Südekum^{1,3}, W. Junge¹, M. Lukas¹, and E. Kalm¹, ¹University of Kiel, Kiel, Germany, ²Çanakkale Onsekiz Mart University, Çanakkale, Turkey, ³University of Bonn, Bonn, Germany.

The objectives were to evaluate the effects of two isocaloric and isonitrogenous concentrates that differ in the rate of carbohydrate degradation in the rumen on lactational performance of dairy cows on pasture. Both concentrates were fed to lactating dairy cows grazing intensive (mineral fertilizer, 200 kg N/ha per year; slurry, 20 m³/ha per year; 100% perennial ryegrass) or extensive (mineral fertilizer, 0 kg N/ha per year; slurry, 20 m³/ha per year; white clover-dandelion-grasses) pastures such that ruminal degradation rate of carbohydrates was either synchronous or asynchronous to pasture crude protein degradation. The synchronous concentrate contained (as-fed basis) more than 50% of barley, tapioca, and beet pulp. The asynchronous concentrate was based on corn (39%) as the primary starch source. Degree of ruminal synchrony of carbohydrate and crude protein degradation was based upon table values. During two complete grazing periods (> 5 months each), 236 dairy cows, 127 (67 Red-Pied and 60 German Friesian) in 1997, and 109 (50 Red-Pied and 59 German Friesian) in 1998, were fed with combinations of one of the concentrates that were allocated according to milk yield and one of the pasture types that were offered for ad libitum intake and rotationally grazed. A 2 × 2 factorial arrangement of treatments was used in a randomized block design. Pasture dry matter intakes averaged 11.7 and 12.6 kg/day for the intensive and extensive pasture. Concentrate type did not affect ($P > 0.10$) milk or milk component yield. Cows on the extensive pasture yielded more ($P < 0.06$) milk than those on the intensive pasture (22.1 versus 21.1 kg/d). Cows on the intensive sward had higher ($P < 0.001$) milk urea concentrations, indicating a lower efficiency of N conversion from feed into milk. Efficiency of N utilization was not affected by concentrate type. Higher ruminal carbohydrate degradability of the synchronous concentrate did not benefit cows in mid to late lactation grazing high-quality pasture.

Key Words: Protein, Carbohydrate, Rumen synchrony

W72 Performance and urinary alkaloid excretion of stocker cattle grazing nontoxic or toxic tall fescue over-seeded with white clover. J. Andrae*¹, N. Hill¹, and J. Bouton², ¹The University of Georgia, Athens, ²The Samuel Roberts Noble Foundation, Ardmore, OK.

Eight paddocks (0.8 ha/paddock) were utilized near Eatonton, GA to determine the effects of tall fescue endophyte strain and white clover presence on urinary ergot alkaloid excretion and animal performance. Jesup tall fescue infected with a toxic endophyte or a nonergot alkaloid-producing endophyte (AR542; aka “MaxQ”) was planted in four paddocks respectively. Two paddocks of each endophyte type were also over-seeded with Durana white clover. Each paddock was grazed with a minimum of two tester steers (mean initial wt 311 kg) in spring of 2003 - 2005. Animal gain, botanical composition, forage availability, and urine alkaloid concentration was monitored at 28 d intervals. Paddocks were grazed for 125, 56, and 113 d in 2003, 2004, and 2005. Put-and-take grazing was utilized to maintain similar forage availability. Data were analyzed as a completely randomized design with a 2X2 factorial arrangement of treatments. Paddock was the experimental unit. Endophyte type and clover were main effects. Drought in 2004 shortened the grazing season and decreased ($P<0.01$) gain/ha by approximately 50% for all treatments. Daily gain of cattle grazing toxic endophyte was similar ($P=0.30$) to AR542 in 2003, but was lower ($P<0.05$) in 2004 and 2005. Cattle grazing toxic endophyte had decreased gain/ha ($P<0.01$) and increased urine alkaloid concentration ($P<0.01$) regardless of year. White clover decreased carrying capacity ($P<0.01$) but improved ADG ($P<0.01$) and gain/ha ($P<0.01$). No endophyte x clover interaction was detected for ADG ($P = 0.38$). Cattle grazing white clover and toxic tall fescue had intermediate ($P<0.05$) urine alkaloid concentrations compared to toxic fescue without clover or all nontoxic tall fescue treatments. The lack of a significant clover x endophyte type interaction for average daily gain suggests that the alkaloid dilution observed in this study was inadequate to completely offset tall fescue toxicosis and improved animal performance from clover was associated with increased nutrient density.

Key Words: Tall fescue toxicosis, Clover, Alkaloids

W73 Removing seasonal affects from pasture plate meter calibrations. E. B. Rayburn, W. L. Shockey*, B. D. Smith, D. A. Seymore, and J. D. Lozier, *West Virginia University Extension Service, Morgantown.*

This study was conducted to develop a calibration for paddock mean falling plate meter height (PH), herbage density (HD) and herbage mass (HM) in rotationally stocked pastures under different fertility treatments and to determine if there was a seasonal or treatment effect on the calibration. Accurate, rapid measurement of HM is needed in pasture research and for on-farm pasture budgeting. Four rotationally stocked pastures were sampled for PH using a standardized falling plate meter. Pastures were predominantly orchardgrass, bluegrass, and white clover. Fertility treatments were poultry litter at 4,480 kg/ha/year, poultry litter at 8,960 kg/ha/year, lime and phosphorous as needed based on soil test, and lime only as needed based on soil test. Pastures were walked on established transects and 15 paired PH and HM samples were taken at random and clipped to ground level. For each data pair, HD was calculated by dividing HM by PH. Paddock means for PH, HD and HM were calculated for each paddock and sampling date. Paddocks were sampled just before grazing over a 3 year period as follows (month/number of sampling periods): May/16, June/8, July/5, August/7, September/4, October/11, and November/8. Regressions of

paddock mean HD and paddock mean HM as functions of PH were calculated using all paddock sampling dates and fertility treatments. The plate meter calibration regression for HD based on PH was: $HD = 264 - 6.6 PH$; $R^2 = 0.29$; $SD_{reg} = 42$. Regression coefficients were significant ($P<0.001$). Estimating mean pasture HM as the product of PH times HD resulted in a second order function without an intercept and was: $HM = 264 PH - 6.6 PH^2$. Compared to the clipped HM measured this model had an $R^2 = 0.93$; $SD_{reg} = 687$. Analysis of variance of regression residuals found no significant effect of season or treatment on the accuracy of HD and HM estimates. This method provides one calibration that applies across seasons and fertility treatment for pastures of similar botanical composition and under the same defoliation management.

Key Words: Pasture, Plate meter height, Yield calibration

W74 Effect of high and low residual herbage mass of a tropical pasture grazed by goats. 1. Grazing behaviour^a. J. S. Fernandes Jr.¹, K. T. Resende¹, J. J. R. Fernandes*³, L. O. Tedeschi², R. A. Reis¹, M. H. M. R. Fernandes¹, and H. M. Silva¹, ¹Universidade Estadual Paulista/FCAV, Jaboticabal, SP, Brazil, ²Texas A&M University, College Station, ³Universidade Federal de Goias, Goiania, GO, Brazil.

The objective of this study was to determine the grazing behaviour of F1 Boer x Saanen goats maintained in a tropical pasture (*Panicum maximum* Jacq), under rotational grazing system in different sward structure. The area was divided into 12 paddocks of 990 m² each, allocated in six blocks. Each paddock was divided into two identical plots (treatments, TRT) with high residual (HR, 3.1 t/ha of green herbage mass; GHM) and low residual (LR, 2.0 t/ha GHM). Each plot was grazed for three consecutive d (D1, D2 and D3) before animals were rotated. Grazing time (GT, min) was recorded during daytime (0700 to 1900 h) and behavior was observed every 10 min, with four animals per TRT. Bite rate (BR, bites/min) was the total number of bites during three minutes, and bite mass (BM, g/bite) was estimated with esophageally fistulated animals. Measurements were conducted during three consecutive grazing cycles of 36 d. The mean stocking rate for HR was 33 goats/ha (or 6.6 animal unity (AU)/ha) and for LR was 43 goats/ha (or 8.4 AU/ha). The GT increased from D1 to D3 (468, 491 and 535 min for D1, D2, D3) in the LR, but did not differ in the HR (468 min). BR did not differ between treatments ($P=0.12$) or among days ($P=0.42$), and averaged 80.3 bites/min. In contrast, BM was higher ($P=0.01$) in HR (0.18 g/bite) than in LR(0.15 g/bite), and decreased from D1 to D3 (0.22; 0.16 and 0.11 g/bite). These differences can be explained by the low herbage allowances in the LR. We observed the functional relationship between BM and GT, in which the animal increased the grazing time to offset the lower BM. Our findings are consistent with the general assumption that BM are greatest during the first day, as a result of the trade-off between quantity and quality of the herbage mass. ^a Sponsored by FAPESP and CNPq, Brazil

Key Words: Ingestive behaviour, Panicum, Residual mass

W75 Effect of high and low residual herbage mass of a tropical pasture grazed by goats. 2. Sward structure^a. J. S. Fernandes Jr.*¹, K. T. Resende¹, M. H. M. R. Fernandes¹, L. O. Tedeschi², R. A. Reis¹, J. J. R. Fernandes³, and F. G. Souza¹, ¹Universidade Estadual Paulista/FCAV, Jaboticabal, SP, Brazil, ²Texas A&M University, College Station, ³Universidade Federal de Goias, Goiania, GO, Brazil.

The objective of this study was to evaluate the residual herbage mass on the sward structure of a rotational tropical pasture (*Panicum maximum* Jacq), grazed by F1 Boer x Saanen goats. The area was divided into 12 paddocks of 990 m² each, allocated in six blocks. Each paddock was divided into two identical plots (treatments, TRT) with high residual (HR) and low residual (LR) green mass (GM). Each plot was grazed for three consecutive d before animals were rotated. Sward height and herbage samples were taken in the morning on day 1, 2, 3 of grazing and on residual mass (D1, D2, D3 and D4). For each sampling, two quadrates of 50 x 50 cm were randomly cast within the plot. Herbage mass (HM) was cut down to the ground level within the quadrates, weighed, divided into three parts: green leaves mass, stem mass and dead herbage mass, and dried at 65°C. Measurements were conducted during three consecutive grazing cycles of 36 d. The HM, GM, leaf proportion and sward height decreased from D1 to R. In contrast stem:leaf ratio (S:L) increased from D1 to R (Table). Sward height was higher for HR than in LR, even though both treatments had similar HM, GM and S:L values in the first grazing day (D1) of the paddock. Our findings suggested that green leaf might be the principal component that dictates intake in tropical pastures, even when herbage allowances are low. ^aSponsored by FAPESP and CNPq, Brazil

Table 1.

Item	TRT	D1	D2	D3	D4
Herbage mass (t/ha)	HR	7.0 ^a	6.4 ^{ab}	5.8 ^{bc}	5.2 ^c
	LR	6.8 ^a	5.8 ^b	5.1 ^b	4.1 ^c
Green mass (t/ha)	HR	4.5 ^a	4.0 ^b	3.5 ^c	3.1 ^d
	LR	4.3 ^a	3.3 ^b	2.7 ^c	2.0 ^d
Stem:Leaf	HR	0.6 ^c	0.7 ^c	1.0 ^b	1.2 ^a
	LR	0.6 ^d	0.9 ^c	1.4 ^b	2.2 ^a
Leaf proportion (%)	HR	43.6 ^a	37.2 ^b	29.5 ^c	26.2 ^c
	LR	40.2 ^a	30.4 ^b	21.2 ^c	14.2 ^d
Sward height (cm)	HR	61.7 ^a	50.9 ^b	40.7 ^c	36.8 ^d
	LR	57.1 ^a	40.0 ^b	29.7 ^c	25.8 ^d

^{A,B}Distinct letters in the same row differ at P < 0.05 by least square means. ^{a,b}Distinct letters in the same column differ at P < 0.05 by least square means

Key Words: Plant structure, *Panicum*, Residual mass

Goat Species: Product Quality and Reproductive Performance of Goats

W77 Comparison of quality characteristics of chevon and lamb. K. R. Eega*, J. H. Lee, G. Kannan, B. Kouakou, and W. R. Getz, *Fort Valley State University, Fort Valley, GA.*

Chevon (goat meat) has been reported to be inferior in palatability compared to other traditional red meats, although it has lower fat and healthier fatty acid profiles compared to lamb. The objective of this study was to determine whether the quality characteristics of chevon differ from those of lamb. Sheep (n = 16) and goats (n = 16) raised under similar situations were slaughtered using standard procedures. After 24 h of cooler storage (4°C), the carcasses were fabricated into primal cuts. Loin chops *Longissimus dorsi* were used for color (CIE L* a* b*), Warner-Bratzler shear force values, cooking loss, percent metmyoglobin, and thiobarbituric acid reactive substances (TBARS) determination at 24 h postmortem. The chops were placed on aluminum pans and covered with aluminum foil, cooked in a convection oven to an internal temperature on 71 °C, cooled at 2 °C for 24 h, and then 1 cm cores were removed for shear value determinations. Analysis of

W76 Defoliation effects on root and rhizome development of kura clover. B. W. Kim*¹ and K. A. Albrecht², ¹*Kangwon National University, Chunchon, Kangwon-Do, South-Korea,* ²*University of Wisconsin, Madison.*

There is limited information on relationship between defoliation and root and rhizome development of kura clover (*Trifolium ambiguum* M. Bieb.). To determine the effects of defoliation severity on root and rhizome growth of young kura clover plant (seedling about 8 wk old), this research was conducted in 2002 (Experiment 1) and 2003 (Experiment 2) in a glasshouse on the University of Wisconsin-Madison. Four kura clover entries were used in this experiment: two were started from seed materials (ARS-2678 and 'Rhizo') and two were clones from mature, field grown Rhizo kura clover plant. Three defoliation frequencies (2-, 4- and 6-wk intervals) and two defoliation intensities (complete and partial defoliation) were imposed on each of the four kura clover entries. Root, rhizome, and leaf dry matter (DM) generally increased with less frequent defoliation, however, the increase in rhizome DM was not significant between 4- or 6-wk defoliation periods. The root and leaf DM under complete defoliation (CD) were significantly lower than under partial defoliation (PD). In Exp. 1, rhizome DM was not significantly different between CD and PD; it was significantly lower under CD in Exp. 2. ARS-2678 showed excellent root development characteristics, however, its rhizome DM was significantly lower than Rhizo clones. The rhizome development from Rhizo clones was greater than that from seed materials. If maximum root and rhizome growth are expected from young kura clover plant, the intensity and frequency of defoliation should be minimized or defoliation should be avoided.

Key Words: Kura clover, Defoliation, Rhizome

data as a Completely Randomized Design showed that Warner-Bratzler shear force values were significantly lower (P ≤ 0.01) in lamb chops compared with chevon chops. The mean (± SEM) shear values were 2.12 ± 0.21 and 1.3 ± 0.21 kg in chevon and lamb chops, respectively. The L* values (lightness) were not different between chevon and lamb chops; however, a* values (redness) of lamb chops were higher (P ≤ 0.01) compared with chevon chops. The mean (± SEM) a* values were 12.2 ± 0.37 and 14.2 ± 0.37, respectively, in chevon and lamb chops. Percent metmyoglobin and TBARS were not different among the chops, indicating that levels of pigment and lipid oxidation were not different between lamb and chevon at 24 h postmortem. Cooking loss was also not influenced by species. The results indicate that lamb may have better tenderness properties compared with chevon, although several other quality characteristics studied were not different.

Key Words: Chevon, Lamb, Tenderness

W78 Effect of fat supplementation on the performance of meat goats fed eastern gamagrass. A. White*, J. Bartlett, and E. Rhoden, *Tuskegee University, Tuskegee, AL.*

Eastern gamagrass (EGG) is a native bunch grass that has excellent potential as forage for ruminants. The objective of this study was to evaluate the performance and carcass characteristics of meat goats fed EGG supplemented with fat (peanut oil). Twenty four intact male Boer crosses (4 mon old) were assigned to one of 4 treatments: diet A, control, no added fat and diets B, C and D with 1.6, 3.2 and 4.8% added fat, respectively. Goats were fed a 60:40 (EGG: Concentrate) ration twice daily for 12 wk and water and mineral block were offered ad libitum. Refusals and intake were monitored daily and BW were recorded weekly. Goats were slaughtered at the end of the study and hot (HCW) and cold carcass weights (CCW) were recorded. No significant difference ($P > 0.05$) was observed among treatments for initial BW, final BW, fasted BW, HCW and CCW. Total BW gain was 8.47, 8.39, 7.64 and 6.20 kg for diets A, C, B and D, respectively. Average daily gain showed no significant differences ($P > 0.05$) among treatments. Goats in diet A had higher ($P < 0.05$) ADFI than those in diets C and D, with an average of 827.78 g/day. Specialty cuts were also evaluated as a percentage of CCW and included the leg, shoulder, loin, neck, and ribs. Diet D showed the largest mean leg percentage (32.79 %), which was higher ($P < 0.05$) than diet B (30.74%). There were no differences observed for the other cuts. Feeding supplemental fat in the diet of goats did not seem to significantly impact their performance except for ADFI. However, the effect of fat supplement on the quality of the meat is being further evaluated.

Key Words: Eastern gamagrass, Goats, Peanut oil

W79 Effects of diet on chemical composition and quality of meat in goats. J. H. Lee*, B. Kouakou, K. R. Eega, and G. Kannan, *Fort Valley State University, Fort Valley, GA.*

Thirty-six Boer x Spanish kids (BW = 20 ± 0.6 kg) were used to determine the effects of diet on the chemical composition and quality of chevon (goat meat). Animals were divided into three groups and randomly assigned to one of three dietary treatments: 18% CP concentrate for 90 d (CC-diet); alfalfa (*Medicago sativa*) hay cubes for the first 45 d followed by concentrate for 45 d (HC-diet); or alfalfa hay diet for 90 d (HH-diet). Goats were slaughtered and the intramuscular and subcutaneous fat samples were obtained from each carcass for analysis of fatty acid composition. Loin chops (*Longissimus dorsi*, LD) were used to determine proximate composition, color (CIE $L^* a^* b^*$), cooking loss, and Warner-Bratzler shear force values. No significant differences were found in protein and ash percentages among the LD muscles of goat carcasses from the three treatments. Goats from the HH-diet group had higher ($P \leq 0.05$) level of moisture (77.1 vs. 74.7%), and lower ($P \leq 0.05$) level of fat (1.32 vs. 2.67%) in LD muscles compared with those from the CC-diet, while the HC-diet group had intermediate levels of moisture and fat. Compared to HH-diet group, the CC-diet group had a higher ($P \leq 0.05$) level of oleic acid (C18:1n9; 43.8 vs. 38.7%), and a lower ($P \leq 0.05$) level of linolenic acid (C18:3n3; 0.12 vs. 0.46%) in the intramuscular fat. The CC-diet group also had a higher ($P \leq 0.05$) level of linoleic acid (C18:2n6; 4.27 vs. 3.11%), and lower ($P \leq 0.05$) levels of decanoic acid (C10:0), myristic acid (C14:0), and C18:3n3 (0.44 vs. 0.76%) in the subcutaneous fat than the HH-diet group. The L^* (lightness) values of loin chops from the HH-diet group were higher ($P \leq 0.05$) than the CC-diet group; however, the a^* values (redness) were not different among the three treatment groups. Warner-Bratzler shear force values

and cooking losses were also not influenced by the diets. Although dietary treatments did not influence meat quality characteristics in this study, chevon from hay-fed goats may have healthier nutritional properties compared to that from concentrate-fed goats.

Key Words: Goats, Diet, Chevron

W80 Reduction of skin and carcass *E. coli* contamination in goats by dietary brown seaweed extract supplementation and skin wash. G. Kannan*, K. R. Eega, J. H. Lee, B. Kouakou, and T. H. Terrill, *Fort Valley State University, Fort Valley, GA.*

Dietary supplementation of brown seaweed extract (*Ascophyllum nodosum*) reduces *E. coli* counts in beef cattle, although the mechanism of action is not clear. This experiment was conducted to determine the effects of seaweed extract supplementation and chlorinated skin wash on skin and carcass microbial contamination in goats. In a Completely Randomized Design with split-plot, thirty-two Boer x Spanish bucks (8 mo of age) were fed a diet containing alfalfa pellets (60%) and Tasco feed supplement (40%) with (4 pens) or without (4 pens) seaweed extract ($n = 16$ goats/treatment) for 14 days. At the end of the feeding trial, two bucks from each pen were spray washed with chlorinated water (50 ppm) after stunning, and the other two bucks were processed as unwashed controls. Skin swab samples were made on the hind legs (5 x 5 cm area) prior to overnight holding, after holding, and after spray washing. Immediately after evisceration, carcass swab samples were taken to assess contamination levels. The pH of rumen and large intestinal contents and concentrations of rumen volatile fatty acids were not different between dietary treatments. Microbial counts in feces were also not different between dietary treatments. However, *E. coli* counts of rumen contents decreased ($P \leq 0.05$) due to seaweed extract supplementation. The main effect of chlorine wash on aerobic plate counts on skin was significant ($P \leq 0.05$), with mean (\pm SEM) counts of 3.65 ± 0.19 and 4.30 ± 0.19 log₁₀ CFU/cm², respectively, in washed and unwashed groups. The goats subjected to seaweed extract dietary treatment plus chlorine wash had the lowest skin *E. coli* counts. Carcass microbial counts were not influenced by any of the factors. The results indicate the seaweed extract supplementation for two weeks prior to slaughter, combined with spray wash during processing, can be used as a viable decontamination strategy in goat processing.

Key Words: Goats, Brown seaweed extract, *E. coli* counts

W81 Effect of initial body condition of Boer x Spanish yearling wethers and level of nutrient intake on body composition. A. Ngwa¹, L. Dawson², R. Puchala¹, G. Detweiler¹, R. Merkel^{*1}, I. Tovar-Luna¹, T. Sahlu¹, C. Ferrell³, and A. Goetsch¹, ¹American Institute for Goat Research, Langston University, Langston, OK, ²Oklahoma State University, Stillwater, ³US Meat Animal Research Center, Clay Center, NE.

Yearling Boer x Spanish wethers were used to assess effects of initial body condition and level of feed intake on body composition. Before the experiment, 27 wethers were fed to achieve high body condition score (BCS; 1 to 5, with 1 = extremely thin and 5 = extremely fat) and BW (I-F) and 27 were fed for low BCS and BW (I-T). During experiments, I-F wethers were fed low amounts of a pelletized diet and I-T wethers received high amounts. In Exp. 1, harvest measures were determined at wk 0, 12, and 24 ($n = 7$). In Exp. 2, other animals ($n = 6$) were used to determine energy expenditure (EE) at three times (wk 1-3, 11-13, and 22-24 for Early, Middle, and Late, respectively). BCS in Exp. 1 was 3.8, 3.2, 2.6, 1.9, 2.8, and 3.5 (SE = 0.11) and live BW

was 53.3, 46.2, 42.4, 36.6, 40.1, and 48.2 kg (SE = 2.03) for I-F:wk 0, I-F:wk 12, I-F:wk 24, I-T:wk 0, I-T:wk 1, and I-T:wk 2, respectively. Changes in carcass mass of protein (-5.9, -5.3, 7.0, and 5.8 g/d) and fat (-1.9, 0.2, 21.4, and 26.6 g/d) were greater ($P < 0.05$) for I-T vs I-F, as was also true for non-carcass protein (6.1, 0.0, 14.5, and 6.3 g/d) and fat (-16.3, -10.4, 13.6, and 26.3 g/d for I-F:wk 1-12, I-F:wk 1-24, I-T:wk 1-12, and I-T:wk 1-24, respectively). Based on energy concentrations in empty body tissue lost or gained in wk 1-12 and 1-24 (14.8, 12.1, 19.9, and 26.4 MJ/kg for I-F:wk 1-12, I-F:wk 1-24, I-T:wk 1-12, and I-T:wk 1-24, respectively; SE = 2.13), the energy concentration in wk 13-24 was 9.4 and 32.9 MJ/kg for I-F and I-T, respectively. In Exp. 2, fasting (5.05, 4.37, 3.16, 4.44, 4.28, and 4.54 MJ/d; SE = 0.34) and fed EE (6.48, 5.97, 4.45, 7.39, 8.44, and 8.47 MJ/d for I-F:Early, I-F:Middle, I-F:Late, I-T:Early, I-T:Middle, and I-T:Late, respectively; SE = 0.58) were influenced by initial body condition x time interactions ($P < 0.05$). In conclusion, the energy concentration in tissue mobilized or accreted by yearling meat goats within certain body condition ranges may not necessarily be the same and appears influenced by initial animal characteristics and subsequent feeding conditions. This project was supported by USDA Project No. 2003-38814-13923.

Key Words: Body composition, Energy, Goats

W82 Urea space and body condition score to predict body composition of meat goats. A. Ngwa¹, L. Dawson², R. Puchala¹, G. Detweiler¹, R. Merkel¹, I. Tovar-Luna¹, T. Sahl¹, C. Ferrell³, and A. Goetsch^{*1}, ¹American Institute for Goat Research, Langston University, Langston, OK, ²Oklahoma State University, Stillwater, ³US Meat Animal Research Center, Clay Center, NE.

Yearling Boer x Spanish wethers (n=40) were used to develop and compare body composition prediction equations for mature meat goats based on urea space (US) and body condition score (BCS). Before the experiment, one-half of the animals were managed to have high BW and BCS (1-5, with 1 being extremely thin and 5 very fat) and the others were managed to have low BW and BCS. During the 24-wk experiment, initially fat wethers were fed to lose BW and BCS and initially thin wethers were fed to increase BW and BCS. BCS, US, and whole body chemical composition were determined after 0, 12, and 24 wk. Mean, minimum, and maximum values were 42.1 (SE = 1.12), 24.5, and 59.0 kg for shrunk BW; 3.0 (SE = 0.11), 1.5, and 4.0 for BCS; 61.3 (SE = 1.01), 53.7, and 76.5% for water; 20.2 (SE = 1.11), 4.7, and 29.7% for fat; 15.6 (SE = 0.19), 13.3, and 18.1% for protein; and 2.9 (SE = 0.062), 2.2, and 3.7% for ash, respectively. For water, fat, and ash concentrations and mass, simplest equations explaining greatest variability (with independent variables of US, BCS, and/or shrunk BW) based on BCS accounted for more variation than ones based on US, although in some cases differences were not large (i.e., water and ash concentrations and mass). Neither US nor BCS explained variability in protein concentration. Equations to predict protein mass based on shrunk BW and US or BCS were nearly identical in R^2 and the root mean square error. A 1-unit change in BCS corresponded to change in full BW of 8.9 kg (full BW, kg = 17.902 + (8.9087 × BCS); $R^2 = 0.653$), fat concentration of 7.54% (% fat = -5.076 + (7.5361 × BCS); $R^2 = 0.612$), and energy concentration of 3.01 MJ/kg (energy, MJ/kg = 0.971 + (3.0059 × BCS); $R^2 = 0.615$). In summary, BCS may be used as or more effectively to predict body composition of meat goats than US. The primary determinant of BCS, within the range of BCS observed in this experiment, was

body fat content. This project was supported by USDA Project No. 2003-38814-13923.

Key Words: Body composition, Goats

W83 Efficacy of melengestrol acetate feeding to advance breeding in hair sheep and meat goats managed in an accelerated mating system. S. Wildeus* and J. R. Collins, Virginia State University, Petersburg.

The experiment evaluated the use of melengestrol acetate (MGA), alone or in combination with PG-600® (PG), to synchronize and advance the onset of breeding in a mixed species herd (n=100) of meat goats (Boer cross, Myotonic, and Spanish) and hair sheep (Barbados Blackbelly, Katahdin, and St. Croix) mated under an accelerated mating system in November, July and March. Animals were allocated to 3 treatment groups stratified by breed-type within species: (1) a corn/soybean supplement (16% CP; fed at 1% BW for 14 d), (2) supplement with MGA (1.13 µg/kg BW/d), or (3) MGA supplement with PG (2.5 ml; 200 IU eCG/100 IU hCG; im) at the end of feeding. Females were mated in two single sire mating groups per breed and males fitted with marking harnesses to aid in estrus detection. Estrus was recorded in 8-h intervals for 4 d, and daily for the remainder of each 30 d mating period. Pregnancy was determined by transrectal ultrasound at the end of, and 25 d after, mating. Litter size was recorded at kidding/lambing. Data were analyzed for effects of treatment, breeding season, and species on incidence and timing of estrus, pregnancy rate and litter size. Time to first estrus after male introduction was shorter ($P < 0.05$) in both MGA groups than the control group (3.4 vs. 7.5 d), while time to conception was shorter ($P < 0.05$) for MGA (4.4 d) than for MGA+PG (6.4 d), which was shorter ($P < 0.05$) than control (9.0 d). This response was similar for both species, however, litter size was reduced ($P < 0.05$) with MGA feeding in sheep (control: 1.91; MGA: 1.58; MGA+PG: 1.76), whereas litter size increased ($P < 0.05$) in goats (control: 1.83; MGA: 2.17; MGA+PG: 2.24). Pregnancy (83.5 to 86.0%) and kidding and lambing rate (76.3 to 81.0%) were not different ($P > 0.1$) between treatment groups, but the incidence of return to estrus was higher ($P < 0.05$) in MGA+PG (17.3%) compared to control (7.1%) and MGA (6.5%). Data indicate that MGA did advance onset of breeding by 4 d, but had no significant effect on pregnancy and kidding/lambing rate. The inclusion of PG reduced fertility of the synchronized estrus.

Key Words: Goats, Hair sheep, Melengestrol acetate

W84 Effect of alternative forages on reproductive performance of meat goats. Y. A. Markley*, E. G. Rhoden, and J. R. Bartlett, Tuskegee University, Tuskegee, AL.

Goats are used as a source of meat, milk and fiber. Bermudagrass (BG) is a warm-season perennial that is used as the standard grass in the southeast. Endophyte infected fescue (EIF) is a cool-season perennial grass that contains a toxic endophyte that is known to cause a decline in reproductive performance of horses and cattle. Eastern gamagrass (EGG) is a native, warm-season, perennial grass. There is little reported evidence on the effects of EIF and EGG on reproductive performance of goats. The objective of this study was to determine the effects of these forages on the reproductive performance of meat goats. Thirty Boer x Spanish female goats (2 to 4 yr of age) were randomly assigned to one of three forages (hay) from d 1 of the study to parturition

for a total study period of 157 d. Goats were fed at libitum a 70:30 hay:concentrate ration. Water and mineral block were provided. Estrus was synchronized using 2 i.m. injections of prostaglandin F2 α (Lutylase) at a dose of 0.5 mg/animal on d 1 and d 11. Does were then exposed to bucks for 60 d. Ultrasounds were done on all does on d 61 and d 90 by rectal ultrasonography. Confirmed pregnancies for treatment groups were EIF (10/10 does), EGG (10/10 does) and BG (10/10 does) resulting in a 100% conception rate for all treatment groups. Mean total kid birth weight/doe was highest ($P < 0.05$) for BG (7.36 \pm 0.58 kg), followed by EGG (6.65 \pm 0.30 kg), with EIF significantly ($P < 0.05$) lower (5.51 \pm 0.60 kg) than BG. These results show that the three forages had no negative impact on conception rates. However, it can be inferred that the EIF contributed to the low birth weights of kids.

Key Words: Alternative forages, Conception rate, Goats

W85 Comparison of pure and crossbred goats on multiple births in a crossbreeding program in Sri Lanka. C. M. B. Dematawewa^{*1}, L. P. Silva¹, and A. S. Premasundara², ¹University of Peradeniya, Peradeniya, Sri Lanka, ²Dept. of Animal Production and Health, Getambe, Peradeniya, Sri Lanka.

A crossbreeding program (using Boer, Jamunapari and local breeds) was carried out in a goat breeding herd located in the dry zone of Sri Lanka (with annual mean temperature, relative humidity and rainfall values of 27.8°C, 80 % and 1400mm, respectively) to evaluate various genotypes for crossbreeding. Percentages of single versus multiple (twin, triplet and quadruplet) births (alive or dead) of dams of five genotypes measured during a 3-yr period were compared in this study. The genotypes included Kottukachchiya (KO), the only recognized local breed with a small body and a uniform black coat; Jamunapari (JM); Jamunapari x Boer F1 cross (BJ50); Boer x Kottukachchiya F1 cross (BK50); and Boer x BK50 backcross (BK75). Management practices included feeding (9 hr of grazing supplemented by concentrates and fodder) and vaccination. A total of 932 kidding records were used in Chi-square analysis to find the association of frequencies of multiple births (FMB) with the genotypes, parities, birth years and seasons (1=Mar-Aug and 2=Sept-Feb). In overall, single, twin, triplet and quadruplet birth percentages were 55.9, 41.6, 2.3 and 0.2, respectively. Only the genotype was significantly associated with FMB ($P < 0.05$). Kottukachchiya breed and BK50 cross recorded the significantly highest ($P < 0.05$) FMB values (61.29% and 58.45% , respectively) when pairwise comparisons were made (with Chi-square analysis using two genotypes at a time). The BK75 crossbred dams was the second highest in FMB value (48.67%). Dams of both JM and BJ50 genotypes recorded the significantly lowest ($P < 0.05$) FMB values (33.61% and 31.39%, respectively). Percentages of triplets born were 3.23, 0, 1.28, 0.80, and 0.71, for KO, BK50, BK75, JM, and BJ50, respectively. One incident of quadruplets (with 2 alive) was reported by BK75. The potential of the local breed for twinning should be considered in designing future genetic improvement programs.

Key Words: Cross breeding, Kidding, Sri Lanka

W86 Effects of extended storage on microbiological quality, somatic cell count and composition of Grade-A goat milk. S. Zeng^{*1}, S. Chen^{1,2}, and B. Bah¹, ¹Langston University, Langston, OK, ²China Agricultural University, Beijing, China.

As specified in the Pasteurized Milk Ordinance, Grade-A goat milk must contain few than 1.0x10⁵ cfu/ml bacteria count and must be

processed within 4 d. However, dairy goat producers in the U.S. are small scale, scattered around and distant from processing facilities. It is not cost-effective to collect goat milk every 2 d as it is with cow milk. Some goat milk is collected only once a week. This study was conducted to determine the effect of extended storage time up to 7 d over a lactation on composition, somatic cell count (SCC), pH and microbiological quality of goat milk in the refrigerated storage tank (4 \pm 1°C) on the farm. Duplicate milk samples were taken daily from the farm tank after the morning milking and analyzed immediately. Results indicated that there were no significant changes ($P > 0.05$) detected in milk fat, protein, lactose, solids-non-fat, SCC and pH during the extended storage, but significant variations ($P < 0.05$) were observed at different stages of lactation. Mean standard plate count (SPC) in goat milk increased ($P < 0.05$) to 1.8x10⁵ cfu/ml on the 6th d of the extended storage, exceeding the Grade-A limit (1.0x10⁵ cfu/ml). Mean psychotropic bacteria count increased ($P < 0.05$) steadily to 1.5x10⁵ cfu/ml within 6 d of storage. Mean coliform count was approximately 500 cfu/ml for the first 3 d and fewer than 2,500 cfu/ml throughout the 7 d storage. In conclusion, when stored under refrigerated and sanitary conditions, goat milk within 5 d could meet the Grade-A limits but would exceed the SPC limit thereafter. Data also indicated that care should be taken when goat milk was stored in the bulk tank during summer months.

Key Words: Extended storage, Goat milk, Microbiological quality

W87 Effects of CLA supplementation on goat milk composition and texture profile of semi-hard goat cheese. S. Chen^{*1,2}, S. Zeng¹, M. Rovai¹, T. Gipson¹, D. Bauman³, A. Lock³, B. Bah¹, and A. Goetsch¹, ¹E (Kika) de la Garza American Institute for Goat Research, Langston University, Langston, OK, ²China Agricultural University, Beijing, China, ³Cornell University, Ithaca, NY.

Thirty Alpine does (BW 50 \pm 7.4 kg) were randomly assigned into three groups to study effects of *t-10, c-12* conjugated linoleic acid (CLA) dietary supplementation on composition of milk and texture profile of semi-hard goat cheese. The trial consisted of three periods (two-wk in length with a 14-d interval) with CLA supplemented at 0, 3 and 6 g/d per doe for treatments 1, 2, and 3, respectively, using a 3x3 Latin Square design. In the first and last three d (E and L, respectively) of each period, milk was collected for cheese manufacture and sampled for analyses of fat, protein, lactose, total solid (TS), pH and somatic cell count (SCC). Cheese texture profile (hardness, springiness, cohesiveness, gumminess and adhesiveness) was determined using an Instron textural analyzer on d 1 and 60 after manufacture. Milk protein, lactose, TS, pH and SCC were similar ($P > 0.05$) among treatments. Cheeses made from milk collected at E had similar texture profiles ($P > 0.05$) d 1 after manufacture. However, after 60 d of aging at 8°C, only treatment 3 showed higher springiness (8.02 mm, $P < 0.05$) than treatments 1 (6.78 mm) and 2 (6.85 mm). For cheeses made from milk collected at L, hardness, cohesiveness and gumminess differed ($P < 0.01$) among treatments on the first d after manufacture. After 60 d of aging, differences ($P < 0.01$) were found for all texture characteristics except adhesiveness. In conclusion, two-wk dietary CLA supplementation to dairy goats did not affect milk composition at the beginning of experimental period but induced changes in texture profiles of semi-hard goat cheese after 60 d of aging.

Key Words: CLA supplementation, Semi-hard goat cheese, Texture profile

W88 Development of a web-based goat producer education program. S. Hart*, T. Gipson, R. Merkel, and T. Sahl, *Langston University, Langston, OK.*

The objective was to develop a web-based goat producer education program for the certification of goat producers conceptually similar to other master farmer programs. In addition, the information was to be available for browsing by the public. Such program is needed to fill the knowledge vacuum and combat disinformation. A collaborative group of goat specialists from 1890 Institutions and major goat industry associations met and identified subject areas that needed to be included in a producer education program. The subject areas were assembled into 22 modules. A core set of modules was identified as having critical information for goat production (such as animal management and breeding modules) with the remaining modules as providing information to meet special needs (such as disaster preparedness and managing guard dogs). Authors were identified and contracted for writing the modules. The modules were reviewed by outside reviewers,

both academic and producers and revised by the authors. Behavioral objectives and test questions were formulated for each module. Pictures for the modules were identified and added. Each module was converted to HTML for the web site. A grading system using Perl was used to keep track of grades from pre- and post-test to document learning. To earn certification, producers must complete the nine core modules with a minimum score of 70% on each one. A producer who makes over 85% on the pre-test is given credit for that module. A number of goat associations have agreed to identify or designate their members who have earned their certification in this course. The producer education course can be accessed online at <http://WWW2.luresext.edu>. In the first month 38 producers have completed 46 modules and improved their knowledge by an average of 25.1 points between the pre- and post-test. In addition, producers have tested out of a total of 67 modules. This producer education system is a valuable training resource for goat producers, extensionists, and scientists alike and provides a valid source for goat information.

Key Words: Education, Extension, Goat

Horse Species: Equine Sciences

W89 Equine muscle Glut-4 expression and glycogen content are altered by dietary energy source and physical conditioning. L. Stewart-Hunt, R. Geor*, and J. McCutcheon, *University of Guelph, Guelph, Ontario, Canada.*

Physical activity is one factor that may modify the effects of diet on mechanisms of glucose utilization in muscle. The objective of this study was to characterize the effects of dietary energy source and physical conditioning on skeletal muscle Glut-4 and glycogen content (GLY) and the activities of hexokinase (HK) and glycogen synthase (GS) in horses. Fourteen mature paddock-rested Standardbred horses completed the following 3 phases: 1) a 3-week baseline phase (Phase 1) in which horses were fed only grass hay cubes; 2) a 6-week adaptation (Phase 2) to a concentrate high in either starch and sugar (HiCHO; 53% nonstructural [NSC] carbohydrate, 2.3% fat, 12.9% CP on a DM basis) or fat (LoCHO; 10% NSC, 14% fat, 12.8% CP on a DM basis), fed in a 1:1 ratio with the hay cubes (6.2% NSC); and 3) a subsequent 7-week period of physical conditioning during which horses remained on previously assigned diets (Phase 3). Middle gluteal muscle biopsies to assess GLY, HK and GS activity, and Glut-4 protein expression were obtained at the end of each phase. Dietary groups were compared by repeated measures ANOVA. Data are presented as mean \pm SD. GS fractional velocity, calculated as active GS divided by total GS, was unchanged in HiCHO and LoCHO in Phases 2 and 3 when compared to Phase 1. HK was also unchanged in both groups at the end of Phases 2 and 3. GLY was unchanged in both treatment groups after Phase 2, but after Phase 3 GLY was increased ($P < 0.01$) in HiCHO (658 ± 37 mmol/kg dm) when compared to LoCHO (533 ± 41 mmol/kg dm). There was no change in Glut-4 throughout the study in LoCHO whereas Glut-4 was increased ($P < 0.01$) in HiCHO after Phases 2 and 3 when compared to Phase 1 such that there was a significant difference ($P = 0.002$) in Glut-4 expression between HiCHO (1.1 ± 0.1 arbitrary units) and LoCHO (0.6 ± 0.05 arbitrary units) following physical conditioning. This study indicated that dietary energy source affects exercise training-associated alterations in glycogen storage and Glut-4 expression in equine skeletal muscle.

Key Words: Horse, Exercise training, Glucose metabolism

W90 Temporal variables of the trot of the hunter pleasure Arabian performance horse. M. Nicodemus* and K. Slater, *Mississippi State University, Mississippi State.*

The Arabian Horse is the oldest pure bred and considered the foundation breed for all other breeds, yet research concerning the Arabian horse gait is lacking. Most of the kinematic research of the trot focuses on the European dressage horse, which has proven to be helpful in both performance and clinical applications. Therefore, the objective of this study was to define the trot of the hunter pleasure Arabian performance horse using temporal variable measurements. 4 registered Arabian horses with championship bloodlines actively showing and placing at the national level of breed recognized shows in the hunter pleasure division were recorded at 60 Hz by a single camcorder placed perpendicular to the horse's plane of travel, at a height level with the horse's topline, and at a distance that allowed for recording of one full stride. Horses were ridden at a trot by a nationally ranked Arabian trainer on a packed, dirt surface where all hooves could be seen clearly. Frame-by-frame analysis determined hoof contact and lift-off. Horses had a velocity of 2.36 ± 0.07 m/s with a stride duration of 718 ± 16 ms and stride length of 1.70 ± 0.04 m. The trot was a leaping (Suspension: $16 \pm 3\%$ of stride) gait with the majority of the stride spent in swing (Stance: fore- $40 \pm 3\%$, hind- $44 \pm 1\%$). Paired t-tests confirmed gait symmetry, as there was no significant differences ($P > 0.05$) found between the left and right limbs during the stance phase. The limbs moved as diagonal pairs (Diagonal advanced placement: $0 \pm 0\%$, Diagonal advanced lift-off: $0 \pm 0\%$, Lateral advanced placement: $53 \pm 1\%$, Lateral advanced lift-off: $50 \pm 2\%$) with the body being supported by diagonal limb pairs ($84 \pm 3\%$) while not in flight. Research subjects were limited to nationally ranked horses in which further studies may find differences in hunter performance based on training level as was found in earlier studies on the European dressage horse. Comparison of the hunter pleasure Arabian performance horse trot with earlier kinematic studies of the European dressage horse find apparent differences between breeds and between performance types suggesting further kinematic research is needed.

Key Words: Arabian Horse, Hunter pleasure, Temporal variables

W91 Parameter estimates for genetic effects on conformation traits of Korean jeju native horse. W. Y. Oh^{*1}, D. J. Choi², M. S. Kang², J. W. Lee³, C. E. Lee¹, and D. H. Baik⁴, ¹National Jeju Agricultural Experiment Station, Rural Development Administration, Jeju City, Jeju Island, Republic of Korea, ²Dept. of Animal Science and Biotechnology, Faculty of Bioscience and Industry, College of Applied Life Science, Jeju City, Jeju Island, Republic of Korea, ³Animal Genomics and Bioinformatics Division, National Livestock Research Institute, Suwon city, Gyeonggi, Republic of Korea, ⁴Department of Animal Resources and Biotechnology, College of Agriculture, Chonbuk National University, Chonju city, Chonbuk Province, Republic of Korea.

Data (N =1,289) were collected from 2001 through 2005 on Korean native horse called Jejuma by the evaluations of Jeju horse commission to estimate genetic parameters for head length, withers height, back height, croup height, body length, chest depth, chest width, hip width, croup width, croup length, chest girth, and cannon circumference as conformation traits of a horse. Estimates of heritability and genetic correlations of these traits were obtained with derivative - free REML. Model included animal genetic and residual random effects. For 12 conformation traits, sex, age, and registration status were used as a fixed effect. For the sex effect, there were few quantifiable differences between mares and stallions. Non - registered horses were much higher and lengthier than those of registered horses. Single-trait analyses were initially done to obtain starting values for multiple-trait analyses. Estimates of heritability for 12 body measures were moderate to high and for the height traits (withers height, back height, and croup height) were moderate (.45 ~.55). The lowest estimate was found for the hip width (.08) while highest values were chest width and body length (.72 ~ .62). Estimates of genetic correlations between cannon bone circumference and head length and withers height and back height were .80 and .98, respectively.

Key Words: Korean native horse, Conformation traits, Genetic parameters

W92 The effect of biologically relevant concentrations of glucosamine and chondroitin on stressed equine cartilage explants. R. S. Harlan, P. S. Chan, J. P. Caron, and M. W. Orth^{*}, Michigan State University, East Lansing.

Glucosamine (GLN) and chondroitin sulfate (CS) have gained popularity for treatment of joint pain and inflammation. We tested biologically relevant concentrations of GLN and CS for their ability to mitigate inflammatory responses in equine cartilage explants. Cartilage (6 mm disks) was collected from carpal joints of horses euthanized for reasons other than lameness and placed into culture plates. Three culture schemes were used: 1) Interleukin-1 (IL-1; 50 ng/ml) with and without GLN + CS (non-impact); 2) IL-1 plus mechanical stress (peak load of 15 MPa in 50 ms) with and without GLN + CS (impact); 3) explants were cultured for two weeks with no mechanical stress and exposed to IL-1 on d 4 and d 10 (long term). Each experiment included an untreated (negative) control group and a positive control of IL-1 alone. The non-impact model tested two concentrations: 1 ug/ml GLN + 5 ug/ml CS (low dose); 5 ug/ml GLN + 20 ug/ml CS (high dose). Impacted specimens were exposed to only the high dose combination. The two-week experiment included the low and high doses of GLN + CS. Nitric oxide (NO) and prostaglandin E₂ (PGE₂) were measured as indicators of inflammation. Proteoglycans in the media were measured as an indicator of cartilage turnover. Cartilage explants at the conclusion of the experiment were digested and assayed for proteoglycan content. Each culture scheme was repeated at least 3 times with cartilage from

different horses. Differences were considered significant at $p < 0.05$ using one-way ANOVA. In the non-impact model, GLN + CS had no effect. When mechanical impact was combined with IL-1, NO production with the GLN + CS treatment was reduced to control levels. Proteoglycan release was also significantly lower in the GLN + CS treatment than the IL-1 + impact positive controls. The long term-cultures showed a trend ($p = 0.08$) for a decrease in NO production in the low dose of GLN + CS + IL-1 compared with IL-1-only. In none of the models was PGE₂ synthesis reduced by GLN +CS. Under these culture conditions, GLN +CS modulate elements of the stress-induced, inflammatory response of equine cartilage.

Key Words: Arthritis, Nutraceutical, In vitro

W93 Caprylic acid: A potential antimicrobial against *Dermatophilus congolensis* infection in horses. S. Valipe^{*}, A. Annamalai, J. Nadeau, and K. Venkitanarayan, University of Connecticut, Storrs.

Dermatophilus congolensis is a gram-positive bacterium that causes "rain rot" a common skin infection in horses. The disease condition results in significant economic losses to horse owners due to its deleterious effect on the performance of affected animals. The widespread use of antibiotics to treat specific bacterial infections in livestock has resulted in the emergence of multi-drug resistant strains of pathogenic bacteria. Thus, there is a need for safe and effective antimicrobial alternatives to antibiotics for treating bacterial diseases in animals. Caprylic acid (CA) is a natural, eight-carbon fatty acid present in breast milk and coconut oil, and is a food-grade chemical approved by the Food and Drug Administration as generally regarded as safe. The objective of this study was to determine the antibacterial effect of caprylic acid, monocaprylin (monoglyceride ester of caprylic acid), and sodium caprylate on *D. congolensis*. Brain heart infusion (BHI) containing caprylic acid (0 mM, 7.5 mM, 12.5 mM, 15 mM, and 17.5 mM), monocaprylin (0 mM, 2.5 mM, 5 mM, and 7.5 mM) or sodium caprylate (0 mM, 15 mM, 50 mM, 60 mM, and 70 mM) was inoculated separately with three strains of *D. congolensis*, and incubated at 37°C for 48 h under anaerobic conditions. Following incubation, the surviving population of *D. congolensis* in each sample was determined by plating 0.1-ml portions of the broth directly or after serial 10-fold dilutions on BHI agar plates. Triplicate samples of each treatment and control were included and the study was replicated three times. The three lipid molecules exerted substantial antimicrobial effect on all three stains of *D. congolensis*. The mean minimum inhibitory and bactericidal concentrations of caprylic acid, monocaprylin and sodium caprylate on *D. congolensis* were 7.5 and 15 mM, 2.5 and 7.5 mM, and 15 and 75 mM, respectively. Results indicate caprylic acid and its derivatives could potentially be used for treating and controlling *D. congolensis*, but validation studies in animals are needed before recommending their application.

Key Words: *Dermatophilus congolensis*, Dermatophilosis, Horses

W94 The effect of sedation on serum cortisol concentration in mares during weaning. B. Cassill^{*}, S. Hayes, J. Ringler, and L. Lawrence, University of Kentucky, Lexington.

Several studies have examined the effect of weaning practices on foals but less is known about the stress experienced by mares at weaning. Sedating mares during the weaning process is a practice that is widely used. This study was conducted to determine if sedation would decrease cortisol levels (an indicator of stress) in mares during weaning. The study used 19 Thoroughbred and Quarter Horse mares (average age 11 ± 4.3 y). Eleven mares (Group N) were weaned without

sedation and eight mares (Group S) were weaned after sedation with acepromazine maleate (0.03-0.04 mg/kg of BW, IV). On the day of weaning, blood samples were collected from mares prior to initiating the weaning process. Mares and foals were abruptly separated by transporting the mares to a different location on the farm. Group S mares were sedated prior to transport. Blood samples were collected 1, 2 and 7 d following weaning. All blood samples were collected before 0900 to limit diurnal variation. Serum was analyzed for cortisol using radioimmunoassay. Cortisol concentration increased from day 0 to day 1 ($P = 0.0014$) but decreased to original levels on day 2. Cortisol concentration in serum was not affected by sedation ($P = 0.8504$). There were no differences in the cortisol concentrations between young mares (5 – 11 y of age) and older mares (13 – 18 y of age) ($P = 0.9069$) nor were there any differences in the % change of cortisol concentrations from day 0 to day 1 ($P = 0.3882$). In addition, change in cortisol concentration was not different between multiparous ($n = 16$) and primiparous mares ($n = 3$) ($P = 0.2236$). In conclusion, cortisol concentration was not affected by sedation or the age of the mares.

Key Words: Horse, Weaning, Stress

W95 Effect of yeast culture supplementation on digestibility of varying quality forage in mature horses. L. M. Morgan^{*1}, J. A. Coverdale¹, M. A. Froetschel¹, and I. Yoon², ¹University of Georgia, Athens, ²Diamond V Mills, Inc., Cedar Rapids, IA.

Supplementation of yeast culture has yielded variable results in many species, particularly when fed to horses. Improving the digestibility of lower quality forages could be advantageous both for the producer and horse health. The objective of this study was to evaluate the effect of non-viable *Saccharomyces cerevisiae* on digestibility of high and low quality forage in mature horses. Sixteen geldings (483.6 ± 25.5 kg and 6.8 ± 3.2 yr), of Quarter Horse ($n = 14$) and Thoroughbred ($n = 2$) breeding, were used in a 4 x 4 Latin Square design with 28-d treatment periods. Russell bermudagrass hay of either high (13.1% CP, 73.1% NDF, 35.3% ADF and 6.0% ash) or low (8.1% CP, 75.3% NDF, 37.6% ADF and 4.3% ash) quality was offered at 1.35% of BW (DM). Diets consisted of high quality forage with the addition of yeast culture (HY), high quality forage without yeast culture (HC), low quality forage with the addition of yeast culture (LY), and low quality forage without yeast culture (LC). All horses were fed a commercial grain mix (12.6% CP, 25.4% NDF, 12.1% ADF and 4.0% ash) offered at 0.45 % of BW (DM) daily. *Saccharomyces cerevisiae*, was added to grain during the morning feeding at a rate of 56 g per horse. BW was measured weekly and feed intake was adjusted accordingly. Total fecal collections (3 days) were made at the end of each treatment period. Fecal samples were obtained every 6 hr and 10% of the total amount was frozen for later analysis. Horses receiving low quality hay (LY and LC) had greater intake expressed as a percentage of BW compared to horses receiving high quality hay (HY and HC) ($P < 0.01$). There was no influence of yeast culture supplementation on intake of grain or forage ($P = 0.23$ and $P = 0.62$ respectively). DM, OM, CP and NDF digestibilities were greater in the diets HC and HY compared to LC and LY ($P < 0.01$, $P < 0.01$, $P < 0.01$ and $P < 0.01$ respectively). DM, CP and NDF digestibilities were greater for horses receiving LY compared to LC ($P < 0.09$, $P < 0.03$ and $P < 0.05$ respectively). Supplementation of yeast culture to mature horses improved digestibility of lower quality bermudagrass hay.

Key Words: Horse, *Saccharomyces cerevisiae*, Digestibility

W96 Nutrient composition of stall waste produced by Florida horse operations. D. L. Cotton*, L. K. Warren, R. A. Nordstedt, J. Kivipelto, and S. C. Dilling, University of Florida, Gainesville.

Data describing the composition of horse stall waste is limited; however, this information could serve as a useful reference for making nutrient management decisions. The objectives of this study were to characterize the composition of stall waste generated by Florida horse operations and to identify management factors that affect the nutrient content of stall waste. Samples of clean bedding and soiled stall waste were gathered from breeding farms (BREED; $n=40$), boarding and training facilities (BOARD; $n=40$) and racetrack stables (RACE; $n=45$) evenly distributed throughout the state of Florida. Material removed during the most recent cleaning of stalls was thoroughly mixed and random grab samples were collected to represent stall waste at each facility. Samples were analyzed for total carbon (C), total nitrogen (N), and total phosphorous (P). Each facility was also questioned about their stall cleaning practices. Across facilities, the most widely used bedding was wood shavings (75%). Hay or straw bedding was utilized by 4% of BOARD, 25% of BREED and 33% of RACE. Clean hay or straw bedding had greater N ($P<0.001$) than clean wood shavings, but the C content of these beddings was similar. On average, stall waste contained $41.8 \pm 0.8\%$ C, $0.69 \pm 0.03\%$ N, and $0.88 \pm 0.1\%$ P. Stall waste from BREED had greater N than BOARD ($P<0.05$) and RACE ($P<0.01$). Stall waste from BOARD had greater P ($P<0.01$) and N ($P<0.05$) than RACE. The C content of stall waste was not different between facilities. The C:N ratio of stall waste was lower in BREED than in BOARD ($P<0.05$) or RACE ($P<0.01$). Across facilities, the C:N ratio of stall waste was lowest ($P<0.001$) with straw or hay bedding (34:1) compared to stall waste with wood shaving bedding (73:1). Stalls were cleaned less frequently on BREED ($P<0.01$) compared to BOARD or RACE. Although bedding type contributed to the differences in stall waste composition between facilities, stall cleaning practices likely had a large impact on the nutrient content of stall waste. Cleaning stalls more frequently may result in the removal of a greater proportion of bedding to manure, which would lower the N and P content of stall waste.

Key Words: Stall waste, Horse farm waste, Horse manure

W97 Circadian variation of pasture NSC and insulin concentrations in horses. B. Byrd^{*1}, K. Treiber¹, D. Kronfeld¹, W. Staniar¹, R. Geor¹, and P. Harris², ¹Virginia Polytechnic Institute and State University, Blacksburg, ²WALTHAM Centre for Pet Nutrition, Melton Mowbray, UK.

Nonstructural carbohydrates (NSC) in pasture may affect insulin dynamics, providing a possible link between NSC and laminitis. We evaluated circadian variation of NSC in spring pasture, quantified the relationship between pasture NSC and circulating insulin in grazing horses, and compared insulin in grazing horses to horses restricted to hay. Fourteen Thoroughbred mares were assigned to pasture ($n = 10$) or hay ($n = 4$). Grazing horses were kept on a 5 hectare pasture. Jugular catheters were inserted at 0600. Hourly samples were collected for 36 h, with pasture sampling from 0600 and blood sampling from 0930. Pasture NSC was determined as the sum of water soluble carbohydrate (WSC) and starch. Plasma insulin was measured by immunoassay. Dietary groups were compared by ANOVA with repeated measures, relationships between NSC and insulin in grazing horses were quantified by regression, and circadian patterns in NSC and insulin were quantified by nonlinear regression fitting sine waves. Pasture NSC was lowest around 0430 ($17.6 \pm 0.3\%$), and highest around 1630

(22.2 ± 0.3%). Hay NSC was 8.9 ± 0.05%. Insulin concentrations were higher in grazing horses than in horses restricted to hay ($P = 0.012$). Group mean insulin concentrations of grazing horses and NSC levels in the pasture were related ($r^2 = 0.032$, $P < 0.001$). Individual mean insulin response was proportional to the increase in insulin per unit of NSC ($r^2 = 0.601$, $P = 0.008$). Sinusoidal circadian patterns in NSC ($r^2 = 0.507$, $P < 0.001$) and insulin in grazing horses ($r^2 = 0.121$, $P < 0.001$) had similar frequency ($P = 0.36$), with changes in insulin delayed by 30 min. The percent change in insulin was 2.5 times that of NSC. The circadian patterns in NSC were attributable to WSC which comprised 93%, and there was no evident pattern in starch (7%). This study indicates that circulating insulin in grazing horses is associated with circadian variation in pasture NSC.

Key Words: Horse, NSC, Insulin

W98 Seasonal variation in cool season grasses. L. Lawrence^{*1}, S. Hayes¹, R. Allman², and G. Rich³, ¹University of Kentucky, Lexington, ²The Farm Clinic, Lexington, KY, ³Rich Equine Nutrition Consulting, Memphis, TN.

Pasture is an important nutritional resource on Central Kentucky horse farms, however both pasture availability and pasture composition will vary during the year. The purpose of this study was to identify variations in the nutritional composition of cool season pasture grasses commonly found in horse pastures. Samples of cool season grasses (tall fescue, orchard grass and blue grass) were collected from Central

Kentucky horse pastures every month for 5 y (2000-2004). Pastures were maintained on fall fertilization schedules based on soil sampling and were regularly clipped to maintain a forage height below 25 cm. Samples were analyzed for crude protein (CP), acid detergent fiber (ADF), calcium (Ca), and phosphorus (P). Digestible energy (DE) content was estimated from CP and ADF concentration (NRC, 1989). Mean values were calculated across all months, plant types and years and also by month across years and plant types. Across all years and months the cool season pastures sampled in this study contained 20.1 ± 4.4% CP, 28.6 ± 4.9% ADF, 0.46 ± 0.08% Ca and 0.41 ± 0.08% P, on a dry matter basis. Concentrations of CP, ADF, Ca and P were affected by month ($P < 0.05$). Pasture quality, based on CP and estimated DE, increased in the spring, decreased in the summer and then increased again in the fall. Mean CP concentration (DM basis) ranged from a high of 24.9 ± 1.7% in April to a low of 14.6 ± 2.4% in July. Mean CP content exceeded 18% from September through May. Mean ADF concentration ranged from 34.5 ± 3.6% in July to 21.5 ± 2.7% in April. Digestible energy was highest in April (3.21 ± 0.17 Mcal/kg) and lowest in July (2.26 ± 0.19 Mcal/kg). Calcium concentration was lowest in the late spring and highest in the fall. For lactating mares and growing horses, calcium intakes of 1.6 to 2 g/Mcal of DE have been suggested (NRC, 1989). During April and May, the Ca:DE ratio in the cool season grasses was below 1.6. Based on these observations, including legumes in Central Kentucky horse pastures may be warranted.

Key Words: Horse, Equine, Pasture

Lactation Biology

W99 Milk yield and udder capacity of cows with different milk concentration milked once or twice daily. D. Clark^{*1}, D. Dalley¹, and S. Davis², ¹Dexcel, Hamilton, New Zealand, ²ViaLactia Biosciences, Auckland, New Zealand.

Four per cent of New Zealand's dairy farmers now milk their herds once daily (1x). Jerseys are more tolerant of 1x milking than Holstein-Friesians and the hours worth of udder capacity is greater for the former. We hypothesized that Holstein-Friesian cows with more concentrated milk would be more tolerant of 1x milking than those producing less concentrated milk. Seventy-two Holstein-Friesian cows were selected as a High milk solid content (fat + protein) group (High MS) and 72 selected as a Low milk solid content group (Low MS). Within each group, 23 cows were allocated to 2x daily milking and 49 cows to 1x daily milking with grazed pasture as the sole feed. Udder capacity was determined as the total volume of milk contained in the udder 40 h after the last milking. Residual milk was removed after an intravenous injection of 10 IU oxytocin. Udder capacity was measured at approximately 90 and 150 days in milk (DIM). Cows milked 1x produced less milk, protein and fat yields and had higher SCC ($P < 0.001$) than those milked 2x. Cows selected for milk solids content did not differ in their milk, protein, fat yield or SCC. There was no milking frequency by milk solids content interaction. Cows milked 2x daily had greater udder capacities at 90 ($P < 0.05$) and 150 DIM ($P < 0.07$) than those milked 1x daily. High MS cows had lower udder capacities at 90 ($P < 0.07$) and 150 DIM ($P < 0.1$) than Low MS cows. Holstein-Friesian cows selected for phenotypically high milk solids content did not produce more milk, protein or fat than those selected for low milk solid content. The latter had 11-16% greater udder capacity when milked 1x daily in early-mid lactation and this

may have compensated for their lower milk solid content. We conclude that milk solid content in the previous lactation is not an effective way of identifying cows that will adapt well to 1x daily milking.

Key Words: Milking frequency, Udder capacity, Pasture

W100 Effects of milking interval on milk constituents from various fractions of ewe milk. A. Dzidic^{*1}, M. Kaps¹, and R. Bruckmaier², ¹University of Zagreb, Zagreb, Croatia, ²University of Bern, Bern, Switzerland.

The aim of this study was to evaluate the effects of milking interval (8 and 16 h) on milk constituents (fat, protein, lactose and dry matter percentage, and somatic cell count) in different milk fractions in Istrian x Awassi x East Friesian crossbreed ewes. Milk fraction samples of 20 ewes were collected during morning and evening milking in early lactation after 25% (M25), 50% (M50), 75% (M75) and 100% (M100) of main milk yield, and machine stripping fraction (MS) when milk flow decreased below 100 g/min from the whole udder. For the statistical analysis, a repeated measures model was used with ewe as a random effect and milking time, peak flow rate, total milk yield, milking interval and milk fraction nested within milking interval defined as fixed effects. The relationships between milk fractions and constituents within milking interval were tested by using linear, quadratic and cubic contrasts. The fat content during main milking ranged from 5.81 to 6.30 % and from 3.00 to 5.70 % after the 8 and 16 h from previous milking, respectively. Compared to the main milk fractions, the MS fraction fat content was higher ($P < 0.05$) after both milking intervals. Protein, lactose and dry matter did not change ($P > 0.05$) through the main milking fractions in both milking intervals. In

contrast, MS fraction was lowest ($P < 0.05$) for protein and lactose, while highest for dry matter. Higher somatic cell count were observed in the M25 and MS fractions compared to all other milk fractions ($P < 0.05$). Milk fat, protein, dry matter and somatic cell count were best described by a quadratic function, while lactose was described by a linear after 16 h and a cubic function after 8 h milking interval. Milking interval strongly influenced all the milk constituents in various milk fractions during ewe milking. Changes in milk constituents between and during ewe milking should be taken into account when analytical milk samples are taken.

Key Words: Milk fractions, Milking interval, Dairy ewes

W101 Effects of omitting two milkings weekly on milk yield, milk composition and udder health in Manchega and Lacaune dairy ewes. V. Castillo, X. Such, G. Caja*, E. Albanell, and R. Casals, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

A total of 42 Manchega (MN) and 18 Lacaune (LC) dairy ewes were used during 15 wk (wk 7 to 22) to study the effect of omitting two milkings weekly throughout lactation on milk yield, milk composition and somatic cell count (SCC). Ewes were milked twice daily (8.00 and 18.00 h), but on Saturday and Monday once daily milking was performed. At 12 and 21 wk, milk was measured daily and sampled for composition and SCC. Friday values were used as reference to evaluate the effect of milking omission. In mid-lactation (12 wk), weekend milk yield (MN: 651 mL/d, LC: 1452 mL/d) and fat content (MN: 6.25%, LC: 5.69%) decreased ($P < 0.05$) by 24 and 8%, respectively in MN, and by 16 and 3%, respectively in LC. In late lactation (21 wk), weekend milk yield losses were lower but still significant (MN: -18%, LC: -9%; $P < 0.001$). However, fat content losses did not differ from mid-lactation values. In both breeds, protein content and SCC did not vary significantly as a result of weekend milking omission in mid- and late-lactation. On Monday, milk yield returned to Friday values in both breeds, but milk fat increased (MN: +14 and +7%; LC: +10 and +6%; $P < 0.01$) in mid- and late-lactation, respectively. Fat content values reached normal level by Wednesday in MN and Tuesday in LC. In mid- and late lactation, Monday log SCC (5.01 and 4.99) was greater ($P < 0.05$) than weekend values (4.13 and 4.63) in MN ewes, returning to the normal values on Friday. In LC ewes there were no differences in SCC between week days. Compared with estimated values for 14 milkings/week, omitting two milkings weekly in mid-lactation decreased (-17%, $P < 0.05$) milk yield in MN whereas it was not significant (-2%, $P > 0.05$) in LC. In late lactation, no milk yield decrease was observed in either breed. Results suggest that omitting two milkings weekly could be an interesting management approach to reduce farm labor with no negative effects on milk yield and milk SCC values in dairy sheep. Moreover, losses in milk yield would be reduced if the milking omission was done during late lactation in MN ewes.

Key Words: Milking suppression, Milking frequency, Dairy ewes

W102 Short-term once-daily milking decreases expression of integrins and cell survival factors with no changes in apoptosis in the bovine mammary gland. K. Singh*¹, J. Dobson¹, C. Phyn¹, C. Prosser², V. Farr¹, and K. Stelwagen¹, ¹*AgResearch Ltd., Ruakura Research Centre, Hamilton, New Zealand*, ²*Dairy Goat Co-operative (N.Z.) Ltd., Hamilton, New Zealand.*

In ruminants, reduced milking frequency results in decreased milk yield, which is associated with a change in mammary epithelial cell

(MEC) integrity. Many cell types require anchorage to the extracellular matrix (ECM) for survival which is mediated via integrin proteins on cell membranes. The aim of this study was to examine the effect of milking frequency on MEC survival factors and the downstream apoptotic signalling events. Non-pregnant multiparous Jersey and Jersey x Friesian dairy cows ($n=4$) at late-lactation were milked unilaterally, either twice-daily (at 0700 and 1500h; control) or once-daily (at 0700 h only) for 4 days, after which cows were sacrificed to collect mammary alveolar tissue. Milk yields, adjusted for pre-treatment values, were decreased ($P < 0.05$) by 21% in once-daily compared with twice-daily milked glands. Gene expression was measured by real-time RT-PCR and the $\beta 1$ -integrin, $\alpha 6$ -integrin, FAK and Bcl-x_{long} mRNA levels were lower ($P < 0.001$) in alveolar tissue from udders milked once-daily relative to those milked twice-daily by 1.9, 2.6, 2.2 and 2.2-fold, respectively. The pro-apoptotic factor Bax mRNA was also lower ($P < 0.001$) by 2.6-fold in once-daily compared to twice-daily milked samples. The numbers of apoptotic nuclei, detected by in situ end-labelling, were low and the same in both once-daily and twice-daily milked mammary glands. These data are consistent with a loss of attachment of epithelial cells from the ECM and down-regulation of cell survival pathways during once-daily milking, although the execution phase of apoptosis has not occurred.

Key Words: Once-daily milking, Apoptosis, Integrin

W103 The association among dry period length, lactation performance and some physiological measures of Holstein cows during the following lactations. M. S. Gulay*¹, M. J. Hayen², K. C. Bachman², and H. H. Head², ¹*Akdeniz University, Burdur, Turkey*, ²*University of Florida, Gainesville.*

The objective of the experiment was to evaluate whether dry period (DP) length (60 d vs. 30 d) affected milk production or physiological measures of Holstein cows during the experimental (EL) and subsequent (SL) lactations. Treatments were arranged in a 3x2x2 factorial design that included DP [TRT-I=60 d dry; TRT-II=30 d dry; and TRT-III=30 d dry+estradiol cypionate (ECP)], pre- and postpartum bST (10.2 mg/d), and prepartum anionic or cationic diets. To accelerate mammary involution, ECP (15 mg) was injected (im) at dry off into cows in TRT-III. Data was collected from farm records for all cows and cohorts (TRT-IV). Across all TRT groups [($n=118$); TRT-I ($n=28$), TRT-II ($n=28$), TRT-III ($n=29$), and TRT-IV ($n=31$)] the culling rates (number of culled cows divided by the total number of cows) during the experimental lactation (EL) were 25.9, 29.0, 25.0 and 28.1% ($P=0.98$), respectively. The pregnancy rates (number of pregnant cows divided by the total number of cows; 74.1, 67.7, 75.0 and 78.1%; $P=0.99$), overall culling rates (66.7, 58.8, 58.8 and 63.6%; $P=0.95$) or number of breedings (3.7, 3.4, 2.5 and 3.6; $P=0.48$) did not differ during SL. Previous lactation and EL Mature Equivalent (ME) milk yields, and percentages of milk fat (MF), milk protein (MP) and somatic cell count score (SCCs) were 9796, 9748, 9513 and 9835 kg ($P=0.89$) and 9748, 9796, 9513 and 9835 ($P=0.89$); 3.68, 3.68, 3.65 and 3.65% ($P=0.98$) and 3.68, 3.65, 3.69 and 3.65% ($P=0.99$); 2.77, 2.87, 2.83 and 2.81% ($P=0.45$) and 2.87, 2.83, 2.77 and 2.81 ($P=0.43$); and 3.85, 3.78, 3.32 and 3.23 ($P=0.27$) and 3.78, 3.32, 3.23 and 3.85 ($P=0.29$), respectively. The DP treatment did not affect respective ME milk yields (8973, 9264, 9022 and 9066kg, respectively; $P=0.97$) or percentages of MF (3.76, 3.80, 3.69 and 3.78%; $P=0.83$), MP (2.72, 2.65, 2.69, and 2.74%; $P=0.58$) or SCCs (5.01, 4.86, 3.95 and 4.19; $P=0.20$) during SL. The results indicated that shortening DP did not have negative effects on the milk production, composition or physiological measures during the EL or SL.

Key Words: Dry period length, Transition period, Subsequent ME yield

W104 Increase in stanniocalcin content in milk of cows at involu- tion. G. Tremblay^{*1}, L. Delbecchi², G. F. Wagner³, B. G. Talbot², and P. Lacasse², ¹Université de Sherbrooke, Sherbrooke, QC, Canada, ²AAFC-Dairy and Swine R&D Center, Lennoxville, QC, Canada, ³University of Western Ontario, London, ON, Canada.

There are several lines of evidence indicating the existence of local control of mammary gland involution. However, the exact nature of this control has not yet been defined. We have shown that estrogen, while reducing milk production, increases the expression and concentration of stanniocalcin (STC) in the mammary gland. Since this paracrine hormone is an inhibitor of Ca transport in some tissues, we hypothesized that it may be implicated in the involution process. To further investigate this hypothesis, front right and rear left quarters of nine Holstein cows in late lactation, five multiparous and four primiparous, were unmilked for 14 days. Milk production of milked quarters was evaluated daily, while milk composition (percentage of fat, lactose, and protein, and SCC) was determined on d -7, d 1, d 2, d 7, and d 14. On the same days, milk samples were taken manually from forequarters to determine the STC content by RIA and the protease activity by zymography. Blood samples were simultaneously taken, to assay serum STC by RIA. Cessation of milking of the right forequarter and left hindquarter led to their drying off. The milk production of the two other quarters increased gradually ($P < 0.001$) reaching about 132 % of pre-treatment level at d 14. The concentration of fat and protein in milk from milked quarters decreased slightly ($P < 0.05$) in the first days following the cessation of milking of the other quarters. Zymography analyses showed a constant increase in protease activity from d 2 to d 14, but only in unmilked quarters. Serum STC increased ($P < 0.01$) by 23 % during drying off. In milk, the STC concentration did not change in milked quarters but increased by 235 % in unmilked quarters ($P < 0.001$). These data support the idea that STC is implicated in the involution process.

Key Words: Mammary gland, Stanniocalcin, Involution

W105 Effects of weaning age and ambient temperature on sow endocrine status and mammary secretions around weaning. C. Farmer^{*1}, D. Flint², and C. Knight², ¹Agriculture and Agri-Food Canada, Dairy and Swine R & D Centre, Lennoxville, QC, Canada, ²Hannah Research Institute, Ayr, UK.

The effects of lactation length and ambient temperature on the endocrine status of sows and on indicators of mammary involution at weaning were studied. Twenty-eight first parity Yorkshire x Landrace sows were housed at 21 (CTL) or 29°C (HS) throughout lactation. Within each temperature group, half the sows were randomly assigned to a weaning age of 22 (W22: CTL, n = 7; HS, n = 8) or 44 days (W44: CTL, n = 6; HS, n = 7). Litter size was standardized to 10 or 11 on day 2 and to 9 on day 23 of lactation. Jugular blood samples and milk samples were collected on days -1, 1, 2 and 3 relative to weaning (day 0). Concentrations of prolactin (PRL), IGF-I and lactose were measured in both fluids and concentrations of Na, K and IGFBP-5 were measured in milk. Standard milk composition was also determined. Lactose was lower ($P < 0.001$) and protein greater ($P < 0.05$) in all milk samples from W44 compared to W22 sows. Percentages of milk fat and dry matter were lower ($P < 0.05$) in W44 than in W22 on days 2 and 3. Milk lactose was reduced ($P < 0.05$) with heat stress on days

2 and 3. The day before weaning, concentrations of PRL in blood ($P < 0.001$) and lactoserum ($P < 0.01$) were lower and those of IGF-I in lactoserum were greater ($P = 0.01$) in W44 than in W22. Values of IGFBP-5 in milk were drastically lower ($P < 0.001$, more than a 4-fold difference), those of Na greater ($P < 0.001$) and those of K unchanged ($P > 0.1$) for W44 compared to W22. The change in these variables following weaning differed according to lactation length ($P < 0.05$). On day 2, the increase in Na seen with weaning at 44 d was greater at 29 than at 21°C ($P = 0.05$). The greater Na/K ratio in W44 compared to W22 shows that mammary epithelial cells tight junctions become leaky as lactation advances. Weaning age therefore has an impact on milk variables which are indicative of the status of mammary involution in sows.

Key Words: Sows, Mammary involution, Lactation length

W106 Effect of bST administration during induction of lactation in 15-month-old heifers on production and health. R. S. Kensinger^{*}, A. L. Magliaro, A. C. W. Kauf, M. L. O'Connor, and L. D. Muller, Pennsylvania State University, University Park.

The objective of the present study was to determine if starting bST treatment during induction of lactation would improve milk production above that of heifers induced into lactation but not treated with bST until 54 DIM. Holstein heifers (n = 32; 420 ± 28 kg BW) were randomly assigned to bST-1 or bST-54 treatment groups. They were induced into lactation at 14.9 ± 0.3 mo of age with daily sc injections of estradiol-17B and progesterone (75 and 250 ug/kg BW/d, respectively) on treatment d 1-7. In addition, heifers in the bST-1 group (n=16) received bST on treatment d 1, and this was repeated every 14 d. The remaining 16 heifers (bST-54) received their first bST dose at 54 DIM. Milking began on treatment d 18 (= d 1 of lactation). Milk yield of heifers in bST-1 (15.1 kg/d) was greater than that of bST-54 heifers (11.1 kg/d) from d 1 to 53 of lactation ($P < 0.01$). Milk protein, fat, and lactose averaged 18.6, 1.7, and 2.0 % on d 1 of milking and 3.9, 4.4, and 5.1 % on d 14. Milk composition was similar between groups. Mean milk production from d 54 to 248 when all heifers received bST was 23.5 and 21.1 kg/d for bST-1 and bST-54 heifers, respectively, and did not differ between groups. Overall, milk yields increased gradually and peaked at 25.6 ± 5.3 kg/d at d 149 ± 60 of lactation. Full lactation milk production was 5944 kg with 3.7 % fat, 3.3 % protein, 185,000 SCC, and 297 DIM. Heifers gained 0.87 kg BW/d during the induced lactation. They conceived with an average of 2.0 services/pregnancy, and 28 of 32 calved. Mean age at first calving was 27.6 mo, calving ease score averaged 1.9, and percent mortality of calves born was acceptable. Administration of bST from the start of induction through 53 DIM increased d 1 to 53 milk production compared to heifers induced without bST. Young heifers induced into lactation were healthy, grew normally, and produced reasonable amounts of milk with normal composition.

Key Words: Induced, Lactation, bST

W107 Characterization and regulation of the bovine stearoyl-CoA desaturase (Scd) gene promoter and effects of conjugated linoleic acid (CLA) on mammary cell growth and apoptosis. A. F. Keating^{*1,2}, F. Q. Zhao², and J. J. Kennelly¹, ¹University of Alberta, Edmonton, Alberta, Canada, ²University of Vermont, Burlington.

The bovine Scd gene plays an important role in the bovine mammary gland where stearic and vaccenic acids are converted to oleic acid and conjugated linoleic acid (CLA) respectively. This study investigated

the areas of the bovine promoter of importance in regulating this key enzyme. An area 36bp in length was identified as having a critical role in transcriptional activation and designated the Scd transcriptional enhancer element (STE). Electromobility shift assay showed that Mac-T cell nuclear protein extract forms three binding complexes on this area and mutagenesis of this area identified the binding sites for these proteins as being likely to be RFX1, SREBP and NF-Y/NF-1. The two main biologically active CLA isomers (cis-9, trans-11 and trans-10, cis-12) were shown to down-regulate the Scd gene promoter transcriptional activity significantly (~70%), with this effect occurring at the STE. Increasing doses of both isomers showed that the trans-10, cis-12 isomer had a more potent effect on transcriptional activity even at low doses with reductions of 70-80% at 15mM/ml compared to the cis-9, trans-11 isomer which showed reductions of 40-55% at this concentration. PUFA, vaccenic acid, steric acid, prolactin, dexamethasone and leptin had no effect on transcription. Transcriptional activity was up-regulated by insulin, and down-regulated by oleic acid. Statistical analysis was carried out using one way anova with significance declared at $p < 0.05$. The effects of CLA on bovine mammary cell growth and survival were also evaluated using growth curve and TUNEL assay. Increasing doses of both CLA isomers had negative impacts on cell growth with significant effects seen at concentrations of 30uM and higher ($P < 0.05$) and resulted in increased induction of apoptosis in the mammary cells. In addition, the expression of the GLUT1 glucose transporter protein was investigated using an immunofluorescence technique and demonstrated that GLUT1 expression was also decreased due to high doses of CLA treatment.

Key Words: Conjugated linoleic acid, Stearoyl Co-A desaturase, Bovine mammary epithelial cell

W108 Histologic aspects of gestational mammogenesis in heifers. S. Ellis* and N. Korn, *Clemson University, Clemson, SC.*

Gestational mammogenesis is critical to successful lactation and dairy production. Previous studies have shown that the proliferative cell population in prepubertal heifers consists largely of lightly staining cells distributed throughout the parenchyma. The purpose of this study was to characterize the cell populations in mammary biopsies collected from primigravid heifers to determine whether the lightly staining cell population serves as the primary proliferative population during gestational mammogenesis. Samples of mammary parenchyma from gravid Holstein heifers (n=3) were collected via routine core biopsy at three stages during gestation (d105, d150, and d250) to assess the frequency, distribution, and histologic characteristics of proliferative epithelial cells. Explants were prepared and cultured for 2h with bromodeoxyuridine (BrdU; 5µg/ml in media at 37°C) to label proliferating cells. Explants were then fixed with 4% formaldehyde, embedded in resin, sectioned at 1.5µm and stained to label cells that had incorporated BrdU. Precise quantification of parenchymal cell populations was problematic because the cytoplasmic staining heterogeneity observed was less than anticipated. A limited number of lightly staining cells were observed, but the gradation between intermediate and dark-staining cells was very difficult to reproducibly discern. Furthermore, we observed a surprising percentage of BrdU-labeled cells that had a distinct secretory morphology, complete with basally displaced nuclei, abundant euchromatin, and secretory vesicle inclusions (up to 34% at d250). The vast majority of cells with a secretory morphology and BrdU labeling were either in contact with luminal spaces or spanned the epithelial layer to contact both the basal and luminal spaces. These results suggest that the lightly staining cells identified as the primary proliferative population in prepubertal

animals do not constitute the main proliferative cell population during gestation. Further investigations are required to confirm these observations.

Key Words: Mammary epithelial cells, Cell proliferation, Mammo-genesis

W109 Lysophosphatidic acid (LPA) stimulates mouse mammary epithelial cell growth. I. S. Yuh*¹ and L. G. Sheffield², ¹*Kangwon National University, Chunchon, Korea,* ²*University of Wisconsin, Madison.*

Lysophosphatidic acid (1-acyl-2-hydroxy-sn-glycero-3-phosphate, LPA) is a bioactive phospholipid having diverse effects on various types of tissues. When normal murine mammary gland (NMuMG) cells were cultured in the presence of 0, .01, .1, 1, 10µM LPA, cell numbers were increased with dose dependency for the 6-day culture periods ($P < 0.05$). However, 100µM LPA appeared to be toxic. In DNA synthesis assay, 10µM LPA increased DNA synthesis 4.5 fold over control ($P < 0.05$). In addition, cell density was increased by LPA. To test the hypothesis that LPA-stimulated cell growth was mediated through its own receptors, NMuMG cells were grown in the presence of 10% FBS, total RNA was extracted, cDNA was synthesized by RT reaction and then LPA subtype receptor gene expressions were amplified by PCR method. NMuMG cells expressed LPA1 and LPA2 receptor genes. LPA (10µM) treatment significantly increased ERK1/ERK2 phosphorylation at 30 min after treatment and then dephosphorylated at 2 hrs after treatment. These results indicate that LPA-induced mammary epithelia growth is likely mediated through MAPK pathway. Interestingly, MAPK activation by LPA was more delayed than by other mitogens such as EGF or ATP (maximum activation at 5 min). Overall results indicate that LPA is mitogenic to normal mammary epithelia and this mitogenic effect is mediated through its own receptors and MAPK activation. It is not clear whether the mitogenic response of LPA was mediated through LPA1 or LPA2 or both type of receptors at this moment.

Key Words: Mammary, LPA, Growth

W110 Changes in mammary gland function during prolonged lactation coincide with changes in mitochondrial biogenic processes. J. George*¹, W. Olea¹, D. Torres¹, R. J. Collier², and D. L. Hadsell¹, ¹*Baylor College of Medicine, Houston, TX,* ²*University of Arizona, Tucson.*

Biphasic changes occur in mammary function during a lactation cycle. In early lactation, increases occur in secretory and metabolic activity, mitochondrial size, and mitochondrial number. During late lactation, these processes decrease and losses of secretory cells occur. The mechanisms driving this change are not well established. Our previous work demonstrated changes in mitochondrial oxidative damage during the lactation cycle. The hypothesis tested here is that changes in mitochondrial biogenesis and expression of anti-oxidant enzymes underly changes in mammary function that occur throughout the lactation cycle. To test this hypothesis, we measured markers of mitochondrial biogenesis within mouse mammary tissue (n=5 to 8/timepoint) collected at different times during secretory activation (days -1, 1, 2, 3, 4 and 5 postpartum) and during prolonged lactation (days 2, 8, 14, 21, 28, and 35 postpartum). Cytochrome c, COX IV, PGC1α, SOD1, SOD2, and catalase were measured by western blotting. Mitochondrial (mt) DNA copy number was measured by real-time PCR. Mitochondrial number and size were measure by morphometric

analysis of electron micrographs of tissue collected on day 8 or 35 postpartum. All of the biochemical markers with the exception of COX IV demonstrated increases ($P < 0.05$) during early lactation. For cytochrome c, a 3-fold increase was observed between day 2 and 14 postpartum. For catalase, SOD1 and SOD2 a 1.5- to 2-fold increase occurred between days 2 and 8 postpartum. For mtDNA a 50% increase occurred between days 2 and 8. All of these changes were preceded by a dramatic upregulation of the transcriptional coactivator PGC1 α on day 1 postpartum. The prolonged lactation period was marked by decreases in cytochrome c and mtDNA copy number. In addition, a decrease in mitochondrial number approached significance ($P = 0.11$). These results suggest that PGC1 α -dependent changes in mitochondrial biogenesis may underly variations in mammary gland function during the lactation cycle. This work support by grant # 2RO1 DK52197 and cooperative agreement #58-6250-6001.

Key Words: Mitochondria, Lactation, Persistence

W111 Characterization of Madin-Darby Bovine Kidney cell line for PPARs. M. Bionaz^{*1}, C. R. Baumrucker¹, J. P. Vanden Heuvel¹, E. Block², and G. A. Varga¹, ¹*Penn State University, University Park*, ²*Church & Dwight Co. Inc., Princeton, NJ*.

The nuclear receptors of peroxisome proliferator-activated receptors (PPARs) are critical for lipid and glucose metabolism. An in vitro bovine model could be useful for preliminary evaluation of the role of PPARs. The Madin-Darby Bovine Kidney (MDBK) cell line has not been reported to be a PPARs agonist responding cell. To test the responsiveness to PPARs agonists the MDBK cells were treated with 50 μ M of Wy-14643 (specific PPAR α agonist) and 10 μ M of rosiglitazone (specific PPAR γ agonist). The gene expression of PPAR α , PPAR γ , and reported PPAR responsive genes, CPT-1 (Carnitine Palmitoyl Transferase-1), ACOX (Acyl CoA Oxidase), LPL (Lipoprotein Lipase) and GAPDH (Glyceraldehyde Phosphate Dehydrogenase) were analyzed using semiquantitative and real time PCR. Three replicates of the cultured cells were harvested at 6, 12, 18, 24 and 48 hours. Statistical analysis was performed using the REPEATED statement of the MIXED procedure of SAS. The results of gene expression were normalized using the expression of house-keeping genes. The statistical model included the effect of treatment (Wy-14643, Rosiglitazone, DMSO), time points (0, 6, 12, 18, 24 and 48), replicate (inside treatment), and treatment x time. Significance was set at $P < 0.05$. Semiquantitative PCR showed expression for all the genes tested, with a higher expression for PPAR γ compared to PPAR α . With real time PCR, CPT-1 mRNA was significantly increase (3 fold) by Wy-14643 treatment at 24 hours and 48 hours. ACOX mRNA expression showed a slight response only at 48 hours (1.6 fold). The LPL gene expression was increased in response to rosiglitazone treatment by 6 hours (28 fold) and highly elevated (460 fold) increase at 24 hours. The results suggest that the MDBK cell line is a promising model to evaluate the role of PPARs for the bovine.

Key Words: PPAR, Agonists, MDBK cells

W112 Treatment of Madin-Darby Bovine Kidney cells with fatty acid PPAR agonists. M. Bionaz^{*1}, E. Shirk¹, J. P. Vanden Heuvel¹, C. R. Baumrucker¹, E. Block², and G. A. Varga¹, ¹*Penn State University, University Park*, ²*Church & Dwight Co. Inc., Princeton, NJ*.

The peroxisome proliferator-activated receptors (PPARs) are nuclear receptors activated by specific fatty acids in a dose-dependent manner. Reports describing dose dependent activation and/or expression PPARs

after fatty acid administration have been published for humans and rodents; however, no data are available on the fatty acid dose effect responses in the bovine. We have shown that the MDBK cell line expresses PPAR α and γ . Our objective was to determine if the MDBK cells are models of fatty acid regulation of PPAR activation and/or expression in vitro. Three biological replicates of MDBK cells were treated for 24 hours with 5 different fatty acids diluted in DMSO (C16:0, C18:1, C18:2, C18:3 and conjugated linoleic acid (CLA)) at 5 concentrations (10, 25, 50, 100 and 200 μ M) and a vehicle control group. The total RNA was extracted and prepared for real-time PCR. The genes analyzed were two PPAR responsive genes CPT1 (Carnitine Palmitoyl Transferase-1) and LPL (Lipoprotein Lipase) and a housekeeping gene GAPDH (Glyceraldehyde Phosphate Dehydrogenase). The results of gene expression were normalized using the data of the house keeping gene. Statistical analysis was performed using the REPEATED statement of the MIXED procedure of SAS with $P < 0.05$ set for significance. The CPT-1 expression was significantly increased by palmitate (7 fold increase with 100 μ M) with lesser responses seen with linolenic, linoleic, CLA and oleic (2.9, 1.8, 1.6 and 1.5 fold increase with 200 μ M, respectively). The LPL expression was increased significantly only by palmitate (5.4 fold increase with 100 μ M). The tested unsaturated fatty acids did not increase LPL mRNA concentration with only linolenate causing an increase in the expression of the gene (1.8 fold increase with 100 μ M). The CLA treatment showed a significant decrease in LPL mRNA at 25 μ M (2.9 fold decrease). Palmitate was the most effective at affecting PPAR responsive genes in MDBK cells, followed by linolenic and linoleic while oleic and CLA fatty acids were ineffective.

Key Words: PPAR expression, MDBK cells, Fatty acids

W113 Unraveling the requirement of insulin for milk protein synthesis: A microarray perspective. K. K. Menzies^{*1,3}, C. Lefevre^{1,2}, K. L. Macmillan³, and K. R. Nicholas¹, ¹*CRC for Innovative Dairy Products, University of Melbourne, Australia*, ²*Victorian Bioinformatics Consortium, Monash University, Clayton, Australia*, ³*School of Veterinary Science, University of Melbourne, Werribee, Australia*.

The mammary explant culture model has been frequently used to mimic lactation and examine the endocrine control of milk protein gene expression. Murine studies show expression of the milk protein genes requires insulin with prolactin and cortisol. The role of insulin in milk protein synthesis in the dairy cow is not as clear. Culture studies using mammary explants from 4 late pregnant cows showed insulin, in the presence of prolactin and cortisol, is essential for alpha-s1-casein gene expression and plays a post-transcriptional role in synthesis of the casein proteins. To elucidate the molecular mechanisms underlying insulin action in the mammary gland a global analysis of the genes induced in the cultured explants was undertaken using Affymetrix microarray. Mammary explants from 2 groups of cows (2 cows/group) were cultured in media with prolactin and cortisol, either with or without insulin. The data was normalized and gene expression analysed using the limma package of Bioconductor. The expression of 298 genes were significantly down-regulated by insulin and 364 genes ($p = 0.01$), including the major milk protein genes, were significantly up-regulated by up to 10-fold, by insulin. Insulin is important for a number of cellular processes essential for functional secretory alveoli. The requirement for insulin in milk protein synthesis is highlighted by its role in inducing the expression of 26 genes known to be involved in protein synthesis such as transcription and translation factors, ribosomal genes and amino acid transporters. A previous study suggests an intense selection pressure for milk yield has altered the regulation of

blood glucose homeostasis such that the top quartile of Australian dairy cows (Australian Breeding Value) have unusually low concentrations of circulating insulin. Whether very low circulating insulin levels has consequent effects on the cows' efficiency for milk protein production is not known. However, the identification of key regulatory genes in the insulin-stimulated pathway of milk protein synthesis may be important to develop breeding strategies to improve the dairy cow's potential for milk protein production.

Key Words: Insulin, Milk protein synthesis

W114 Shortening the dry period from 60 to 40 days does not affect colostrum quality but decreases colostrum yield by Holstein cows.

D. J. Grusenmeyer*, C. M. Ryan, D. M. Galton, and T. R. Overton, *Cornell University, Ithaca, NY.*

Holstein cows (n=334) at the end of first or greater lactation on three commercial dairy farms were used to determine whether dry period length affects colostrum quantity and quality as assessed by direct measurement of total immunoglobulin G (IgG) concentrations. Cows producing 22 kg/d of milk or more at 60 d before expected calving were assigned randomly to receive either a 60 d (actual mean = 58 d) or 40 d (actual mean = 40 d) dry period. The first milking following calving was weighed and sampled for subsequent analysis for total IgG by Single Radial Immunodiffusion. Total IgG content averaged 77.0 mg/ml and was different across the three farms (84.3, 81.6, 65.0 mg/ml; $P < 0.0001$), but was not affected by managing for 60 versus 40 d dry (77.6 vs. 76.4; $P = 0.69$). Using 50 mg/ml of total IgG as an objective threshold concentration for acceptable colostrum quality, 21% of samples had total IgG concentrations below 50 mg/ml; this proportion was not affected by dry period length but varied substantially across farms (range 10 to 36% of cows). Colostrum yield averaged 7.9 kg and varied across farms (6.7, 7.6, 9.4 kg; $P < 0.001$). Shortening the dry period from 60 to 40 d decreased colostrum yield (8.9 vs. 6.8 kg; $P < 0.001$); this difference was consistent across farms (treatment by farm, $P = 0.92$). Using 3.6 kg as an objective threshold for minimum successful production of colostrum, 30% of cows managed for 40 d dry produced less than 3.6 kg of colostrum compared to 13% of cows managed for 60 d dry ($P < 0.001$). There was no relationship ($P > 0.05$) between colostrum yield and total IgG concentration in this dataset. Overall, results suggest that colostrum yield, but not quality, is decreased by managing cows for 40 versus 60 d dry periods. In addition, there appears to be no relationship of colostrum quantity and quantity in Holstein cows.

Key Words: Dry period, Colostrum, Transition dairy cow

W115 Effect of subclinical mastitis and breed on somatic cell counts and milk constituents and the accuracy of using pooled samples. E. L. Huether*, D. W. Holcombe, and E. R. Kretschmer, *University of Nevada, Reno.*

Accurate mastitis testing programs that allow for early detection are vital to the maintenance of a healthy, economically productive flock. Research examined the accuracy of using the somatic cell counts (SCC) of pooled samples from the right and left udder halves as well as the effect of subclinical mastitis and breed on milk constituents. Seventeen Suffolk and 66 Rambouillet multiparous and primiparous ewes were weaned at 90 ± 7 d (mean \pm SD) postpartum. A milk sample was collected from each udder half and an aliquot from each sample was then pooled. Milk samples were classified according to their SCC values as either normal ($< 500,000$ cells/ml-1) or as having subclinical

mastitis ($\geq 500,000$ cells/ml-1) and SCC values were transformed into the natural log (ln). Milk SCC averaged from the right and left udder halves did not differ ($P = 0.91$) from the pooled values. Fat, protein and lactose percentages were not affected ($P \geq 0.56$) by sampling method. Somatic cell counts (ln) were increased ($P < 0.0001$) in udder halves with subclinical mastitis when compared with non-mastitic udder halves (8.2 and 4.2 ± 0.2 ln, respectively; mean \pm SE). Fat percentages tended to be increased ($P = 0.09$) in udder halves with mastitis than normal udder halves (5.7 and 4.8 ± 0.4 %, respectively). Percentage of protein was greater ($P < 0.0001$) in mastitic udder halves (6.5 %) than non-mastitic udder halves (5.6 %). Lactose percentages decreased ($P < 0.0001$) in udder halves with mastitis (3.9 %) versus normal udder halves (4.8 %). Somatic cell counts and protein percentages were greater ($P \leq 0.03$) for the Rambouillet versus the Suffolk breed (6.0 and 5.0 ± 0.2 ln; 6.4 and 5.5 ± 0.2 ln, respectively). Suffolks displayed greater ($P \leq 0.04$) fat (5.7 and 4.8 %, respectively) and lactose (4.6 and 4.1 %, respectively) percentages than Rambouillets. These data indicate that pooled samples can be used to accurately determine SCC and milk constituents in ewe milk. Protein and lactose percentages were affected by mastitis and may be useful indicators of mastitis infection.

Key Words: Ewe, Mastitis, Somatic cell count

W116 Regulation of haptoglobin (Hp) mRNA expression in the bovine mammary gland parenchyma during experimental mastitis.

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Expression of Hp mRNA, one major acute phase protein in cattle, was detected in homogenates of the bovine mammary gland. The aim of this study was to localize Hp mRNA expression within the udder at the cellular level and to quantify any difference of the level of this expression caused by two major mastitis pathogens. For this purpose 3 quarters of each of 3 cows were subsequently inoculated with *Escherichia coli* (*E. coli*) at 6, 12 and 24 h pre-slaughter, the 4th quarter received saline 24 h pre-slaughter as control. Another 3 cows received *Staphylococcus aureus* (*S. aureus*) accordingly. After slaughter, tissue samples of each quarter were collected for analyses by *in situ* hybridization (ISH) and real-time RT-PCR. ISH allocated Hp mRNA expression to the alveolar epithelium of the mammary gland. In addition, evaluating the number of cells expressing Hp mRNA revealed a significant difference between the 4 quarters treated with *E. coli* ($P < 0.05$) in contrast to the quarters exposed to *S. aureus*. A 17-fold rise in the number of epithelial cells expressing Hp in mammary tissues was detected during the course of *E. coli* infection, whereas Hp mRNA expression in response to *S. aureus* infection appeared unchanged. This divergence was confirmed by quantitative real-time RT-PCR: in contrast to *S. aureus* infected animals, Hp mRNA expression differed significantly between the quarters of *E. coli* infected animals ($P < 0.05$). In the latter a 176-fold increase was observed from 0 to 24 h. In summary, this is the first study reporting the localization of Hp mRNA in mammary epithelium of cows. The lack of response to *S. aureus* within the first 24 h after infection is in contrast to *E. coli* infection and possibly highlights pathogen-species dependent modulation of the host's immune defense in the udder

Key Words: Haptoglobin, Dairy cow, Mastitis

W117 Effect of sampling day and number of lambs raised on somatic cell counts (SCC) and cell populations in ewe milk. E. R. Kretschmer¹, D. W. Holcombe¹, D. Redelman², and D. L. Garner¹, ¹University of Nevada, Reno, ²Sierra Cytometry/UNR Cytometry Center, Reno, NV.

The objective of this research was to examine the effects of number of lambs raised per ewe and day of milk sampling on live, dead and total somatic cell counts (SCC) including the percentages of specific cell types (monocytes, granulocytes, apoptotic cells and large cells) in ewe milk. Each udder half of thirty-two Rambouillet ewes (2 - 5 yr old) was sampled at 24 h after birth (d 0) and at d 10, 20, 30, 40, 50, and 70 ± 1 d (mean ± SD) and at d 93 ± 10 d postpartum. Four ewes raised triplets, 16 ewes raised twins and 12 ewes raised single offspring. Somatic cell numbers in the ewe milk were quantified by flow cytometry and expressed as log₁₀ values. The number of lambs raised increased the number of live cells ($P = 0.03$) and total cells ($P = 0.07$); ewes raising triplets had more cells than ewes raising twins or singles. Day of sampling had no effect ($P = 0.32$) on the number

of dead cells, but did affect ($P < 0.05$) the number of live and total cells in milk; values decreased at subsequent sampling days after d 0 but increased again at d 93. Difference in large cell percentages were noted ($P < 0.04$) at d 20, 50 and 70 relative to the number of lambs raised. Total number of granulocytes were greater ($P = 0.036$) for triplets than for twins or single offspring. Monocyte numbers were lower ($P < 0.0001$) at d 0 and increased throughout lactation, whereas the total large cell population was greatest ($P < 0.0001$) early in lactation and continued to decrease throughout lactation. Total granulocytes for all groups were greater at d 0 ($P = 0.015$) than that of the subsequent sampling days, and increased again at d 93, whereas, the percentage of live granulocytes and apoptotic cells increased ($P < 0.04$) from d 0 to d 93 for all lambing groups. In conclusion, ewes raising triplets had more live and total SCC, likely reflective of an increase in the total granulocytes. Cell populations were either increased or decreased from d 0 to d 90 depending on cell type.

Key Words: Somatic cell count, Mastitis, Sampling day

Nonruminant Nutrition: Dietary Influences on Boars, Sows and Gilt Development

W118 True calcium and phosphorus digestibility and the endogenous calcium and phosphorus outputs associated with soybean meal for multi-parity sows measured by the simple linear regression technique. K. Kuang¹, R. He¹, J. Wang², Y. L. Yin^{3,4}, and M. Z. Fan⁴, ¹Huazhong Agricultural University, Wuhan, Hubei Province, China, ²The Chinese National Institute of Animal Sciences, Beijing, China, ³The Chinese Academy of Sciences, Changsha, Hunan Province, China, ⁴University of Guelph, Ontario, Canada.

Six Yorkshire x Landrace dry sows, with an average initial BW 200 kg and 5-7 parity, were housed individually and fed six diets (2 kg/d) according to a 6x6 Latin square design. The diets were soybean meal (SBM)-cornstarch-glucose based and contained six graded levels of Ca (1.58, 1.69, 1.94, 2.30, 2.88 and 3.65 g/kg DMI) and P (0.79, 1.91, 2.91, 4.04, 4.86 and 5.82 g/kg DMI). Chromic oxide (0.35%) was included in the diets as a digestibility marker. Each experimental period lasted 8 d with a 5-d adaptation and 3-d collection of fecal samples. True digestibility of Ca ($27 \pm 5.0\%$) and P ($44.0 \pm 4.5\%$) and the endogenous outputs of Ca (1.19 ± 0.12 g/kg DMI) and P (0.78 ± 0.17 g/kg DMI) associated with the solvent-extracted SBM for the sows were obtained by the simple linear regression analysis technique. In conclusion, Ca associated SBM was poorly digestible in sows. The endogenous fecal Ca output associated with SBM was relatively high in sows.

Key Words: Phosphorus, True digestibility, Sows

W119 Development of procedures to assess the potential for parturient hypocalcemia in sows. C. Darriet and T. D. Crenshaw*, *University of Wisconsin, Madison.*

Parturient hypocalcemia, also known as milk fever, is a common disorder in dairy cows, but occurrence in sows is not known. An increased incidence of unexplained sow mortality near farrowing has triggered questions about potential involvement of hypocalcemic related disorders as contributors to the incidence of mortality. A long-term objective was to develop procedures that could eventually be used to assess the incidence of hypocalcemia in a large population of sows. The current experiment was designed to assess diurnal variation

in serum Ca and blood gas responses of sows at farrowing. On gestation day 111, indwelling venous catheters were placed in 15 multiparous or single parity sows fed diets with either minimal (0.75%) or excess (1.50%) Ca for 4 wk prior to farrowing. Five blood samples were collected at 15-min intervals (0, 15, 30, 45, and 60 min) within each of 4 designated times (0700, 1000, 1300, and 1900) within a day on gestation day 113 (G113) and lactation day 1 (L1). On the day of farrowing (L0), 5 blood samples (at 15-min intervals) were collected within each of 2 times (6 and 9 h after birth of the first pig). Blood gas assays (pH, pO₂, pCO₂, base excess and blood Na, K and Ca (ionized)) were performed on 1 sample at each designated hour within days G113, L0, and L1. Serum Ca values (mg/dL) of sows fed diets with minimal or excess Ca were not different for any of the daily collections (9.28 vs. 9.48 ± 0.09 , G113; 9.31 vs. 9.83 ± 0.11 , L0; and 9.88 vs. 9.43 ± 0.06 , L1) pooled across hourly times and 15 min interval samples. Within days (G113, L0 and L1) no diurnal pattern was detected ($P > 0.10$). Blood pH and blood gas values were not affected by diet or day of sampling. These results provide evidence that single daily blood samples can be collected from a large population of sows to assess incidence of hypocalcemia relative to other production traits. Diurnal patterns are not a significant source of error in assessment of serum Ca in sows at farrowing.

Key Words: Sows, Hypocalcemia, Mortality

W120 The effect of omega-3 fatty acid addition to sow diets on milk composition. S. A. Meers*, C. R. Dove, and M. J. Azain, *University of Georgia, Athens.*

The objective of this study was to determine the effects of feeding a diet containing n-3 fatty acids during late gestation and/or lactation on sow milk composition. The study was designed as a 2 x 2 factorial arrangement with main effects of feeding n-3 fatty acids in the gestation diet and/or lactation diet. Diets were corn-SBM based diets such that the gestation diet (G) was calculated to contain approximately 3290 kcal ME, 13% CP and, 0.78% lysine, while the lactation diet (L) was calculated to contain 3242 kcal ME, 17.5% CP and, 1.15% lysine. Omega-3 fatty acids, supplemented in the form of an encapsulated product (Fertiliium®, United Feeds, Sheridan, IN), added to the G or

L diet resulted in a shift of the n-6/n-3 ratio from approximately 20 in the control to 13 in the n-3 G diets and 13 to 10, respectively, in the L diets. Fertulium® is 17.5% fat, with about 15% of that as EPA and DHA, and was added at only 1.5% of the diet. Sows (n=44) were allocated by parity to either the control or n-3 diet at approximately d 60 of gestation. Sows were moved to the farrowing barn on d 110 and switched to the L diet, with half of the sows in each dietary treatment maintained on the same diet and half switched to the other diet (Control or Omega-3). Litters were weaned at an average of 21 d and sows were maintained on their respective diets through re-breeding. Milk samples were obtained from each sow within 24 h of farrowing, at d 7, and at weaning. The addition of n-3 fatty acids increased the total n-3 percent of milk from O/O sows (1.35%) as compared to C/C sows (1.12%, $p < 0.0001$). While the percent of total n-6 in the milk did not change, the change in n-3 significantly altered the n-6/n-3 ratio (17.49 for C/C to 14.56 for O/O, $p < 0.0001$). There was a diet effect on both EPA and DHA concentrations. Addition of n-3 to the L diet increased the concentrations of EPA (0.09% in O/O vs. 0.03% in C/C, $p < 0.0001$) and DHA (0.14% vs. 0.03% in O/O and C/C respectively, $p < 0.0001$) regardless of which G diet the sow consumed. These results demonstrate that small additions of n-3 fatty acids to the maternal diet can significantly alter the milk consumed by progeny.

Key Words: Omega-3 fatty acid, Sow, Pig

W121 Protein and dry matter digestibility of colostrums by newborn piglets. C. Lin*¹, D. C. Mahan², and S. W. Kim¹, ¹Texas Tech University, Lubbock, ²The Ohio State University, Columbus.

This study was conducted to determine the nutrient digestibility of colostrums by newborn piglets. Colostrums were collected from 120 sows within 12 h postpartum after injection of oxytocin. Total of 6 L colostrums were used in this study. Twelve, 1 d old, male piglets were selected from three litters and housed individually in the crates with heating lamps to maintain the temperature at 35°C. All the piglets were fed colostrums containing 0.25% (w/w) Cr oxide as an external marker. Pigs were provided seven meals of colostrums per day for 3 d allowing 40.0 mL/meal for d 1, 55.0 mL/meal for d 2, and 70.0 mL/meal for d 3. Colostrums were hand fed using baby milk bottles. Entire fecal samples with unique chromium color were collected. Total collection of the fecal samples was done 7 times daily to ensure collecting fresh samples. Fresh fecal samples were immediately weighed, stored in the freezer (-20°C), freeze-dried, and ground for chemical analysis. Colostrums were also freeze-dried and ground for chemical analysis. Contents of dry matter and crude protein were determined to calculate nutrient digestibility. Total tract digestibility of protein and dry matter in colostrums from piglets averaged 96.9±0.40 % and 98.3±0.21 % and these values were not affected by litter origin.

Key Words: Colostrums, Protein, Pigs

W122 Determination of bioequivalence ratio of D-α- to DL-α-tocopheryl acetate based on tissue α-tocopherol content of swine. H. Yang*¹, D. Mahan², D. Hill³, T. Shipp³, T. Radke¹, and M. Cecava¹, ¹ADM Animal Nutrition, Quincy, IL, ²The Ohio State University, Columbus, ³ADM Animal Health and Nutrition, Quincy, IL.

Gilts (n=24; BW=67 kg) were individually housed to determine bioequivalence ratio (BR) of d-α-tocopheryl acetate (DαT) to dl-α-tocopheryl acetate (DLαT). The study had five treatments (TRT) in a RCB design in four or five replicates. TRTs were 1) DLαT addition

at 22 mg/kg, 2) DαT addition at 16.18 mg/kg (BR1.36), 3) 11 mg/kg (BR2.00) and 4) 8.33 mg/kg (BR2.64), and 5) 6.71 mg/kg (BR3.28). Prior to initiation of Exp, pigs were fed a non-vitamin E fortified diet for 30 d. Corn-SBM diets were formulated to contain TID lysine 0.9% (depletion diet) and 0.8% (Exp diet). Day 0 serum α-tocopherol (αT) was a covariate for analysis of all tissue αT. Polynomial analysis was conducted for DαT TRTs. As dietary DαT decreased, αT decreased linearly for lung ($P < 0.05$), heart, kidney, spleen, liver and d15 and 32 serum ($P < 0.01$), whereas there was a cubic effect for brain ($P = 0.05$), loin ($P = 0.15$) and fat ($P = 0.09$). Tissue & serum αT data from DαT TRTs were used to generate seven linear regression equations to calculate BR. BR was 2.76, 2.45, 2.88, 2.76, 2.66, 2.83 and 2.89 for heart, kidney, spleen, lung, liver, d15 and 32 serum, respectively. αT content for each tissue was highly correlated with that for serum on d0 ($P < 0.12$), 15 and 32 ($P < 0.05$), with coefficients higher for d15 than d0, but similar to d32. These results suggest an average biological equivalence ratio of 2.75 for growing swine, substantially above the accepted USP value of 1.36.

Table 1.

Trt	DLαT	BR1.36	BR2.00	BR2.64	BR3.28	P Value for DαT				
						SE	Lin	Quad	Cubic	
PPM	22.00	16.18	11.00	8.33	6.71					
Serum αT (μg/ml)										
d 0	0.71	1.16	1.11	1.01	1.11	0.12	0.55	0.73	0.49	
Tissue αT on d 32 (μg/g)										
Heart	3.89	4.75	4.38	3.96	3.67	0.27	0.01	0.43	0.94	
Kidney	2.07	2.53	2.17	1.91	1.62	0.14	0.01	0.29	0.69	
Spleen	2.98	4.44	3.59	3.22	2.71	0.17	0.01	0.45	0.39	
Liver	2.96	4.39	3.33	2.75	2.75	0.23	0.01	0.38	0.45	
Lung	2.11	3.48	2.43	2.42	2.34	0.44	0.04	0.37	0.78	
Brain	4.94	5.19	4.93	5.46	4.20	0.40	0.26	0.28	0.05	
Loin	1.22	1.71	1.53	1.83	1.34	0.26	0.54	0.69	0.15	
Fat	3.55	5.16	4.65	5.04	4.05	0.39	0.11	0.53	0.09	

Key Words: Pigs, Vitamin E, Tocopherol

W123 Amino acid requirements of lactating sows: Selection of source data for factorial estimates. K. T. Soltwedel*¹, N. R. Augspurger², S. K. Webel², D. D. Hall³, and J. E. Pettigrew¹, ¹University of Illinois, Urbana, ²JBS United, Sheridan, IN, ³AusGene International, Gridley, IL.

Factorial estimates of AA requirements of lactating sows vary widely depending on which source data on AA ratios of mammary and maintenance requirements and mobilized body protein are used. This experiment was designed to provide evidence about which source datasets may be appropriate. Data were collected on 410 sows and their litters, of which 378 were used in the analysis because sows that weaned 7 or fewer pigs were removed from the dataset. Three experimental diets, each formulated to 0.65% standardized ileal digestible (SID) Lys, were used in the study. Supplemental L-Lys•HCl was included at 0.0 (Diet 1), 0.1 (Diet 2), and 0.3 (Diet 3) percent of the diet respectively. L-Lys•HCl replaced intact Lys, primarily from soybean meal, resulting in diets with similar levels of SID Lys but varying levels of other AA. Sows were allotted to treatment on the basis of parity. The SID Thr:Lys ratios calculated to be in Diets 1, 2, and 3 from analyzed amino acid values were 0.68, 0.63, and 0.50, respectively; corresponding ratios for Val:Lys were 0.93, 0.85, and 0.70. Pre-planned orthogonal contrasts for Diet 1 vs. 2, and Diets 1 and 2 vs. 3 were tested. The contrast of Diet 1 vs. Diet 2 was not significant for any response variable. However, when Diets 1 and 2 were compared to Diet 3, overall litter ADG tended to be higher (2.22

± 0.03 and 2.25 ± 0.03 vs. 2.18 ± 0.03 kg/d; $P = 0.10$), litter ADG from d 9 to weaning was higher (2.46 ± 0.03 and 2.45 ± 0.03 vs. 2.37 ± 0.03 kg/d; $P < 0.01$), and piglet BW at weaning was higher (5.86 ± 0.05 and 5.85 ± 0.05 vs. 5.74 ± 0.05 ; $P = 0.05$). These results suggest SID Thr:Lys and SID Val:Lys ratios required in the diet did not exceed 0.63 and 0.85, respectively. These ratios are consistent with requirement estimates of NRC (1998) and Kim et al., (2001) but suggest Thr:Lys and Val:Lys requirement ratios supported by previous measures of mammary amino acid uptake are too high.

Key Words: Sows, Threonine, Valine

W124 Effects of feed allowance levels on nitrogen retention and blood hormone levels in gestating and dry gilts. D. Wu^{*1,2}, F. Yang¹, A. Zhou¹, Z. Wang¹, and K. Wang¹, ¹*Sichuan Agricultural University, Ya'an, Sichuan, China*, ²*University of Guelph, Ontario, Canada*.

Eighteen high-producing crossbred gilts (Landrace×Meishan) were used to investigate the effect of feed allowance levels on N retention and blood hormone levels in gestating and dry gilts. The gilts were randomly allotted to three feed allowance levels (High:2×maintenance; Medium:1.2×maintenance; Low:0.65×maintenance). Three of the gilts for each of the treatments were bred on the fourth estrus. Bred and dry gilts' BW (95.8 ± 1.78 kg) and backfat thickness (23 ± 1.2 mm) at the breeding were similar among treatments. After breeding, the gilts were housed individually in automatic weighing metabolic cages. The N balance was measured after breeding, and during early-, mid-, and late-gestation. The 6-d nutrient-balance collection commenced on d 0, 30, 60, and 90. Serum progesterone, leptin, GH and insulin levels were measured at d 5, 35, 60 and 95 during the gestation. At similar feed allowance levels, gestating gilts gained more BW ($p < 0.01$) than dry gilts during the gestation. There were no differences ($p > 0.05$) in fecal N excretion and apparent N digestibility between the gestating and dry gilts. However, urine N excretion in the gestating gilts were lower ($p < 0.05$) than that of the dry gilts for all the treatment groups during the mid- and late-gestation. Efficiency of N retention of the gestating gilts at the low feeding level was significantly higher ($p < 0.01$) compared with that of dry gilts during gestation. The progesterone or leptin level of the gestating gilts on all treatments was higher ($p < 0.05$) than that of the dry gilts during gestation. However, GH or insulin level was only significantly higher during the late gestation. It is concluded that gestation influenced hormone secretion and had more N retention and body gain compared with dry gilts, especially at the low feed allowance level.

Key Words: Feeding levels, Nitrogen efficiency, Gilts

W125 Effect of feeding rye silage and feed restriction on performance and reproductive development in developing gilts. J. H. Cho^{*1}, Y. K. Han², B. J. Min¹, Y. J. Chen¹, H. J. Kim¹, J. S. Yoo¹, J. W. Kim¹, and I. H. Kim¹, ¹*Dankook University, Cheonan, Chungnam, Korea*, ²*Sungkyunkwan University, Suwon, Gyeonggi, Korea*.

This study was conducted to evaluate the effects of feeding rye silage and feed restriction on growth performance and reproduction in developing gilts. Twenty four replacing gilts (Landrace×Yorkshire, 67.63 ± 1.17 kg) were used in 49 d growth assay. Dietary treatments were included 1) CON(basal diet), 2) S15(15% feed restriction + ad libitum rye silage) and 3) S30(30% feed restriction + ad libitum rye silage). In growth performance, ADG(1.088 vs 0.921 vs 0.782 kg) and ADFI(3.024 vs 2.590 vs 2.257 kg) were significantly the highest in CON ($P < 0.05$) among treatments. Average daily silage intake was

not significant difference between S15 and S30 treatments($P > 0.05$). F:G was the lowest in CON(2.779) vs silage treatments(2.812 , 2.886)($P < 0.05$). Average silage intake of S1 and S2 treatments was increased as time increased($P < 0.05$). While all gilts of S15 and S30 treatments became pregnant, one gilt of CON became pregnant. Also, first estrus and mating occurred earlier in S15 and S30 than those of CON. In conclusion, 15% feed restriction and feeding rye silage reduced growth performance, but gilts reached first estrus earlier with an increased pregnancy.

Key Words: Rye silage, Feed restriction, Replacing gilts

W126 Tissue concentrations of selenium in boars fed a diet supplemented with selenium from organic or inorganic sources. M. J. Estienne^{*}, A. F. Harper, and R. J. Crawford, *Virginia Polytechnic Institute and State University, Blacksburg*.

Dietary supplementation with 0.5 ppm sodium selenite enhances fertility in boars. Because of environmental concerns, however, the U.S. FDA limits the amount of supplemental Se to 0.3 ppm for all swine. The objective of this experiment was to determine tissue concentrations of Se in boars fed diets supplemented with 0.3 ppm Se from either sodium selenite or an organic source that is purportedly more bio-available than traditional inorganic sources. Mature boars (444.1 ± 0.5 d of age) were fed at a rate of 2.0 kg/d, a control diet (no supplemental Se), or a diet supplemented with 0.3 ppm Se from either an organic (Sel-Plex; Alltech, Inc., Nicholasville, KY) or inorganic (Premium Selenium 270; North American Nutrition Co., Inc., Lewisburg, OH) source for 70 d ($n = 3$ boars/group). At the end of the trial, samples of whole blood, liver, and testicular parenchyma were collected, and tissue Se concentrations determined using atomic absorption analysis. Concentrations of Se in testicular tissue were higher ($P < 0.05$) in boars fed the organic source (397.7 ± 23.5 ppb) compared with controls (317.3 ± 23.5 ppb), with boars fed the inorganic source having an intermediate value (380.7 ± 23.5 ppb), that was not different ($P > 0.05$) from the other groups. Levels of Se in liver were similar ($P > 0.05$) for boars fed the organic (534.3 ± 33.2 ppb) or inorganic source (516.0 ± 33.2 ppb) and concentrations in both groups were greater ($P < 0.01$) than controls (293.0 ± 33.2 ppb). Whole blood concentrations of Se were higher ($P < 0.01$) in boars fed the organic source (180.7 ± 11.7 ppb) compared with controls (115.0 ± 11.7 ppb), with boars fed the inorganic source having an intermediate value (152.7 ± 11.7 ppb), that was not different ($P > 0.05$) from the other groups. Tissue Se concentrations were greatest for boars fed the diet containing an organic source of Se, suggesting that even in a relatively brief trial bio-availability was influenced by the source of supplemental Se.

Key Words: Boar, Selenium, Testicle

W127 Comparative study of two analytic methodologies for the determination of acid-insoluble ash for evaluation of nutrients digestibility in broiler diets. E. Jiménez-Moreno, J. M. González-Alvarado, A. Coca, R. Lázaro, and G. G. Mateos^{*}, *Universidad Politécnica de Madrid, Spain*.

Two methodologies widely used in digestibility trials for determination of acid-insoluble ash (AIA) in feeds and faeces are the procedure described by Vogtmann et al., 1975, (VO; Br. Poult. Sci. 16, 531) based on the boiling of the complete sample (4N HCl for 30 min), followed by ashing at 600°C for 6 h, and the procedure described by Van Keulen and Young, 1977, (VK; J. Anim. Sci. 44, 282) based on the sequential analysis of DM, ash, and boiling (2N HCl for 5 min) to determine

AIA. In our test we used 12 experimental diets of similar nutritive value to determine apparent retention of nutrients and the AMEn by both techniques in 18 d-old broilers. The main difference among diets was the cereal used (corn vs. rice), the type of processing of the cereal (raw vs. heat processed), and the inclusion of a fiber source (none vs. 3% oat hulls vs. 3% soybean hulls) and all of them included 1% celite an additional indigestible marker. Each treatment was replicated three times (9 birds caged together). The AIA values of feeds and excreta were lower when determined by VK than when determined by VO (1.693 vs. 1.748% DM for diets and 6.655 vs. 6.961% DM for excreta; $P < 0.001$) but no interactions of technique x dietary treatment were

found. The correlation coefficient of the AIA content of feeds and excreta between VO and VK techniques was good ($r > 0.99$). Nutrient digestibility and AMEn of the diets were lower when calculated with the VK technique than when calculated with the VO technique (74.6 vs. 75.0% for DM, 79.1 vs. 79.5% for OM, and 3,022 vs. 3,033 kcal/kg for AMEn; $P < 0.05$) but no interactions between techniques used for AIA determination and dietary treatments were observed. We concluded that either technique is acceptable to determine the apparent retention of nutrients and the AMEn of diets in poultry experiments.

Key Words: Acid-insoluble ash, Nutrient digestibility, Broilers

Nonruminant Nutrition: Enzyme Supplementation

W128 Investigating possible interactions between phytase and xylanase in wheat-based diets for growing pigs. T. A. Woyengo^{*1}, C. M. Nyachoti¹, J. S. Sands², and W. Guenter¹, ¹University of Manitoba, Winnipeg, Manitoba, Canada, ²Dansico Animal Nutrition, Marlborough, United Kingdom.

An experiment was conducted to determine the effect of combining phytase and xylanase on total tract nutrient digestibility and performance of growing pigs. Ten wheat-based diets were fed to 60 (30 barrows and 30 gilts) Cotswold growing pigs from 19.9±1.2 to 60.2±2.4 kg BW. The ten diets included a control and a nutrient reduced (energy, Ca and P) diet supplemented with phytase at 3 levels, i.e, 0, 250 and 500 FTU/kg and xylanase at 3 levels, i.e, 0, 2000 and 4000 XU/kg in a 3x3 factorial arrangement to give 9 treatment combinations. Each diet was randomly assigned to 6 pigs balanced for sex. Chromic oxide was added to the diets (at rate of 0.5 %) during the first and last 10 d of the experiment to determine nutrient digestibility at about 20 and 60 kg BW, respectively. Enzyme supplementation had no effect ($P > 0.05$) ADFI, ADG, G:F and crude protein digestibility. Phytase supplementation did not influence ($P > 0.05$) energy digestibility while xylanase supplementation only increased ($P < 0.05$) energy digestibility at 60 kg BW when it was given at 4000 XU/kg. Phytase supplementation increased Ca and P digestibilities ($P < 0.05$) at both 20 and 60 kg BW. But there was no effect ($P > 0.05$) of increasing the level of phytase on digestibility of Ca and P. Xylanase supplementation at 4000 XU/kg increased digestibility of Ca, but not of P, at both 20 and 60 kg BW. There were no significant interactions ($P > 0.05$) between phytase and xylanase with regard to nutrient digestibility. In summary, phytase supplementation improved Ca and P digestibilities while xylanase improved Ca and energy digestibilities, but neither affected pig performance. Furthermore, there were no synergistic effects of phytase and xylanase on nutrient digestibility and pig performance.

Key Words: Wheat, Phytase, Xylanase

W129 Effects of supplemental dietary phytase and strontium on bone strength of weanling pigs fed a high phosphorus diet. P. K. Roy^{*}, K. Yasuda, R. Maiorano, K. R. Roneker, and X. G. Lei, Cornell University, Ithaca, NY.

Our laboratory has previously shown positive impacts of supplemental microbial phytase (AppA2) and strontium (Sr) on bone traits of weanling pigs fed phosphorus-adequate diets. The aim of the present study was to determine if supplemental phytase (OptiPhos, JBS United, Inc., Sheridan, IN) and Sr (SrCO₃, Alfa Aesar, Ward Hill, MA) still

exerted that positive effect in pigs fed a high phosphorus diet. Forty pigs (BW = 7.60 ± 0.14 kg) were allocated into four groups (n = 10). Group 1 were fed a corn-soy basal diet (BD) + 0.25% inorganic phosphorus (iP, dicalcium phosphate) + 50 mg Sr/kg (Diet 1). Group 2 were fed Diet 1 + 0.10% iP (Diet 2). Group 3 were fed BD + 0.35% iP + 3,400 units of phytase/kg (Diet 3). Group 4 were fed Diet 3 + 50 mg Sr/kg (Diet 4). After 8-wk feeding, five female pigs close to the mean value from each group were killed to collect bone samples for mechanical analysis. Plasma iP concentrations and body weight of individual pigs were measured biweekly, and showed no differences between treatments. Elevating dietary iP from 0.25 to 0.35% in the diet containing 50 mg Sr/kg significantly ($P < 0.05$) improved breaking strength of femur and metacarpals by 9 and 20%, respectively (Diets 1 vs. 2). Supplementing phytase in the diet containing 0.35% iP and 50 mg Sr/kg improved ($P < 0.05$) breaking strength of the two bones by 10 to 11% (Diets 2 vs. 4). Supplementing Sr in the diet containing 0.35% iP and phytase produced non-significant effect on bone strength (Diets 3 vs. 4). In conclusion, 3400 iu/Kg phytase supplementation improved bone strength of pigs fed diet containing 0.35% phosphorus, but the moderate level of Sr supplementation did not produce benefit as an alternative of phytase in those pigs.

Key Words: Pigs, Phytase, Strontium

W130 Supplemental dietary phytase and strontium improves bone traits of weanling pigs fed a phosphorus-adequate diet. A. R. Pagano¹, K. R. Roneker¹, K. Yasuda^{*1}, T. D. Crenshaw², and X. G. Lei¹, ¹Cornell University, Ithaca, NY, ²University of Wisconsin, Madison.

Previous research in our laboratory has shown that dietary phytase supplementation at 2,000 units (U)/kg enhanced bone strength of weanling pigs fed phosphorus-adequate diets, possibly by improving dietary strontium (Sr) absorption. The objective of this study was to determine if supplementing Sr and phytase additively improved bone traits of those pigs. A total of 32 weanling pigs (BW: 11.4 ± 0.3 kg) were allotted to four groups (n = 8) fed a corn-soy, phosphorus-adequate (0.65%) basal diet (BD), the BD + Sr (50 mg/kg, SrCO₃, Alfa Aesar, Ward Hill, MA), the BD + phytase (2,000 U/kg, OptiPhos, JBS United, Inc., Sheridan, IN), or the BD + Sr (50 mg/kg) + phytase (2,000 U/kg) for 6 wk. Weight gain, plasma alkaline phosphatase activity, and plasma inorganic P concentration of individual pigs were measured weekly, but no differences among treatments were detected. Femurs and metacarpals were collected from both front legs at the end of experiment to test mechanical properties, mineral density (BMD,

g/cm²), and mineral content (BMC, g). Breaking load and BMD of metacarpal were improved (5 to 24%, $P < 0.05$) by supplemental Sr and(or) phytase. Femur BMD and metacarpal BMC were enhanced ($P < 0.05$) by supplemental phytase. Compared with the other three groups, pigs fed Sr + phytase had higher ($P < 0.04$) BMC (9 to 24%) and BMD (8 to 17%) of both bones and greater ($P < 0.05$) breaking load of femur (12 to 19%). No interactions of dietary Sr and phytase were observed on any of the measures. In conclusion, supplemental Sr and phytase additively improved bone development of weanling pigs fed phosphorus-adequate diets.

Key Words: Pigs, Phytase, Phosphorus

W131 The effect of adding high levels of phytase in the nursery/grower diets on growth performance, carcass characteristics, and bone strength in grower-finishing pigs. T. C. Tsai*¹, C. R. Dove¹, M. J. Azain¹, and M. Bedford², ¹University of Georgia, Athens, ²Syngenta Animal Nutrition Inc., RTP, NC.

The objective of this study was to determine if there were sustained benefits of high levels of phytase (12,500 U/kg) in nursery /grower phase on subsequent performance. At an initial weight of 20 kg, 80 pigs were assigned to one of 5 dietary treatment groups in pens of 4 pigs (2 barrows, 2 gilts) each. There were three dietary phases fed: 20-45 kg, 45-90 kg and 90-130 kg during the 16 wk study. Diet 1 was the positive control and contained 0.35, 0.30 and 0.25% avail. P in the 3 phases, respectively. Diets 2-5 had no inorganic P added and contained 0.13, 0.10 and 0.10% avail. P. Diet 2 was the negative control diet. Diet 3 was supplemented with 500 U/kg phytase (Quantum 2500D™) in all phases; Diet 4 with 12,500 U in phase 1 and 500 U in phase 2 and 3; diet 5 had 12,500 U in phase 1 and 2 and 500 U/kg in phase 3. In phase 1, addition of 500 U/kg phytase (711g/d) increased growth over the negative control (650 g/d), while 12,500 U (863 g/d) normalized gain to that of the positive control (873 g/d). Overall, growth rate was greater in pigs that were fed high levels of phytase early and then lower levels than in those fed 500 U for the entire study. Phytase addition improved phosphorous digestibility in each phase. There was no effect of phytase on carcass characteristics when adjusted for BW. Metatarsal bone weight was reduced with the low P diet and increased with 500 U phytase. Bone weight was not different from the positive control in pigs that were fed 12,500 U phytase in phase 1 or 2. Percent ash and bone strength were reduced on the low P diet and restored with addition of any level of phytase. These results suggest that the benefits of feeding high levels of phytase in the nursery and/or grower phase are sustained in the finisher phase.

Table 1

Diet:	1	2	3	4	5		
Phase:		Neg.	Control,	Phytase	(U/kg)		
20-45 kg	Pos.	0	500 U	12500U	12500U		
45-90 kg	Ctrl.	0	500 U	500 U	12500U	SEM	P
90-130kg		0	500 U	500 U	500 U		Value:
Gain, g/d							
20-45kg	873	650	711	859	868	20	0.001
20-130kg	989	721	896	952	1014	20	0.001
Slaughter wt., kg	130.6	101.5	122.2	127.0	133.9	2.7	0.001
Loin area, cm ²	47.9	38.5	43.4	48.8	47.1	1.1	0.001
Tenth rib fat, mm	20.9	16.6	21.3	21.4	22.6	1.2	0.01
Bone ash, %	45.4	37.2	44.0	45.4	45.9	1.0	0.001
Bone strength, kgf	117.4	54.9	106.0	91.1	110.0	8.4	0.001

Key Words: Pigs, Phosphorous, Phytase

W132 Effect of enzyme supplementation and inclusion level of wheat distillers dried grains with solubles on energy and nutrient digestibilities in growing pigs. F. O. Opapeju*, C. M. Nyachoti, and B. A. Slominski, University of Manitoba, Winnipeg, MB, Canada.

The influence of enzyme supplementation on energy and nutrient digestibilities in a barley-based diet containing 15% or 30% wheat distillers dried grains with solubles (DDGS) was evaluated. Four ileal cannulated growing barrows housed individually in metabolism crates were allotted to experimental diets in a 4x4 Latin square design with 2x2 factorial arrangement of treatments. The experimental diets were 1) 15% wheat DDGS without enzyme, 2) 15% wheat DDGS with enzyme, 3) 30% wheat DDGS without enzyme, and 4) 30% wheat DDGS with enzyme. Enzyme supplement consisted of xylanase, β -glucanase and cellulase as main activities. Chromic oxide (0.3%) was included in the diets as an indigestible marker. Following a 4-d acclimation period to experimental diets, ileal digesta were collected for 2 consecutive days for determination of apparent ileal digestibility (AID) of nutrients. Enzyme-supplemented diets had higher ($P < 0.05$) AID (%) of DM (67 vs. 65), organic matter (OM) (71 vs. 69) and energy (68 vs. 66) compared with diets not supplemented with enzyme. For indispensable AA, the effect ($P < 0.05$) of enzyme supplementation on AID (%) was only observed for methionine (82 vs. 77) and threonine (68 vs. 62). Level of DDGS inclusion had no effect on AID of DM, energy, OM, ash, phosphorus, calcium and indispensable AA except for arginine (82 vs. 78 % for 15 and 30% inclusion level of DDGS, respectively). There was an interaction effect ($P \leq 0.05$) of inclusion level of DDGS and enzyme supplementation on DM, ash and methionine. For example, enzyme supplementation improved ($P < 0.05$) AID of DM and methionine in the diet with 30% wheat DDGS whereas no such effect was observed in the diet with 15% wheat DDGS. In conclusion, the results indicate that wheat DDGS could be effectively utilized in growing pig diets and that higher amount of wheat DDGS could be used with appropriate enzyme supplementation.

Key Words: Enzyme supplementation, Pigs, Wheat distillers dried grains with solubles

Nonruminant Nutrition: Nutrition – Broilers, Layers, Guinea Pigs, Rabbits and Rats

W133 No absorption of ochratoxin A and fumonisin B1 in rat small intestine detected with Ussing diffusion chamber. V. Pizzamiglio¹, E. Grilli¹, L. Fabbri¹, A. Piva^{*1}, and B. Weström², ¹*Dipartimento di morfofisiologia veterinaria e produzioni animali, Ozzano Emilia (BO), Italy*, ²*Department of cell and organism biology, Lund, Sweden*.

Aim of the present study was to investigate *in vitro* absorption of ochratoxin A (OTA) and fumonisin B1 (FB1) in rat small intestine with Ussing chamber method. Male rats (n=10), Sprague-Dawley strain, weighing 350-400 g underwent laparotomy under ether anesthesia. Jejunum, 10 cm from the ligament of Treitz, was removed, immediately immersed in a modified oxygenated Krebs-Ringer buffer at room temperature; twelve pieces 2.5 cm long were cut, opened along the mesenteric border, and mounted in Ussing chambers. The experiments started, within 30 min after the anesthesia, when the buffer in the 12 mucosal reservoirs was exchanged with 5 ml buffer containing mycotoxins and/or marker molecules to monitor mucosal integrity (¹⁴C-Mannitol, FITC-Dextran 4400, and ovalbumin) as follow: chambers 1 and 7, OTA; chambers 2 and 8, OTA+M; chambers 3, 6, 9, and 12, M; chambers 4 and 10, FB1; chambers 5 and 11, FB1+M. At the onset of the experiments, the concentrations of the corresponding substances in the mucosal reservoir were: OTA=200 ppb, FB1=30 ppm, ¹⁴C-Mannitol=0.031 μ Ci/ml, FITC-Dextran 4400=1 mg/ml, ovalbumin=25 mg/ml. For 2 h, every 20 min, a 1 ml sample had been withdrawn from serosal reservoir for OTA, FB1, and marker analysis, and replaced with 1ml of fresh buffer. At 2 h, a 1 ml sample was withdrawn from mucosal reservoirs of mycotoxin containing chambers for analysis. The apparent permeability coefficients (P_{app}) for marker molecules revealed the integrity of the mucosal segments, and that OTA and FB1 separately did not influence mucosal permeability in mycotoxins and M containing chambers (2, 5, 8, and 11). OTA and FB1 analysis in serosal reservoirs revealed no presence of them; OTA and FB1 analysis of mucosal samples withdrawn at 2 h revealed concentrations similar to those at the beginning of the experiment. No passage of OTA and FB1 through intact rat small intestine mucosa was observed. Other studies are required to better explain mycotoxins uptake in other parts of rat gastrointestinal tract.

Key Words: Mycotoxin, Ussing chamber, Rat

W134 Dietary high-tannin sorghum increases growth rate in rats. R. Larraín* and J. Reed, *University of Wisconsin, Madison*.

High tannin sorghums (HTS) contain proanthocyanidins (condensed tannins), usually recognized as anti-nutritional factors. The objective of this study was to test if diets containing increasing amounts of HTS affect the growth of rats. Male Sprague Dawley rats were used in a factorial design with four diets and two feeding periods. Diets modified from NIH-07 contained corn and HTS at a ratio of 0:50, 20:30, 35:15 and 50:0 percent of the diet (S0, S20, S35 and S50, respectively). HTS had 37.6 mg/g proanthocyanidins (vanillin method). Feeding periods were 2 and 10 weeks (2W and 10W). Rats (n=9 or 10) were randomly assigned to diets within each feeding period. Rats in 2W and 10 W groups started the experiment at 13 and 5 weeks of age (329 and 151 g), respectively. They were killed by decapitation. ADFI and weight were measured and ADG and G:F calculated for d 1, 2, 3, 7, 10 and 14 in 2W groups and d 1, 2, 3, 7 and once a week thereafter for groups 10W. Data were analyzed as repeated measures with S0 as control. Differences were calculated using contrast within each day and feeding period. Group 10W-S35 had significantly higher ($p<0.05$) intake than

10W-S0 at d 1, 2, 3 and 7 (19.9 ± 0.37 , 20.1 ± 0.36 , 20.3 ± 0.36 and 21.0 ± 0.43 g vs. 18.8 ± 0.35 , 19.0 ± 0.34 , 19.2 ± 0.34 and 19.7 ± 0.40 g) and tended to be higher than 10W-S0 ($p<0.1$) at d 14 and 21. Similarly, 10W-S35 had significantly higher gain than 10W-S0 at d 1, 2, 3 and 7 (9.0 ± 0.46 , 8.8 ± 0.42 , 8.6 ± 0.38 and 7.8 ± 0.28 g/d vs. 7.6 ± 0.44 , 7.5 ± 0.40 , 7.4 ± 0.36 and 6.9 ± 0.29 g/d) and tended to be higher than 10W-S0 at d 14. 10W-S35 had significantly higher weight than 10W-S0 at d 70 (414.7 ± 8.66 g vs. 390.7 ± 8.21 g) and tended to be higher than 10W-S0 from d 21 to 63. G:F was not different between controls and HTS diets in 10W and 2W groups. Up to 50% HTS in the diet did not reduce ADG in rats. Furthermore, 35% HTS increased ADFI and ADG during the first week of feeding and produced animals with higher weight at d 70. Inclusion of moderate amounts of HTS in diets may have a positive impact in growth of rats.

Key Words: Proanthocyanidins, Sorghum, Growth rate

W135 Utilization of deglycosylated soy protein in monogastrics. B. C. Tooker and T. S. Stahly*, *Iowa State University, Ames*.

The effects of deglycosylating dietary soy protein on body growth, protein digestibility and biomarkers of allergenicity and gut inflammation in a monogastric animal were evaluated. Deglycosylated (Degly) and glycosylated (Gly) soy proteins were created by processing a single source of soy protein isolate in the presence or absence of a deglycosylating enzyme (Endo H). Each subunit (α' , α and β) of conglycinin, the major glycosylated protein in soy, was deglycosylated by enzyme exposure. Based on the MW shift (SDS-PAGE) observed for the deglycosylated subunits, a consistent portion of the mannose units in the N-linked oligosaccharide side chains were removed. The amino acid profiles of the proteins were not altered by Degly. To evaluate the two protein sources, rats (Sprague Dawley) from dams fed soy-free diets during pregnancy/lactation (to prevent allergenic priming) were used. Rats in each of fifteen littermate pairs were weaned (20 d), penned individually, randomly allotted within litter to one of the two diets and allowed to consume feed ad libitum for 20 d. The diets consisted of a 86:14 mix of a basal mix (starch, corn oil, cellulose, min, vit) and test protein sources. Body growth rates (d 0 to 20) and digestibility of dietary N (total fecal collection on d 17-20) were not ($P>.10$) altered by Degly. On d 20, intestinal gene (qRT-PCR) expression of PAR-2 and TNF α , biomarkers of intestinal inflammation, also were similar ($P>.10$) between protein sources. Based on these data, deglycosylating soy protein does not modify the digestibility or inflammatory potential of soy proteins.

Key Words: Soy protein, Deglycosylation, Digestibility Par-2

W136 A study of sweet (Surumi, Patacamya, Sayana, Chucapaca) and bitter (Real) Bolivian quinoa cultivars compared to corn, barley and oats on the lactation of improved guinea pigs. R. N. Pate¹, N. P. Johnston^{*1}, E. Rico², A. Bonifacio³, R. O. Kellems¹, and D. L. Kooyman¹, ¹*Brigham Young University, Provo, Utah*, ²*University of San Simon, Cochabamba, Bolivia*, ³*University of San Andres, La Paz, Bolivia*.

Quinoa is an Andean grain that is noted for its amino acid profile which is especially high in lys. Traditionally the production of bitter (saponin-containing cultivars) has prevailed. However, many new sweet cultivars that are saponin-free now exist but there is little information as to their feeding value. A trial was conducted to evaluate

the feeding value during lactation of the sweet quinoa cultivars Surumi, Patacamaya, Sayana and Chucapaca and the bitter cultivar Real using the improved Andean guinea pig as the animal model. The quinoa-based diets were compared to those based on corn, barley and oats. The bitter variety Real was fed as-is (saponin containing) or washed (saponin free). Growth and F:G of the nursing progeny were used as parameters to indicate the impact of diet on lactation. Thirty-six pregnant females were divided into nine treatment groups. The trial began following parturition and continued for two weeks at which time the progeny were weaned. The net progeny gains from feeding the sweet quinoa cultivars (136 to 148g) and oats (134g) were similar ($P>0.05$) but greater ($P<0.05$) than feeding the bitter cultivar (Real) (93g), corn (100g) and barley (74g). Gains from Real-washed (110g) were similar ($P>0.05$) to those from Real. Feed consumption was reduced ($P<0.05$) from feeding Real and barley. The sweet cultivar treatments Sayana (3.75:1) Patacamaya (3.88:1), and Chucapaca (4.17:1) supported the conversion of F:G more efficiently ($P<0.05$) than Real-washed (5.45:1), corn (5.43:1) and barley (5.45:1). The feeding value of sweet quinoa cultivars appeared very promising. Feeding any of the sweet cultivars during lactation resulted in superior progeny gains and better feed conversion than the bitter cultivar (saponin- containing or free). Their feeding value was also superior to corn or barley but similar to oats.

Key Words: Quinoa, Guinea pig, Lactation

W137 Level of soluble fiber and medication influence the presence of intestinal pathogen microbiota in young rabbits. M. S. Gómez-Conde¹, A. Pérez de Rozas², I. Badiola², S. Chamorro¹, G. G. Mateos^{*1}, J. C. De Blas¹, J. García¹, and R. Carabaño¹, ¹Universidad Politécnica, Madrid, Spain, ²CreSA (UAB-IRTA), Bellaterra, Spain.

The aim of this work was to study the effect of the level of neutral detergent soluble fiber (NDSF) and medication with 200 ppm apramycin sulphate and 120 ppm tylosine tartrate in drinking water on frequency of detection (FD) of *Clostridium perfringens*, *Clostridium difficile* and *Campylobacter* spp. at ileum and cecum. Three isonutritive diets (33% NDF, 20% CP, 20% starch) were formulated. Differences in NDSF were obtained by a partial substitution in the control diet of alfalfa hay (28% of inclusion and 10.3% NDSF) with either oat hulls (14.7% and 7.9% NDSF) or a mixture of sugar beet and apple pulps (15+5% and 13.1% NDSF). Eighteen rabbits/treatment weaned at 25 d were slaughtered at 35 d to collect intestinal digesta for characterizing microbiota population by restriction fragment length polymorphism. Data were analyzed by using the proc mixed of SAS including NDSF level, medication, and intestinal site as main effects and their interactions. Rabbit was considered as a random effect. Rabbits fed the lowest NDSF concentration had a higher FD of *C. perfringens* (39.4 vs. 24.3%; $P = 0.016$), *Campylobacter* spp. (50.0 vs. 27.8%; $P = 0.001$) and *C. difficile* (33.0 vs. 21.6%; $P = 0.090$) compared to diets with a higher NDSF levels. *Clostridium difficile* ($P = 0.001$) and *Campylobacter* spp. ($P = 0.081$) were more frequently detected in cecum than in ileum. Intestinal site did not affect FD of *C. perfringens*. Medication decreased FD of all the bacteria studied ($P < 0.001$). An interaction between level of NDSF and medication ($P = 0.023$) was detected for the FD of *C. perfringens*. When non-medicated rabbits were fed the low NDSF diet, they showed the highest FD of *C. perfringens*, but this effect was not detected with medication. In conclusion, the FD of intestinal pathogen bacteria might be partially modulated by NDSF.

Key Words: Rabbit microbiota, Soluble fiber, Medication

W138 The effect of xylanase enzyme and fat type on growth performance of broilers fed wheat-based diets. Z. Nemati, A. Taghizadeh*, and G. A. Moghaddam, Tabriz University, Tabriz, East Azarbayjan, Iran.

This study was carried out to determine the effect of xylanase enzyme and fat type on growth performance and intestinal viscosity of broiler fed wheat based diet. An experiment was carried out using 384 seven-d Arian 110 chickens in a 4x2 factorial design with 5% different fat sources [Beef tallow, soybean oil, blend fat [soybean oil (37.5 g/kg diet) + Beef tallow (12.5 g/kg diet)] or other blend fat [soybean oil (12.5 g/kg diet) + Beef tallow (37.5 g/kg diet)], which were termed T, S, ST1 and ST2, respectively and Nutrex® enzyme addition [none or enzyme (0.5 g/kg diet)] to a wheat (60%) based broiler diet. All of the diets were isocaloric and isonitrogenous with considering the difference between fat sources and enzyme supplementation (NRC, 1994). At 42 d of age, one bird per replicate was killed and carcass of them was analyzed. Body weight (BW), feed intake (FI) and coefficient feed ratio (FCR) were recorded weekly with pen as the experiment unit. The intestinal viscosity was measure by centrifuging of collected the first fraction of small intestinal contents (12000 rpm) and determining of the supernatant phase viscosity using viscometer. Results showed that enzyme supplementation improved body weight, body weight gain and feed/gain ratio of broiler fed diet contains enzyme ($p<0.01$). Where as the chickens fed diet no enzyme supplementation have lower feed intake but showed no significant differences. Although no significant difference was found between performance of broilers fed different fat source, performance of broiler fed soybean oil was better than the other groups. Except of feed intake, no interaction was observed between fat type and enzyme supplementation. In addition, supplementation of diets with the enzyme reduced the intestinal viscosity of broilers. Using xylanase enzyme in broiler improved growth performance and weight of carcass. It is evident from the present studies that the addition of xylanase could eliminate negative effect of non-starch polysaccharide content in wheat grain, however, its application with different fat sources required further research.

Key Words: Xylanase, Fat, Broiler

W139 Effect of protease supplementation selected from mud flat microorganism on growth performance, nutrient digestibility, total protein and BUN concentration in broilers. H. J. Kim*, B. J. Min, J. H. Cho, Y. J. Chen, J. S. Yoo, Q. Wang, and I. H. Kim, Dankook University, Cheonan, Chungnam, Korea.

This study was conducted to investigate the effect of protease supplementation selected from mud flat microorganism (*Bacillus clausii* I-52) on growth performance, nutrient digestibility, total blood protein and BUN concentration in broilers. A total of 480 broiler chickens were randomly allocated into four treatments with six replications and fed for 5 wk. Dietary treatments included 1) HND (high nutrient density diet), 2) HNP (high nutrient density diet + 0.1% protease), 3) LND (low nutrient density diet) and 4) LNP (low nutrient density diet+0.1% protease). Through the entire experimental period, weight gain (1551.53, 1549.71, 1521.81 vs. 1402.90 g) and F:G (1.66, 1.64, 1.68 vs. 1.81) were improved in treatments of HND, HNP and LNP compared with treatment of LND ($P<0.05$). DM digestibility (71.69, 72.68, 71.83 vs. 70.32 %) was improved in pigs fed HND, HNP and LNP treatments compared with pigs fed LND treatment ($P<0.05$). N digestibility (69.81 vs. 65.94 %) was improved in treatment of HNP compared with treatment of LND. Total blood protein content (3.68 vs. 2.93, 3.05, 2.91 mg/dl) in the broilers fed the HND treatment was

higher than the broilers fed HNP, LND and LNP treatments ($P < 0.05$). In conclusion, protease selected from mud flat microorganism was effective for improving weight gain, nutrient digestibility and total blood protein concentration in broiler chickens.

Key Words: Protease selected from mud flat microorganism, Growth performance, Total protein

W140 Effect of protease supplementation selected from mud flat microorganism on egg quality, nutrient digestibility and total protein concentration in laying hens. H. J. Kim*, B. J. Min, J. H. Cho, Y. J. Chen, J. S. Yoo, Q. Wang, and I. H. Kim, *Dankook University, Cheonan, Chungnam, Korea.*

This study was conducted to investigate the effect of protease supplementation selected from mud flat microorganism (*Bacillus clausii* I-52) on egg quality, nutrient digestibility and total protein concentration on laying hens. A total of 252 laying hens were randomly allocated into three treatments with seven replications for 8 wk. Dietary treatments included 1) CON (basal diet), 2) PRO1 (basal diet + 0.05% protease) and 3) PRO2 (basal diet + 0.1% protease). Through the entire experimental period, hen-day egg production (94.69, 94.66 vs. 92.71 %) was improved in CON and PRO2 treatments compared with PRO1 treatment ($P < 0.05$). Egg shell breaking strength, egg shell thickness, yolk color unit, yolk height, yolk diameter, egg yolk index, albumen height, egg weight and Haugh Unit were not different among the treatments ($P > 0.05$). DM digestibility (73.27, 72.67 vs. 71.36 %) was improved in CON and PRO2 treatments compared with PRO1 treatment ($P < 0.05$). N digestibility (73.63 vs. 71.70 %) was improved in PRO2 treatment compared with CON treatment ($P < 0.05$). Total blood protein concentration was not different among the treatments ($P > 0.05$). In conclusion, protease selected from mud flat microorganism was effective for improving daily egg production and nutrient digestibility.

Key Words: Protease selected from mud flat microorganism, Egg quality, Nutrient digestibility

W141 Performance of broilers on nutrients restriction at different stages of growth. Y. H. Shim, J. D. Lohakare, J. H. Yun, Z. Jin, S. O. Lee, J. Y. Choi, and B. J. Chae*, *Kangwon National University, Chunchon, Republic of Korea.*

In two experiments, day-old Ross broilers were fed energy and protein restricted diets at different stages of growth. In Exp. 1, the energy and protein were restricted to 10 and 20% respectively, less than control during starter phase (0 to 3 wk). The diets were: Control (3200 kcal ME and 22% CP), T1 (2880 kcal ME and 22% CP), T2 (3200 kcal ME and 17.60% CP), and T3 (2880 kcal ME and 17.60% CP). During finisher phase (4 to 6 wk), they were fed a common diet (3200 kcal ME and 20% CP). In Exp. 2, birds were fed a common diet during starter phase (3200 kcal ME and 22% CP), but during the finisher phase, the treatment diets were restricted by 10% energy and 10% CP than to control. In short, the diets were: Control (3200 kcal ME and 20% CP), T1 (2880 kcal ME and 20% CP), T2 (3200 kcal ME and 18% CP), and T3 (2880 kcal ME and 18% CP). Each treatment had 5 replicates with 42 birds each in both experiments. During Exp. 1, final BW and G:F ratio were improved ($P < 0.05$) in control group (2,175g and 1.80) than T1 (2,119g and 1.91), T2 (2,043g and 1.94) and T3 (2,070g and 2.00). The dressing and breast meat percentages were higher ($P < 0.05$) at 3 wk in T1 than T2 and T3, but not different from the control. Also at 3 and 6 wk, serum urea N and triglyceride levels were not influenced by dietary treatments; however, serum cholesterol and total blood protein

levels were lowered ($P < 0.05$) in T3 than control. During Exp. 2, BW and G:F ratio were higher ($P < 0.05$) in control group than in birds fed the treatment diets at 4 wk, however, it was similar to T2 at the end of 6 wk. The abdominal fat percent, expressed as percent of BW, was the lowest ($P < 0.05$) at 6 wk in T1 among the control, T2 and T3, but dressing percent, liver weight, heart weight and breast meat percentages were not affected ($P > 0.05$). Also at 6 wk, serum levels of urea N, triglyceride, and cholesterol were not influenced by dietary treatments; however, serum glucose was higher ($P < 0.05$) in control than others. It is concluded that nutrient restriction during starter phase affects broiler performance, but 10% CP restriction during the finisher phase presents an option in economizing production.

Key Words: Broilers, Nutrient restriction, Growth performance

W142 Determination of endogenous amino acid flows at the terminal ileum of broiler chickens fed various protein sources using the homoarginine technique. V. Ravindran*¹, G. Ravindran¹, and W. L. Bryden², ¹Massey University, Palmerston North, New Zealand, ²University of Queensland, Gatton, QLD, Australia.

Addition of purified sources of fiber to diets has been shown to increase the flow of undigested endogenous protein leaving the small intestine of pigs and poultry. No reports exist on the effects of high levels of fiber naturally occurring in feedstuffs, because until recently no suitable method was available to estimate the ileal endogenous recovery associated with specific feedstuffs. In the present study, the homoarginine technique was employed to determine the ileal endogenous flow of AA in broilers fed diets containing casein, soybean meal (SBM), canola meal (CM) and cottonseed meal (CSM). The four feedstuffs were guanidinated. Assay diets based on dextrose and the guanidinated ingredients were offered ad libitum to three pens of 5-wk old (Cobb) broilers for 7 d and digesta from the terminal ileum was collected. Endogenous flow was calculated using the homoarginine: AA ratios. The analyzed neutral detergent fiber contents in SBM, CM and CSM were 89, 237 and 366 g/kg, respectively. The ileal endogenous flow of N and most AA were similar ($P > 0.05$) between casein and SBM. The flow of N, asp and glu were greater ($P < 0.05$) in CM diets compared to those in SBM diets. The flow of N and most AA in casein were lower ($P < 0.05$) than those in CM. The endogenous AA flows in birds fed CSM diets were higher ($P < 0.05$) than those fed diets with other protein sources. Amino acid N as a percentage of total N in ileal flow was lower ($P < 0.05$) in CM and CSM diets, which may suggest increased mucus glycoprotein secretion with these fibrous protein sources. These results showed that ileal endogenous flows of N and AA were increased by protein sources with high fiber contents.

Key Words: Homoarginine, Endogenous amino acid flow, Broiler

W143 Evaluation of Neem (*Azadirachta indica*) leaf meal on performance, carcass characteristics and egg quality of laying hens. B. O. Esonu*¹, O. O. Emenalom¹, A. B. I. Udedibie¹, A. Anyanwu¹, U. Madu¹, and O. A. Inyang², ¹Federal University of Technology, Owerri, Imo State, Nigeria, ²Micheal Okpara College of Agriculture, Umuagwo, Imo State, Nigeria.

12-week feeding trial was conducted to evaluate the effect of Neem (*Azadirachta indica*) leaf meal on the performance, carcass characteristics and egg quality of laying hen. Neem (*Azadirachta indica*) is one of the indigenous tropical plants predominant in Nigeria. It is commonly known as Neem and popularly called "Akum-shut-up"

in Ibo land and "Dogoyaro" in Hausa. The leaves were harvested, chopped to facilitate drying until the material became crispy while still retaining its greenish colouration. The material was milled using a hammer mill to produce leaf meal. Four layer diets were formulated to contain the leaf meal at 0%, 5%, 10% and 15% dietary levels respectively. One hundred and twenty (120) Shikha Brown layers already ten months in lay were divided into four groups of thirty birds each and randomly assigned to the four treatment diets in a completely randomized design (CRD). Eggs were collected twice daily and the internal characteristics of the eggs measured. At the end of the feeding trial, three birds were selected from each treatment group, slaughtered and eviscerated for dressed carcass weight determination. There were significant ($p < 0.05$) differences in feed intake, hen day egg production and egg yolk colour among the groups. However, there were no significant ($p > 0.05$) differences in body weight gain, feed conversion ratio, Haugh unit, shell thickness, yolk index, albumen index, egg circumference and dress carcass weight characteristics among the groups. Results from this experiment suggests that 15% inclusion level of Neem (*Azadirachta indica*) leaf meal in laying hen diet has no deleterious effects on the birds.

Table 1. Proximate composition of Neem leaf meal (DM Basis)

Nutrients	%Dm
Dry matter (in air dry meal)	92.42
Crude Protein	20.68
Crude fat	4.13
Ash	7.10
Crude fiber	16.60
Nitrogen free extract	43.91

Key Words: Neem leaf meal, Performance, Layers

W144 Effects of dietary delta-aminolevulinic acid and chitooligosaccharide on egg production, egg quality and hematological characteristics in laying hens. Y. J. Chen^{*1}, B. J. Min¹, J. H. Cho¹, H. J. Kim¹, J. S. Yoo¹, J. D. Kim³, H. R. Kim², D. K. Kang¹, and I. H. Kim¹, ¹Dankook University, Cheonan, Chungnam, Korea, ²Pukyong, Busan, Korea, ³CJ Feed Co., Incheon, Korea.

Delta-aminolevulinic acid (ALA), which is synthesized by the condensation of glycine and succinyl-CoA, is the committed step of the heme synthesis pathway. Chitooligosaccharide (COS), made from chitin or chitosan, was suggested to have some similar physiological effects with ALA. An 8 wk experiment was conducted to evaluate the effects of ALA and COS in layer diets on egg production, egg quality and hematological characteristics. Two hundred seventy 21 wk old (Hy-line brown) layers were randomly assigned to five treatments with nine replications (six layers in adjacent three cages). Dietary treatments were 1) CON (Control diet), 2) ALA1 (CON + ALA 2 ppm), 3) ALA2 (CON + ALA 4 ppm), 4) COS1 (CON + COS 0.1%) and 5) COS2 (CON + COS 0.2%). All diets were formulated met or exceeded NRC (1994) recommendation for laying hens. Egg production and egg shell breaking strength were not affected by supplementation of either ALA or COS ($P > 0.05$). Egg weight was higher in ALA1 treatment than CON, ALA2 and COS2 treatments ($P < 0.05$). Egg shell thickness was higher in ALA1 and COS1 treatments than CON treatment ($P < 0.05$). Yolk color unit was increased in ALA1 treatment compared with COS1 treatment ($P < 0.05$). Egg yolk index was also increased in ALA and

COS treatments compared with CON treatment ($P < 0.05$). Haugh unit was not significantly affected among all the treatments ($P < 0.05$). No effects were observed on RBC, lymphocyte, Hb, total protein, albumin and total iron binding capacity with the supplementation of ALA and COS ($P > 0.05$). WBC was increased in ALA1 treatment compared with CON treatment ($P < 0.05$). Iron concentration was higher in ALA2 treatment than CON and COS1 treatments ($P < 0.05$). In conclusion, dietary supplementation of ALA has beneficial effects on egg quality in laying hens.

Key Words: Delta-aminolevulinic acid, Chitooligosaccharide, Laying hens

W145 Effect of phytase supplementation on the calcium and phosphorus retention in layers. L. Babinszky^{*1}, J. Tossenberger¹, C. S. Szabó¹, B. Mészáros¹, and I. Kühn², ¹University of Kaposvár, Hungary, ²AB Enzymes GmbH, Darmstadt, Germany.

A trial was conducted with Hy-Line Brown layers during the first 84 days of the laying cycle to evaluate their Ca and P retention (intake - excretion in excreta) at different production levels (45 - 75 - 95 % of final production peak). The 32 layers evenly distributed over 4 treatments were fed a corn soybean meal based diet. The Ca content of the diets was identical across all treatments (38.4 g/kg). The dietary P level of treatment 1 (P+) was 4.7 g/kg total P with no added phytase. Dietary P was reduced from the level of P+ to 3.7 g/kg in treatment 2 (P-) which contained no added phytase either. Dietary P levels of treatment 3 and 4 were the same as in P- but these diets were supplemented with phytase (type 3-phytase produced by *Trichoderma reesei*) at the level of 250 PPU/kg (P-²⁵⁰) and 500 PPU/kg (P-⁵⁰⁰), respectively. Trial data were analyzed with GLM (SAS, 1999). Ca retention increased with higher production levels ($P \leq 0.05$). Ca retention decreased when dietary P was lowered ($P \leq 0.05$), but was not affected by phytase supplementation (data not shown). P retention increased significantly with the level of production in case of P- and P-²⁵⁰ (see table). Phytase supplementation at 250 PPU/kg improved the P retention of layers significantly ($P \leq 0.05$) when the dietary P level was low. Increasing the phytase supplementation to 500 PPU/kg had no further effect on P retention, which is in accordance with published data. The 20% reduction of the dietary P was a reduction of 40% in non phytate P. This extreme reduction could not be fully compensated by phytase supplementation. In conclusion it is not possible to reduce the dietary P level by 20% in layer diets without adversely affecting the Ca and P retention, even if phytase supplementation is applied.

Table 1

Production level, %	P retention, mg/day				RMSE
	P+	P-	P- ²⁵⁰	P- ⁵⁰⁰	
45	145 _x	74 ^a _y	107 ^a _z	114 _z	12
75	136 _x	84 ^{ab} _y	113 ^a _z	118 _z	15
75	136 _x	84 ^{ab} _y	113 ^a _z	118 _z	15

^{a,b} Means in a column differ ($P \leq 0.05$); ^{x,y,z} Means in a row differ ($P \leq 0.05$)

Key Words: Layer, Phosphorus, Retention

Physiology and Endocrinology: Endocrinology/Metabolic Physiology

W146 Glucose-dependent insulin response in dairy cows within segregating family structure is related to milk yield. H. M. Hammon*, O. Bellmann, J. Voigt, F. Schneider, and C. Kühn, *Research Institute for the Biology of Farm Animals (FBN), Dummerstorf, Germany.*

An experiment has been initiated using segregating F₂ offsprings from crosses of Charolais bulls and German Holstein cows to evaluate properties of nutrient transformation in cattle with respect to secretion type (German Holstein) and accretion type (Charolais). In 51 dairy cows of 5 F₂ families glucose-dependent insulin response was investigated during first lactation to test the hypotheses that insulin response segregates within the F₂ population and that the level of milk yield affect insulin response after glucose challenge. Cows received intravenous glucose infusions (1 g/kg BW^{0.75}) 10 d before and 30 and 100 d after parturition. Blood samples were taken before and 7, 14, 21 and 28 min after glucose challenge, glucose (whole blood) and insulin plasma concentrations were measured, and areas under the concentration curve were calculated for glucose (AUC_{gluc}) and insulin (AUC_{ins}). The GLM and CORR procedures of SAS were used to evaluate data. Milk yield was low, ranging from 5.3 to 13.6 kg on d 30 and 0.4 to 10.4 kg on d 100 of lactation among F₂ families and showed significant differences among families. After glucose challenge glucose concentrations increased in all cows, but AUC_{gluc} did not differ among families at any d. Insulin concentrations also increased after glucose challenge in all cows, showed no between-family differences for AUC_{ins} before parturition, but AUC_{ins} differed (P < 0.05) among groups on d 30 and 100 of lactation. Calculated correlations revealed a significant negative relationship between milk yield and AUC_{ins} on d 30 and 100 of lactation. In conclusion, milk production of F₂ Charolais × German Holstein cross bred dairy cows was on a low level, but differed among families. Glucose-dependent insulin response also differed among families during lactation, but not during dry period, and was inversely related to milk production. This suggests that genetic capacity for milk production is related to peripheral insulin-dependent glucose metabolism in cows.

Key Words: Cow, Glucose metabolism, Cross breeding

W147 Characterization of metabolic hormones and insulin sensitivity in transition dairy cows. C. C. Stanley*, C. C. Williams, D. T. Gantt, J. C. Roberts, and S. R. Adams, *LSU Agricultural Center, Baton Rouge.*

A study was conducted to characterize insulin sensitivity at the end of gestation and in early lactation by using the frequently sampled glucose tolerance test (FSIGT), insulin tolerance test (ITT), and hyperinsulinemic euglycemic clamp test (EC). The FSIGT with minimal model computer analysis (MM), the EC, and the ITT were performed in 5 Holstein cows at 7-10 days prior to anticipated calving date and again at 7-10 days after calving. During the FSIGT glucose was administered (0.3g/kg BW) followed 20 min later by insulin administration (0.03 IU/kg BW) through a jugular catheter. Blood samples were collected relative to glucose administration for a 3 hr period for measurement of plasma glucose and insulin concentrations which were used in the MM to determine glucose effectiveness (S_G), insulin sensitivity (S_I), and the acute insulin response relative to glucose administration (AIR_G). The EC used a variable rate of glucose infusion to achieve euglycemia while infusing insulin at 6 mU/ kg •min⁻¹. Blood was collected every 5 min, and glucose concentrations

were measured using a handheld glucometer. Glucose disposal rate (GDR) was calculated from the glucose infusion rate after euglycemia was achieved. The GDR was converted to S_I by factoring the change in plasma insulin from basal to hyperinsulinemia and plasma glucose at euglycemia. Plasma was analyzed for glucagon, insulin, and glucose concentrations during the basal and steady states. The ITT consisted of bovine insulin administration (0.1 IU/kg of BW) through a jugular catheter. Samples were collected for plasma leptin, glucose, glucagon, and insulin analyses during the 3 hour test. There was a main effect of week for mean plasma glucagon concentrations (P < 0.05) with an increase in basal concentrations after calving. There were no effects (P > 0.05) of week for mean basal plasma insulin, glucose, or leptin concentrations or for GDR, S_I EC, S_I MM, S_G, or AIR_G. All tests reflected a numerical increase in insulin sensitivity after calving, although the responses indicated low insulin sensitivity both pre- and postpartum.

Key Words: Transition cows, Metabolic hormones, Insulin sensitivity

W148 Bovine somatotropin and dietary fat enriched with omega-3 fatty acids in dairy cows: III. Postpartum ovarian activity. M. Carriquiry*, C. R. Dahlen, W. J. Weber, G. C. Lamb, and B. A. Crooker, *University of Minnesota, St. Paul.*

Multiparous cows (n=59) were blocked by expected calving date and previous 305ME and assigned randomly to a 2x2 factorial design to determine effects of bST (POSILAC®) and dietary fat on ovarian activity during the first 90 DIM. Isocaloric diets (1.98 Mcal NEL_{1x}) that included whole, high-oil sunflower seeds (10% of dietary DM, SS) or a mixture of Alifet-High Energy® and Alifet-Repro® (3.4 and 1.5% of dietary DM, AF) were provided from calving. Cows received 0 or 500 mg bST (N, Y) every 10 d from 12 to 70 DIM and at 14 d-intervals thereafter. Follicular dynamics, luteal growth and development (transrectal ultrasonography) and plasma P4 concentrations were evaluated (3X/wk) from 15 to 90 DIM. Breeding started after 90 DIM. Means differed when P<0.05. Days to first ovulation (33.6 ± 1.4) and incidence of anovulation at 45 or 70 DIM did not differ among treatments but time to first ovulation was less variable for AFY. Intraovulatory intervals were similar among treatments (22.1 ± 0.9 d). Incidence of 2-wave cycles was greater for SSY (71.0%) and AFN (80.0%) but more 3-wave cycles occurred with AFY (83.3%). Growth rate of the ovulatory follicle was greater for AF than SS (1.9 vs 2.2 ± 0.11 mm/d) and diameter of ovulatory follicles was larger for AFN than the other treatments (17.9 vs 15.7 ± 0.7 mm). Multiple ovulations tended (P<0.10) to increase with bST. Maximal CL volume did not differ among treatments. Area under the P4 curve was reduced for SSY (63.2^a, 48.1^b, 55.5^{ab}, and 61.4^a ± 5.1 dxng/mL for SSN, SSY, AFN, and AFY). The number of class 1 (2 to 5 mm; decreased), class 2 (6 to 9 mm; increased), and class 3 (10 to 15 mm; tended to increase (P=0.07)) follicles were altered by bST. Class 2 follicles were reduced with AF. Neither diet nor bST affected the number of class 4 (>15 mm) or the mean size of class 2, class 3, and class 4 follicles. Initiation of bST at 12 DIM and dietary omega-3 fatty acids enhanced ovarian activity during the first 90 DIM and could benefit reproductive performance.

Key Words: bST, Omega-3 fatty acids, Follicular dynamics

W149 The ontogeny of insulin-like growth factor-I (IGF-I) modulation of GH secretion from porcine anterior pituitary cells in culture. C. R. Barb* and G. J. Hausman, *USDA, ARS, Russell Research Center, Athens, GA.*

The ontogeny of IGF-I modulation of GH secretion from the anterior pituitary was studied. Anterior pituitary cells collected from 110 day old fetuses (n=4), 2- (n=7), 4- (n=8) and 6- (n=7) month old gilts were studied in primary culture. On day 4 of culture, 100,000 cells/well were challenged with 0.1, 10 or 1000 nM [Ala15]-hGRF-(1-29)NH₂, or 0.01, 0.1, 1, 10, 30 nM IGF-I alone or in combinations with 1000 nM GRF. Secreted GH was measured at 4 h after treatment. Basal (control) GH secretion was 267 ± 46, 76 ± 8, 39 ± 3 and 40 ± 7 ng/well for fetal, 2-, 4- and 6 month old animals, respectively. Relative to control at 4 h, all doses of GRF increased (P < 0.0001) GH in fetal pituitary cultures. Only 1000 nM GRF increased (P < 0.001) GH secretion in pituitary cultures from 4- and 6-month old pigs whereas pituitary cultures from 2 month old pigs did not respond to GRF. All doses of IGF-I increased (P < 0.04) basal GH secretion except for 0.01 nM in fetal pituitary cultures. Only the 1, 10 and 30 nM IGF-I increased (P < 0.04) basal GH secretion in pituitary cultures from 6 month old gilts. All doses of IGF-I failed to affect GH secretion in pituitary cell cultures from 2- and 4- month old gilts. Only 0.1, 10 and 30 nM IGF-I enhanced (P < 0.01) GH response to 1000 nM GRF from fetal pituitary cells in cultures. In pituitaries from 2 month old pigs only 30 nM IGF-I enhanced (P < 0.02) the response to 1000 nM GRF. All doses of IGF-I failed to influence the GH response to 1000 nM GRF in pituitary cultures from 4- and 6 month old pigs. These results demonstrate that GRF and IGF-I modulation of GH secretion is age dependent and occurred independent of hypothalamic input.

Key Words: Pituitary, GH, IGF-I

W150 Effects of glutamine supplementation on lymphocyte subpopulations and proliferation in the peripheral blood supply of the transition dairy cow. J. A. Woodward*², R. J. Christopherson¹, C. J. Field¹, S. Goruk¹, G. Murdoch¹, M. A. G. von Keyserlingk², J. A. Bell¹, and J. R. Thompson², ¹*University of Alberta, Edmonton, Canada*, ²*University of British Columbia, Vancouver, Canada.*

Most infectious and metabolic diseases occur in dairy cows in the weeks following calving, likely due to immunosuppression. Glutamine, the most abundant free amino acid in circulation, plays a key role in supporting immune cell proliferation and function in stressed animals. The objective of this study was to determine if supplementation with glutamine could reduce the degree of immunosuppression in transition cows. Twenty-eight cows received either a saline infusion (n=9) or a glutamine infusion of either 0.25 mmol•kg^{-0.75}•h⁻¹(n=10) or 0.50 mmol•kg^{-0.75}•h⁻¹(n=9). Infusions were given for 7 days, 8h•d⁻¹, beginning the day of calving. Lymphocytes from the peripheral blood supply were isolated on days 0, 7, 14, and 21 following calving. Using immunofluorescence and flow cytometry the percentage of cells belonging to various lymphocyte subpopulations was determined. Ability of lymphocytes to proliferate when incubated with and without mitogens was determined by thymidine uptake. Animals supplemented with glutamine had significantly higher (P<0.05) percentage of naive T cells and B cells, as indicated by detection of CD62L marker. On day 21 glutamine treated animals had significantly higher (P<0.05) percentage of both CD62L positive cells and CD14 positive cells; CD14 is a marker of granulocytes and monocytes. Though there was no difference between treatments for the ability of the lymphocytes to respond to mitogens, unstimulated lymphocytes from control

animals had significantly higher thymidine uptake than unstimulated lymphocytes from glutamine supplemented cows, indicating a higher degree of immune activation in control animals. Together, the evidence indicates that the control animals have an activated immune system in comparison to glutamine treated animals, suggesting the immune system of the glutamine-treated animals was exposed to fewer antigens. Further research is necessary to determine by which mechanism, protective or otherwise, glutamine affects immune system activation in transition dairy cows.

Key Words: Glutamine, Immunosuppression, Dairy cattle

W151 Leptin genotype influences lactation performance of Holstein cows. J. E. P. Santos*¹ and R. C. Chebel², ¹*University of California Davis, Tulare*, ²*University of Idaho, Caldwell.*

Objectives were to evaluate the relationships between leptin genotype and lactation performance in Holstein cows. Sequencing of DNA at the Exon-2 region of the leptin gene was performed in 814 lactating Holstein cows to determine the presence of single nucleotide polymorphism. Resulting genotypes were CC=282 (34.6%), CT=392 (48.2%), and TT=140 (17.2%). Cows were milked three times daily and milk yields were recorded for individual cows once monthly during the first 305 d in lactation by the official California DHIA milk test. Monthly milk samples were analyzed for somatic cell count (SCC), and concentrations of fat and true protein at the DHIA Laboratory in Tulare, CA. All cows received 500 mg of exogenous bovine somatotropin every 14 d, starting at 63 ± 3 d postpartum. Data were analyzed for repeated measures using the MIXED procedure of SAS controlling for genotype, month postpartum, parity and interactions. Single nucleotide polymorphism in the Exon-2 region affected (P=0.04) average daily milk yield (CC = 40.1 ± 0.26, CT = 41.0 ± 0.22, TT = 40.3 ± 0.37 kg/d) and 3.5% fat corrected milk (CC = 40.1 ± 0.25, CT = 41.0 ± 0.21, TT = 40.6 ± 0.36 kg/d). Concentration of fat in milk was not affected (P= 0.47) by leptin genotype (CC = 3.53 ± 0.03, CT = 3.54 ± 0.02, 3.58 ± 0.04 %), but daily fat yield tended (P=0.06) to be influenced by genotype and it was higher (P=0.02) for cows with the CT than CC genotype (CC = 1.40 ± 0.01, CT = 1.43 ± 0.01, TT = 1.43 ± 0.01 kg/d). Similarly, leptin genotype did not (P=0.76) affect concentration of true protein in milk (CC = 2.98 ± 0.01, CT = 2.99 ± 0.01, TT = 2.98 ± 0.01 %), but it influenced (P=0.006) the average daily protein yield (CC = 1.19 ± 0.01, CT = 1.21 ± 0.01, TT = 1.19 ± 0.01 kg/d). Finally, linear SCC score was not affected (P=0.21) by leptin genotype (CC = 2.20 ± 0.06, CT = 2.33 ± 0.05, TT = 2.26 ± 0.08). Our data suggest that single nucleotide polymorphism in the Exon-2 region of the leptin gene influences lactation performance, and CT cows produced more milk, 3.5% fat-corrected milk, true protein, and fat than CC cows.

Key Words: Leptin, Dairy cow, Milk production

W152 Influence of maternal nutrition on placental vascularity and mRNA expression of angiogenic factors (AFs) and their receptors (AFRs) in adolescent sheep. D. A. Redmer*^{1,2}, R. P. Aitken², J. S. Milne², M. L. Johnson¹, D. Rouse¹, P. P. Borowicz¹, M. Borowicz¹, K. C. Kraft¹, L. P. Reynolds¹, J. S. Luther^{1,2}, and J. M. Wallace², ¹*North Dakota State University, Fargo*, ²*Rowett Research Institute, Aberdeen, Scotland, UK.*

Placental and fetal growth are compromised in rapidly growing adolescent ewes. Our aim was to determine the ontogeny of placental AF/AFR mRNA expression and vascular morphology throughout gestation. Singleton pregnancies (single sire) were established by

embryo transfer and then adolescent dams were offered a high (H, n=30) or control (C, n=34) nutrient intake. Whole placentomes, collected at Day (D) 50, 90 or 130 of gestation, were (a) frozen for quantitative real-time RT-PCR determination of placental AF/AFR mRNA expression or (b) perfusion-fixed and stained for quantification of vascular morphology. Placentome mass was independent of nutrition at D50 and 90, and by D130 both placentome (- 46%) and fetal weight (-20%) were reduced in H pregnancies. Placentome mRNA expression of vascular endothelial growth factor (VEGF), angiopoietin (Ang)-1 and Ang-2, basic fibroblast growth factor (FGF-2), endothelial nitric oxide synthase (eNOS), and placental growth factor (PLGF), and AFRs VEGFR-1 (flt), VEGFR-2 (KDR), and FGFR-2 increased as gestation advanced ($P<0.001$), whereas, hypoxia inducible factor (HIF1 α), soluble guanylate cyclase (NO receptor) and neuropilin (NP)-2 declined ($P<0.05$). H-intakes reduced NP-1 expression ($P<0.04$) at each stage and increased eNOS at D130 ($P<0.01$). Tie-2 (Ang receptor) expression was unaffected by stage or nutrition level. H-intakes reduced ($P<0.004$) capillary area density and size in the cotyledon at D50, but thereafter placental vascular morphology per unit tissue was largely unaffected. Similarly, caruncular vascular morphology was independent of nutrition throughout. This study provides clues as to the AF/AFR's involved in the nutritional mediation of placental growth. As vascular morphology per unit placenta is largely unperturbed at D90 and 130, the data further suggest that it is the small size of the placenta and thus the reduction in total vascular volume that is the major limitation to fetal nutrient supply in late pregnancy.

Funded by the Scottish Exec. Environ. and Rural Affairs Dept., NIH HD045784.

Key Words: Angiogenesis, Placenta, Nutrition

W153 Propionate infusion alters G protein-coupled receptor GPR41 mRNA expression and the leptin system in goats. M. Mielenz, C. Seybold, and H. Sauerwein*, *University of Bonn, Germany.*

The importance of the GPR41 for the regulation of the leptin system in ruminants is not yet clarified. The aim of this study was to compare GPR41 mRNA expression in two different fat depots and to test the effects of intravenously infused propionate on GPR41 mRNA, serum leptin and its mRNA as well as leptin receptor mRNA in goats. In mice, GPR41 is recognized to be regulated by short chain fatty acids (SCFAs) with propionate being the most potent ligand. Propionate up-regulates leptin synthesis in this species. In contrast to monogastric mammals, ruminants almost entirely depend on SCFAs as energy source, but the reports about the relevance of propionate for leptin secretion in these species are controversial. Castrated male goats (Deutsche-Edelziege, 10 to 12 months old) were allocated to infusions through jugular catheters after an overnight fast. They received propionate infusions (96 $\mu\text{mol}/\text{kg}^*\text{min}$; n=8) or NaCl-solution (equivalent Na-concentration; n=5). After recording leptin baseline concentrations for 1h, infusions were carried out for 260 min. Blood samples were collected in 10 to 15 min intervals and analyzed for leptin by ELISA. The mRNAs of leptin, leptin receptor (long form) and GPR41 from subcutaneous adipose tissue (SAT) and perirenal adipose tissue (PAT) were quantified by real-time RT-PCR after euthanasia (propionate group: n=4; NaCl group: n=5). Repeated measures analysis of serum leptin values showed an increase in the propionate versus the control group ($p<0.05$). Estimation of the mRNA expression data indicated a tendency for an increase of leptin mRNA in PAT ($p=0.081$)

but not in SAT ($p=0.106$). The leptin receptor mRNA decreased in PAT ($p=0.042$) and in SAT, the latter decrease, however, did not reach the level of significance ($p=0.286$). GPR41 mRNA was elevated in SAT ($p=0.029$) but not in PAT ($p=0.756$). In conclusion, we established the expression of GPR41 in adipose tissue of a ruminant species; the effects of the propionate challenge indicate that GPR41 is involved in mediating propionate effects on the leptin system, at least at the provocative dosage tested.

Key Words: Ruminant, GPR41, Propionate

W154 Evaluation of the adaptive capability in dairy cows during the periparturient period. S. Hachenberg, C. Weinkauff, S. Hiss, U. Müller, and H. Sauerwein*, *University of Bonn, Germany.*

The transition of pregnancy to lactation with the concomitant negative energy balance during early lactation requires substantial adaptive performance of the cow. Based on parameters of fat mobilization, we aimed to evaluate the adaptive status in dairy cows during the periparturient period. Blood samples were collected weekly from 4 wk ante partum to 12 wk post partum (p.p.) from 38 high yielding Holstein Frisian cows. For differentiating "adaptive performance satisfying" versus "adaptive performance limited" (AP-ltd), non-esterified free fatty acids (NEFA), beta-hydroxybutyrate, insulin-like growth factor-1 (IGF-1) and leptin were determined in serum and BCS was recorded. The animals were classified by using different thresholds and/or parameter combinations to determine which parameter will yield maximal consent with the other parameters to qualify only one or few parameters for field applications (GLM; SPPS). Health status was characterized using the concentrations of haptoglobin (Hp), the numbers of leukocytes and neutrophils as well as oxidative stress (dROM test) in blood. Liver impact was evaluated via glutamate-dehydrogenase (GLDH) activity in blood. From 7 criteria of classification, most information on fat mobilization was obtained from NEFA (>0.5 mM in wk 1 p.p.) as well as IGF-1 (<39 ng/mL in wk 1 p.p.) threshold values, and were combined as the criterion NEFA+IGF-1. Using this, the classification was matching in 27 animals. Meaningful conclusions about the relation between adaptive, health and liver status could be made on the basis of NEFA- and NEFA+IGF-1-classification. In the "AP-ltd" animals (NEFA; n=17 and NEFA+IGF-1; n=13), increased GLDH activities ($p<0.05$) and reduced leukocyte numbers ($p<0.001$) were determined. No differences were detected for neutrophil numbers, oxidative stress and concentration of Hp. In conclusion, routine determination of IGF-1 seems not justified to determine adaptive status. Instead, NEFA values >0.5 mM during the first wk of lactation were considered as the most suitable parameter for identifying limited adaptive performance.

Key Words: Dairy cow, NEFA, Transition

W155 Hot season and BCS affect leptin secretion of periparturient dairy cows. U. Bernabucci*, N. Lacetera¹, L. Basiricò¹, B. Ronchi¹, P. Morera¹, E. Seren², and A. Nardone¹, ¹DiPA, *Università della Tuscia, Italia*, ²DiMorfiPA, *Università di Bologna, Italia*.

The study was carried out to ascertain the effects of the hot season and BCS on leptin secretion in transition dairy cows. Twenty-four Holstein cows were utilized in the study. Twelve cows (SP cows) gave birth in spring (28 March to 30 April, 2003). The remaining 12 cows (SU cows) gave birth in summer (15 June to 2 July, 2003). The two groups were balanced for parity and body condition score (BCS), and were fed the same rations. The 24 cows were selected on a BCS basis: cows with BCS <2.5 , BCS from 2.6 to 3.5, and BCS >3.5 were assigned

to low (LBCS), medium (MBCS), and high (HBCS) BCS groups, respectively. From -32 to 38 d relative to calving BCS was registered, and blood samples were taken weekly. Plasma leptin was determined. Data were analyzed using the Mixed Procedure of SAS. During SP, either the day (9-20 h) or the night (21-8 h) temperature-humidity index (THI) was below the upper critical THI (72). During SU, the mean daily THI values were 79.5 ± 2.9 during the day, and 70.1 ± 4.7 during the night. Furthermore, during SU, three heat waves occurred. The first heat wave lasted 5, the second 6, and the third 15 d. BCS began to decrease approximately 15 d before calving in SU cows, whereas in SP cows BCS started to decline after calving. Plasma leptin decreased ($P < 0.05$) approaching to calving both in SU and SP cows. The HBCS cows showed higher ($P < 0.05$) BCS reduction than LBCS and MBCS groups both during SU and SP. Compared with SP cows, plasma leptin was higher ($P < 0.01$) in SU cows. In SU cows only, either before or after calving, a negative relationship ($P < 0.01$) was found between plasma leptin and BCS, and HBCS cows had lower ($P < 0.001$) plasma leptin compared with their LBCS and MBCS counterparts. On the contrary, SP-HBCS cows had higher ($P < 0.01$) plasma leptin when compared with their LBCS and MBCS counterparts. Results reported herein, indicate that hot season is responsible for increased leptin secretion, and for changes into the relationships between body condition and leptin secretion in periparturient dairy cows.

Key Words: Leptin, Heat stress, Dairy cow

W156 Detection of photonic emissions with varying concentrations of *Salmonella typhimurium*-lux through porcine intestinal tissue: A comparison of two photonic imaging systems. K. Moulton^{*1}, E. Williams¹, P. Ryan¹, D. Moore¹, S. Kim¹, D. Lay², and S. Willard¹, ¹Mississippi State University, Mississippi State, ²USDA-ARS Livestock Behavior Research Unit, West Lafayette, IN.

The objective was to correlate photonic emissions with concentration of *Salmonella typhimurium* (*S. typh*-lux; transformed with plasmid pAK1-lux) using the Berthold/NightOwl (BNO) and Stanford Photonic (SP) imaging systems in porcine intestinal tissues. Porcine small and large intestines were obtained after harvest and cleaned of digestive material. Two intestinal segments were imaged per session and 18 images were collected in both the SP and BNO imaging systems (1 to 60 s and 3 to 300 s, respectively). Varying concentrations of bacteria were used in small and large intestine studies, ranging from 5.7×10^5 to 8.0×10^7 CFU/ml. For each experiment, one segment was empty for a background count and one segment was injected with *S. typh*-lux broth; the difference of which was used in analysis. Throughout imaging (up to 6 replicates) *S. typh*-lux broth was serially diluted, plated and 24 h later counted to determine concentrations of bacteria imaged. Images from the SP and BNO systems were analyzed using Image J (NIH) and WinLight software, respectively. Data analysis included correlations between imaging systems, photonic emissions and bacterial concentrations. From small intestines, photonic emissions were positively correlated with bacterial concentration in SP ($R=0.80$) and BNO ($R=0.60$; $P < 0.05$) systems. The correlation between imaging systems in small intestines relative to photonic emissions was 0.73 ($P < 0.05$). From large intestines, photonic emissions were positively correlated with bacterial concentration in SP ($R=0.52$) and BNO ($R=0.60$; $P < 0.05$) systems. The correlation between imaging systems in large intestines relative to photonic emissions was 0.65 ($P < 0.05$). These data indicate that concentrations of *S. typh*-lux are highly correlated with photonic emissions, and may be detected through porcine intestinal tissues using either SP or BNO imaging systems. [USDA-NRI grant #

2003-35201-13841; USDA-ARS funded Biophotonic Initiative # 58-6402-3-0120]

Key Words: Biophotonics, *Salmonella*, Porcine intestines

W157 Modulation of bovine hepatic ApoB100, ApoE and MTP gene expression by fatty acids. J. A. A. Pires^{*2}, D. Pirazzi¹, D. G. Mashek², L. Basiricò¹, S. J. Bertics², R. R. Grummer², and U. Bernabucci¹, ¹Università della Tuscia, Viterbo, Italy, ²University of Wisconsin, Madison.

The objective was to investigate the effect of different fatty acids (FA) on the gene expression of ApoB100, ApoE, and microsomal triglyceride transfer protein (MTP), which are involved in the VLDL synthesis and secretion by bovine hepatocytes. Hepatocytes were isolated from three 7 to 10 d old male Holstein calves, cultured in monolayer, and treated for 48 h (from 20 to 68 h after seeding) with either no FA added (control) or 0.1, 0.2 and 1.0 mM of C16:0, C18:0, C18:1, C18:2, C18:3, C20:5, C22:6, or a physiological FA mix (NEFA; 15% C18:0, 30% C16:0, 45% C18:1, 5% C16:1, and 5% C18:2). Gene expression was quantified by Real-Time PCR, using ubiquitin as internal control. Data were analyzed by the Mixed Procedure of SAS using a model with fixed effect of treatment and random effect of calf. Contrasts were 1) linear and 2) quadratic concentration effects of single FA treatments; 3) linear and 4) quadratic concentration of NEFA treatment (positive control); 5) saturated and mono-unsaturated vs. polyunsaturated (PUFA); 6) C18 PUFA vs. long chain PUFA; 7) omega-6 vs. omega-3; 8) C20:5 vs. C22:6. Increasing the length and degree of unsaturation of FA down-regulated gene expression of ApoB and MTP (contrasts 5, 6, 7; $P < 0.05$) and ApoE (contrasts 6, 7, 8; $P < 0.01$). Increasing the concentration of single FA down-regulated gene expression of ApoE and MTP (contrast 1; $P < 0.05$), but not of ApoB. Increasing NEFA concentration up-regulated gene expression of ApoB100 (contrast 3; $P < 0.01$), ApoE (contrasts 3, 4; $P < 0.05$) and MTP (contrast 4; $P < 0.001$). These results show that FA modulate the gene expression of proteins involved in VLDL metabolism. Additionally, concentration effects of the NEFA and single FA treatments differed; for most single FA treatments, increasing concentration down-regulated gene expression while increasing the concentration of NEFA mix, which reflects the FA profile *in vivo*, up-regulated gene expression.

Key Words: Fatty acids, Hepatic apolipoprotein, Bovine

W158 Characterization of bovine granulocyte chemotactic protein-2 in mammary glands with *Escherichia coli* mastitis. J.-W. Lee^{*1} and X. Zhao², ¹National Pingtung University of Science and Technology, Neipu, Pingtung, Taiwan, ²McGill University, Ste-Anne-de-Bellevue, Quebec, Canada.

Neutrophils, migrating from the blood into to the milk in response to inflammatory signals, are considered as the first line of defense for eliminating invading bacteria in the mammary glands. The promptness of neutrophil recruitment is very crucial to the outcome of mastitis. By using the Differential Display (DD)-PCR technique, we previously demonstrated that the expression of a bovine chemokine gene, granulocyte chemotactic protein-2 (GCP-2), is upregulated in bovine mammary epithelial cells stimulated with the lipoteichoic acid, but not the peptidoglycan, from *Staphylococcus aureus*. In the present study, 6 dairy cows with clinical *Escherichia coli* (*E. coli*) mastitis were used to investigate the involvement of GCP-2 in infections induced by

Gram-negative bacteria. Biopsy samples and milk somatic cells were collected from the quarters with or without clinical *E. coli* mastitis in an animal. The expression of GCP-2 gene was analyzed by real-time PCR and calibrated with the expression of a house-keeping gene (β -actin). The expression of GCP-2 gene is significantly ($P < 0.05$) increased in tissues (15.8 ± 5.6 fold) and milk somatic cells (17.39 ± 2.8 fold) collected from the quarter with clinical *E. coli* mastitis in comparison with the control quarter in the same animal. The preliminary results suggest that bovine GCP-2 might be another chemoattractant, in addition to interleukin (IL)-8 and C5a, produced by mammary cells during mastitis. Further research is required to investigate whether GCP-2 has a direct effect on recruiting leukocytes, such as neutrophils, to the site of infection.

Key Words: Mastitis, Chemoattractant, Neutrophil

W159 Somatotropic axis components in and growth rates of IGF-I divergent Angus heifers receiving exogenous bovine (b) ST. K. J. Steinman^{*1}, T. A. Hoagland¹, M. E. Davis², and S. A. Zinn¹, ¹University of Connecticut, Storrs, ²The Ohio State University, Columbus.

To determine growth rate and measure components of the somatotropic axis, 30 Angus heifers divergently selected for greater (H; n=14) or lesser (L; n = 16) IGF-I concentrations were treated with exogenous bST [single-injection in tail head, 500 mg (Posilac); n=22] or no bST (control; n = 8). Animals were grouped into pens with 3 or 4 H heifers and 4 L heifers per pen. Blood samples (N = 3, 10 mL) were collected at 30 min intervals by jugular venipuncture from a jugular vein on d -6, -4, -2, 0, 1, 3, 5, and 7 relative to bST administration. Sampling regimen was conducted at approximately 320, 370, and 420 d of age (d 0). Animals were weighed weekly. Serum concentrations of ST and IGF-I were quantified by RIA, and IGFBP-2 and -3 concentrations were determined by Western ligand blot. Initially, H heifers were heavier ($P = 0.008$; 265.1 ± 7.6 kg) than L IGF heifers (237.4 ± 7.4 kg) and this difference was maintained throughout the experiment ($P = 0.05$). However, ADG was not different ($P = 0.89$) between H (0.6 ± 0.03 kg) and L (0.6 ± 0.03 kg) IGF heifers, nor did bST-treatment influence ADG ($P = 0.95$). Before bST treatment, no differences were observed in ST ($P = 0.10$; 13.9 ± 2.6 vs. 18.8 ± 2.5 ng/mL), IGF ($P = 0.34$; 134.4 ± 20.8 vs. 106.3 ± 20.3 ng/mL), or IGFBP-3 ($P = 0.27$; 60.4 ± 4.3 vs. 52.3 ± 4.3 AU) in H and L IGF heifers, respectively. Concentrations of IGFBP-2 in L heifers tended to be greater than in H animals ($P = 0.08$; 41.1 ± 2.0 vs. 35.9 ± 2.1). Following bST-treatment, ST (35.8 ± 3.6 ng/mL), IGF-I (216.6 ± 14.9 ng/mL) and IGFBP-3 (86.0 ± 3.0 AU) increased ($P = 0.001$) compared with controls, but there were no differences ($P \geq 0.14$) in ST, IGF-I or IGFBP-2 between genetic groups. Following bST treatment, IGFBP-3 was increased on d 5 and 7 in H compared with L ($P < 0.05$; 95.2 ± 5.7 vs 76.7 ± 5.7 AU) IGF heifers. Although these heifers came from IGF-I divergent genetic lines, no differences due to genetic line in basal or bST-induced IGF-I, ST or IGFBP-2 concentrations were observed. However, the increase in IGFBP-3 in H IGF heifers may account for increased BW in this genetic group.

Key Words: Beef cattle, Insulin-like growth factor, Somatotropin

W160 Relative quantification of ghrelin mRNA in Holstein calves. S. L. Greenwood^{*}, D. R. Glimm, A. F. Keating, N. S. Beswick, and J. J. Kennelly, University of Alberta, Edmonton, Canada.

The discovery of the novel orexigenic peptide ghrelin in monogastrics has stimulated research regarding ghrelin's involvement in feed intake

in ruminants. Though ghrelin mRNA expression is primarily found in the stomach, mRNA expression has also been observed in various other non-digestive tissues in monogastrics. The objectives of this study were to examine ghrelin mRNA expression in calf tissues, including various non-gastrointestinal tissues, and determine the influence of adrenocorticotrophin hormone (ACTH) injection on ghrelin, leptin and stearoyl-CoA desaturase (SCD) mRNA expression. Twenty-one different tissue types were collected from 6-month-old male Holstein calves (n=12) after euthanasia. The calves were used in a stress response study and were injected with either saline or ACTH. The calves (3/group) were then euthanized at 15, 50 or 100 minutes following injection of 0.56 IU/kg ACTH or immediately following saline injection. RNA was isolated using the TRIzol method, and mRNA expression was determined using Real-time PCR. Cyclophilin was used as the control gene. Ghrelin, leptin and SCD mRNA expression was determined relative to cyclophilin expression and averaged within treatment groups. Ghrelin mRNA expression was most abundant in the abomasum in all treatment groups. However, ghrelin mRNA expression was also observed in the lung, spleen, kidney, aorta, endocardium, testis, epididymis, gall bladder, duodenum, jejunum and ileum. These findings are the first to indicate that ghrelin mRNA expression is present in non-gastrointestinal tissues in ruminants and could provide insight into possible endocrine and/or paracrine roles of ghrelin.

Key Words: Ghrelin, Adrenocorticotrophin hormone

W161 Transcriptional profiling of hepatic constitutive androstane receptor and target genes in relation to boar taint compounds in backfat of pigs. D. L. Greger^{*1}, C. Morel³, G. Bee², S. Ampuero², C. R. Baumrucker¹, and J. W. Blum³, ¹Pennsylvania State University, University Park, ²Agroscope Liebefeld-Posieux, Posieux, Switzerland, ³University of Bern, Switzerland.

The primary causes of off-odors in pork from uncastrated male pigs, a phenomenon commonly known as "boar taint", are the presence of pheromonal androstene steroids as well as skatole and indole in adipose tissue. The latter compounds are products of microbial tryptophan metabolism. Hepatic cytochromes p450 (CYP) catalyze diverse reactions that are involved in the metabolism of compounds that cause boar taint. Constitutive androstane receptor (CAR) is a nuclear receptor (NR) known to regulate transcription of many hepatic genes including CYP genes. The objective of this investigation was to determine whether CAR mRNA expression is related to expression of hepatic CYPs and associated with concentrations of boar taint compounds. Liver samples from market weight pigs were collected at slaughter and total RNA extracted from 18 intact males and 8 castrates. Real-time reverse-transcription polymerase chain reaction (RT-PCR) was performed to quantify relative mRNA abundance for NR and selected target genes. Concentrations of androstenone, skatole and indole in backfat were determined by HPLC. Hepatic expression of CAR was positively correlated ($P < 0.05$) with mRNA expression of PXR (pregnane X receptor), CYP2E1, CYP2A6, CYP1A2, and uridine glucuronosyl transferase 1A1 (UGT1A1). CAR mRNA abundance was negatively correlated with skatole ($r = -0.41$; $P < 0.05$) and indole ($r = -0.64$; $P < 0.01$); CYP2B22 mRNA abundance was negatively correlated ($P < 0.05$) with indole ($r = -0.49$; $P < 0.05$) concentrations in backfat. Abundance of PXR mRNA was negatively correlated with indole concentrations ($r = -0.41$; $P < 0.05$), but was not associated with skatole level in backfat ($P > 0.10$). These results suggest that CAR plays an important role in regulating transcription of hepatic

genes involved in metabolism of compounds that cause boar taint in intact male pigs.

Key Words: Boar taint, Constitutive androstane receptor, Liver

W162 Expression of beta-adrenergic receptors in adipose tissue of Holstein dairy cattle. J. Sumner* and J. McNamara, *Washington State University, Pullman.*

The objective was to determine the expression of beta-adrenergic receptors in adipose tissue of Holstein dairy cattle. Activity of hormone sensitive lipase and responsiveness to beta-adrenergic stimulation increases during the transition period; and the adaptation varies among cattle with different milk production ability. However, expression of beta-adrenergic receptor subtypes and their potential role in control of lipolysis is unknown for dairy cattle. Therefore, twenty Holstein dairy cattle were grouped by lactation number (1, 2, and 3 or more). Mean 305ME was 13350 kg (SE 423); 3.6% fat and 3.3% protein. 305ME for 1st, 2nd and higher parity cows were 14936, 12791, and 11326 (SE 931). Fat averaged 3.55 and protein 3.3 %. Day 30 postpartum production was 39.3 kg/d (SE 3.4) with 3.6% fat and 2.7% protein and d 90 postpartum production was 48.8 kg/d (SE 1.5) with 3.4% fat and 2.9% protein. Body weight and BCS, measured at -30, 30, 90 and 270 days around calving averaged 682, 598, 634 and 638 kg and 3.3, 2.3, 2.5, and 2.7 BCS units. Subcutaneous adipose tissue was biopsied from the tailhead region. Duplicate samples were extracted for RNA and tissue was also incubated to measure basal and stimulated lipolysis. The RNA was used to synthesize cDNA, and using forward and reverse primers of CCCAGGCACCGAAAACCT and TCCCTTGTGAATCAATGCTATCA, we determined that the beta-2-adrenergic receptor is expressed in Holstein adipose tissue at all time points measured during late pregnancy and lactation, by PCR and agarose gel analysis as well as real time RT-PCR. Beta-3 receptors were also measured using forward and reverse primers of AGGCAACCTGCTGGTAATCG and GTCACGAACACGTTG-GTCATG, and these were also expressed, with qualitative assessment suggesting at a lower amount. This is the first demonstration of expression of beta-receptor subtypes in Holstein adipose tissue.

Key Words: Beta-adrenergic receptors, Lipolysis, Transition dairy cattle

W163 Evaluation of reproduction and blood metabolites in heifers fed dried distillers grains plus solubles or soybean hulls during late gestation. C. L. Engel*, H. H. Patterson, B. L. Perry, and G. A. Perry, *South Dakota State University, Brookings.*

Dried distillers grains plus solubles (DDGS) contain both undegradable intake protein and fat, which have both been shown to increase reproduction when supplemented to primiparous heifers. The mechanisms leading to enhanced reproduction when fat or UIP are supplemented have not been fully defined. The objective of this experiment was to evaluate DDGS or soybean hulls (SBH) during the last trimester of gestation on reproductive efficiency. Ninety-five cross bred heifers were stratified by expected calving date, body weight, BCS, and randomly assigned to DDGS or SBH (n = 6 pens per treatment). Diets were developed to meet the nutrient requirements at d 240 of gestation and were limit fed during the last trimester of gestation until parturition. Blood samples were collected prior to calving and once per week following calving for 4 weeks. There was no effect of treatment on BCS at calving ($P = 0.29$; 5.9 ± 0.07). Treatment had no effect on circulating concentrations of GH ($P = 0.51$)

or IGF-1 ($P = 0.18$). However, time influenced both GH ($P < 0.01$) and IGF-1 ($P < 0.01$). Circulating concentrations of GH were elevated at calving (14.4 ± 1.5 ng/mL) and decreased by 4 d after calving (9.0 ± 1.6 ng/mL). Circulating concentrations of IGF-1 rose for the first 2 d following calving (57.1 ± 5.2 ng/mL) and then decreased through d 6 (30.5 ± 5.6 ng/mL). At the start of the breeding season there was no difference between DDGS and SBH in the percent of heifers that had initiated estrous cycles ($P = 0.75$; 74% and 70%; respectively). There was a tendency ($P = 0.11$) for more DDGS treated animals to become pregnant during a 64 d natural service breeding season compared to SBH treated animals (92% vs 80%; respectively). However, there was no difference in the distribution of pregnancies ($P = 0.30$) between treatments. In summary, DDGS and SBH fed during the last trimester of pregnancy to heifers had similar effects on GH and IGF-1, but DDGS tended to improve pregnancy rates during a defined breeding season.

Key Words: DDGS, Gestation, Pregnancy

W164 Responses of tissues to epinephrine as affected by homeorhetic state in dairy cattle. K. L. Smith*, A. K. Rauf, B. C. Benefield, A. W. Bell, and T. R. Overton, *Cornell University, Ithaca, NY.*

In vivo epinephrine (EPI) challenges were used to evaluate changes in peripheral tissue responses to catecholamines in the late prepartum (PRE), early postpartum (POST) and midlactation (ML) periods in Holstein cows. Periparturient (n=6) cows were studied during 4 periods (-30 to -26 d and -12 to -8 d PRE; 3 to 7 d and 26 to 30 d POST) and ML (n=5) cows were studied on d 148 to 152 POST. During each period, cows were administered a randomized sequence of 5 doses of EPI (0.2, 0.4, 0.8, 1.2 and 1.6 $\mu\text{g/kg BW}$) by i.v challenge. Blood was sampled frequently via jugular catheter from 30 min pre-challenge to 2 h post-challenge. Plasma NEFA and glucose responses to 0.8 and 1.6 $\mu\text{g/kg BW}$ of EPI were used to estimate tissue sensitivity and responsiveness. Both plasma glucose ($\text{mg/dl} \cdot \text{min}^{-1}$) and NEFA ($\mu\text{Eq/L} \cdot \text{min}^{-1}$) area under the curve (AUC) increased dose-dependently following EPI challenge. Periparturient cows had larger NEFA response during POST than PRE for both 0.8 and 1.6 $\mu\text{g/kg BW}$ of EPI, suggesting both greater sensitivity and responsiveness of adipose tissue to EPI during POST. Periparturient cows had larger glucose responses to both doses only at d 26 to 30 POST. Responses of NEFA for cows studied in ML were intermediate compared to those during PRE and POST. Responses of glucose for cows studied during ML were comparable to those at d 26 to 30 POST. Overall, responses of peripheral tissues to EPI were greater during lactation than during late pregnancy; those differences were more pronounced for release of NEFA from adipose tissue.

Table 1. Responses by day relative to parturition

	-30 to -26	-12 to -8	+3 to +7	+26 to +30	ML	SE
NEFA AUC						
0.8 $\mu\text{g/kg BW}$	579 ^b	525 ^b	1893 ^a	1725 ^a	1228 ^{ab}	380
1.6 $\mu\text{g/kg BW}$	837 ^{bc}	718 ^c	1937 ^a	2146 ^a	1672 ^{ab}	371
Glucose AUC						
0.8 $\mu\text{g/kg BW}$	280 ^b	319 ^b	186 ^b	555 ^a	632 ^a	78
1.6 $\mu\text{g/kg BW}$	538 ^{bc}	446 ^c	512 ^b	851 ^a	780 ^{ab}	98

Means within the same row with different superscripts differ, $P < 0.05$

Key Words: Transition cow, Epinephrine, Homeorhesis

W165 Responses of tissues to insulin as affected by homeorhetic state in dairy cattle. K. L. Smith*, A. K. Rauf, B. C. Benefield, A. W. Bell, and T. R. Overton, *Cornell University, Ithaca, NY.*

In vivo insulin (INS) challenges were used to evaluate peripheral tissue responses to insulin in the late prepartum (PRE), early postpartum (POST) and midlactation (ML) periods in Holstein cows. Periparturient (n=7) cows were studied during 4 periods (-30 to -26 d and -12 to -8 d PRE; 3 to 7 d and 26 to 30 d POST) and ML (n=5) cows were studied from d 148 to 152 DIM. During each period, cows were administered a randomized sequence of 5 doses of INS (0.2, 0.4, 0.8, 1.2 and 1.6 µg/kg BW) by i.v. challenge conducted once daily. Blood was sampled frequently via jugular catheter from 30 min pre-challenge to 2 h post-challenge. Plasma glucose and insulin responses to 0.8 and 1.6 µg INS/kg BW were used to estimate tissue sensitivity and responsiveness, respectively. Plasma glucose (mg/dl*min⁻¹) area under the curve (AUC) decreased and plasma insulin (ng/ml*min⁻¹) AUC increased dose-dependently following INS challenge. Plasma glucose AUC after 0.8 µg INS/kg BW was lower during PRE than during d 3 to 7 POST and ML; however, glucose AUC following 1.6 µg INS/kg BW was similar among PRE and POST and lower than ML. Plasma insulin AUC after 0.8 µg INS/kg BW was greater during d -12 to -8, d 3 to 7, and d 26 to 30 compared with d -30 to -26 and ML and was greatest after 1.6 µg INS/kg BW during d -12 to -8 and intermediate during d 3 to 7 POST compared to other study periods. Collectively, these data suggest that peripheral tissue responses to INS are greatest during ML and least during the immediate prepartum period.

Table 1. Responses by day relative to parturition

	-30 to -26	-12 to -8	+3 to +7	+26 to +30	ML	SE
Glucose AUC						
0.8 µg/kg BW	148 ^c	194 ^{bc}	238 ^a	211 ^{ab}	240 ^a	17
1.6 µg/kg BW	249 ^b	254 ^b	256 ^b	246 ^b	358 ^a	35
Insulin AUC						
0.8 µg/kg BW	74 ^b	155 ^a	136 ^a	124 ^a	53 ^b	18
1.6 µg/kg BW	190 ^b	269 ^a	223 ^{ab}	196 ^b	172 ^b	28

Means within the same row with different superscripts differ, P < 0.05

Key Words: Transition cow, Insulin, Homeorthesis

W166 Acute and chronic reduction in plasma progesterone concentrations after feed intake in dairy cows. R. M. Santos*, G. C. Perez, D. G. B. Demetrio, A. B. B. Maciel, and J. L. M. Vasconcelos, *FMVZ-UNESP, Botucatu, SP, Brazil.*

This study tested the hypothesis that an increase in feed intake (FI) decreases plasma progesterone (P4) acutely (5h after FI) and chronically (12h after FI) in cows treated with intravaginal P4 device (CIDR®, 1,9g), without a CL (Exp.1) or during the estrous cycle, with a CL (Exp.2). In Exp.1, non-lactating Holstein cows (n=21) were synchronized with Ovsynch protocol. At day 7 after the 2nd GnRH all cows received a PGF2α injection, to regress the CL (95%; 20/21), and were divided (Fatorial 2x2) according to number of CIDR (1 vs. 2) and FI (2 vs. 8 kg of concentrate, offered twice a day, for 14 days). To evaluate the acute effects of FI on P4, blood samples were collected every 15min for 6h at day 14. In Exp.2, non-lactating Holstein cows (n=7), were synchronized with the same protocol, and at day of the 2nd GnRH divided in 2 groups: 8 kg (n=7) or 2 kg (n=4) of concentrate,

with one replicate. In both experiments, to evaluate the chronic effects of FI on P4, daily blood samples were collected, 12h after FI. Plasma P4 was determined by RIA. The data were analyzed by PROC MIXED of SAS. For Exp.1, there was an interaction (P<.01) between number of CIDR, FI and day on P4 at 12h after FI. Cows receiving 1CIDR and 8 kg of concentrate had lowest P4 and cows receiving 2CIDR and 2 kg of concentrate had highest P4. On day 14, was detected the interaction (P<.01) between FI and moment of the blood sample on P4, showing the acute effect of FI on P4. Cows receiving 8 kg of concentrate had higher decrease in P4. In Exp.2, there was an interaction (P<.05) between FI and day on P4 at 12h after FI. P4 decreased more for the group that received 8 kg concentrate. The effects of FI on P4 at 12h after FI, shows the chronic effect of FI on exogenous (Exp. 1) and endogenous (Exp. 2) P4. The acute and chronic reduction on P4 by FI in cows is probably due to an increase in P4 metabolism. These effects of FI on P4 could explain the decrease in fertility in lactating dairy cows.

Key Words: Feed intake, Progesterone, Dairy cow

W167 Effects of Posilac on immune and endocrine responses of channel catfish challenged with *Edwardsiella ictaluri*. B. Peterson*, B. Small, and A. Bilodeau, *USDA-ARS Catfish Genetics Research Unit, Stoneville, MS.*

Research was conducted to examine the effects of recombinant bovine somatotropin (rbST, Posilac) on immune and endocrine responses to channel catfish challenged with *Edwardsiella ictaluri* (*E. ictaluri*). Four hundred and eighty fish (11.7 ± 1.0 g) were randomly assigned to two treatments with six replicates each: 1.) sham-exposed (one needle puncture per week for 3 wks and then challenged with *E. ictaluri*) and 2) rbST-exposed (Posilac, injected at 30 mg/g body weight per week for 3 wks and then challenged with *E. ictaluri*). Fish were sampled on d (1, 4, 8, or 14) (d 0 = *E. ictaluri* challenge). Non-exposed groups (d 0 controls) of fish were sampled on d 0. On each of the sample days, liver, kidney spleen, gut, and blood were collected. During the three-week period prior to challenge, rbST-treated fish gained 19% more (P < 0.01) weight. Levels of bacteria were higher (P < 0.05) on d 4 and 8 in rbST-exposed fish but were similar on d 14 compared to sham-exposed. Plasma levels of lysozyme were elevated (P < 0.01) in rbST-exposed fish on d 4, 8, and 14 compared to sham-exposed fish. Compared to d 0 controls, IGF-I levels decreased (P < 0.05) in challenged fish while levels were similar (P > 0.10) between treatments throughout the study. Similarly, abundance of GHR receptor (GHR) mRNA tended to decrease (P = 0.06) in liver of challenged fish while levels were similar (P > 0.10) between treatments in the spleen, kidney, liver, and gut throughout the study. Abundance of toll like receptor 5 (TLR5) mRNA increased (P < 0.05) in liver of fish challenged with bacteria compared to d 0 controls while levels were similar (P > 0.10) between treatments in the spleen, kidney, liver, and gut throughout the study. Mortality was higher in rbST-exposed fish compared to sham-exposed fish. An increase in lysozyme in rbST-exposed fish may reflect increases in bacterial levels of *E. ictaluri*. A decrease in GHR mRNA and plasma IGF-I suggests a down regulation of the somatotrophic axis in response to disease. While TLR5 mRNA increased in response to disease, there was no apparent effect of exogenous rbST.

Key Words: rbST, GHR, TLR5

W168 Effects of milking frequency in early lactation on prolactin and growth hormone release and on milk production throughout lactation. E. A. Albers, C. C. Williams*, C. F. Hutchison, D. T. Gantt, C. Leonardi, L. R. Gentry, and C. C. Stanley, *LSU Agricultural Center, Baton Rouge, LA.*

Twenty-five multiparous Holstein cows were assigned to one of two treatments to study the response of increased milking frequency during early lactation on milk production and hormonal concentrations. Treatments consisted of milking 4 times per day (4X; n = 12) or 2 times per day (2X; n = 13) for the first 21 days of lactation. Cows in the 4X group were milked at the beginning of the normal 2X milking time and again after the remaining herd had been milked (2 to 3 hours later). After 21 days, all cows were returned to the 2X milking schedule. Milk yield and component analyses were obtained from records generated through the monthly DHIA testing procedures. On days 9 and 21 of lactation, fifteen cows (4X, n = 7; 2X, n = 8) were fitted with indwelling jugular catheters and allowed approximately 1 hour of rest prior to sample collection. Blood samples were collected at 30 minute intervals for 8 hours beginning two hours prior to afternoon milking. Plasma was analyzed for prolactin (PRL) and growth hormone (GH) by radioimmunoassay. There was no effect ($P < 0.05$) of treatment on mean GH concentrations. However, GH concentrations differed during the 8 hour sampling period on both days, with GH concentrations being greater ($P < 0.05$) on day 9. There was a treatment by time interaction ($P < 0.01$) for PRL concentrations on days 9 and 21, with PRL being greater in cows milked 4X/d. Milk production, energy corrected milk (ECM) and fat corrected milk (FCM) were decreased ($P < 0.05$) in cows milked 4X. No effect of treatment was observed ($P > 0.05$) for percent milk protein or percent milk fat. These data indicate that increased milking frequency during the transition period did not improve milk production in these dairy cows.

Key Words: Milking frequency, Milk production, Hormones

W169 Evaluation of an early marker of failed pregnancy: Changes in expression of Mx2 mRNA in peripheral blood mononuclear cells in dairy heifers of different reproductive statuses. J. L. Stevenson*¹, R. C. Chebel¹, J. C. Dalton², T. L. Ott³, C. Gifford³, and K. Racicot³, ¹University of Idaho, Caldwell, ²University of Idaho, Caldwell, ³University of Idaho, Moscow.

The objective of the present study was to evaluate the correlation between reproductive status and steady-state levels of Mx2 mRNA in peripheral blood mononuclear cells of dairy heifers. Holstein heifers (n = 257), 13 ± 1 mo of age, were assigned to be inseminated (BRED; n = 209) or not (NON-BRED; n = 48) after the completion of a synchronization protocol. All heifers received a CIDR insert for 7 d and at CIDR removal heifers received one injection of PGF2a (study d 0). Heifers from the BRED group were inseminated upon detection of estrus from study d 0 to 3, and those not inseminated received a GnRH injection concomitant with fixed time AI 72 h after PGF2a injection (study d 3). All heifers from the NON-BRED group received a GnRH injection on study d 2 to induce ovulation and were not inseminated. Blood samples collected on study d 2 and 20 were used to determine steady-state levels of Mx2 mRNA using quantitative real-time PCR, and fold increase in Mx2 mRNA levels from study d 2 to 20 was calculated. Pregnancy was diagnosed at 30 and 65 d after AI. Data were analyzed using GLM procedure of SAS. Pregnancy rate at 30 d and 65 d after AI were 49.6% and 43.7%, respectively, and pregnancy loss between 30 d and 65 d after AI was 11.9%. Heifers diagnosed as

pregnant on d 30 (NON-BRED = 1.61 ± 0.41, BRED/Non-pregnant = 2.03 ± 0.34, BRED/Pregnant = 2.98 ± 0.34 fold) and 65 after AI (NON-BRED = 1.61 ± 0.41, BRED/Non-pregnant = 2.12 ± 0.32, BRED/Pregnant = 2.99 ± 0.36 fold) had greatest ($P = 0.03$) Mx2 mRNA fold change between study d 2 and 20. There was no difference ($P = 0.94$) in Mx2 mRNA fold increase between pregnant heifers that experienced or did not experience fetal loss between 30 and 65 d after AI. The range of Mx2 mRNA fold increase was as follow: NON-BRED = 0.05-13.02; BRED/Non-pregnant = 0.05-13.08; BRED/Pregnant = 0.15-14.32; and Bred/Aborted = 0.19-6.73. The present study indicates that increased levels of Mx2 mRNA in peripheral blood mononuclear cells are related to pregnancy at 30 and 60 d after AI in dairy heifers.

Key Words: Dairy heifers, Gene expression, Reproductive status

W170 Influence of breed type and temperament on anatomic and endocrinologic parameters of the bovine hypothalamic-pituitary-adrenal (HPA) axis. K. O. Curley, Jr.*¹, J. Lyons¹, M. S. Brown², T. E. Lawrence², J. A. Carroll³, R. C. Vann⁴, S. T. Willard⁵, T. H. Welsh, Jr.¹, and R. D. Randel⁶, ¹Texas Agricultural Experiment Station, College Station, ²West Texas A&M University, Canyon, ³Livestock Issues Research Unit, ARS-USDA, Lubbock, TX, ⁴Brown Loam Experiment Station, Raymond, MS, ⁵Mississippi State University, Mississippi State, ⁶Texas Agricultural Experiment Station, Overton.

Temperament has been shown to affect bovine adrenal cortical and medullary stress responses. The biological mechanisms responsible for increased secretion of glucocorticoids and catecholamines in beef cattle with poor temperament remain undetermined. The objective of this study was to compare anatomic and endocrinologic parameters of the hypothalamic-pituitary-adrenal (HPA) axis within and across temperament and breed type. Exit velocity (EV), the rate at which the cattle exited the squeeze chute and traversed a fixed distance (1.83 m), was used to identify the 10 calmest (C) and 10 most temperamental (T) weaned calves from both Brahman (B) and Angus (A) herds. The steers were fed to a similar rib fat thickness at a feedyard in Canyon, TX. Blood samples were obtained via coccygeal venipuncture on d113 of the feeding period. Serum concentrations of cortisol (CS), and plasma concentrations of epinephrine (EPI) and norepinephrine (NOR) were determined by RIA and EIA, respectively. Temperament influenced CS ($P = 0.001$; C = 16.98 ± 1.8, T = 31.07 ± 3.7 ng/mL), EPI ($P = 0.025$; C = 136.71 ± 17.5, T = 490 ± 159.2 pg/mL), and NOR ($P = 0.044$; C = 307.23 ± 22.9, T = 1119.83 ± 427.6 pg/mL). However, no effects of breed or breed by temperament interaction were observed for these endocrine parameters. At the time of harvest, left adrenal glands and pituitaries were collected so that adrenal cross-sectional areas and pituitary weights could be analyzed. There were no effects of temperament or breed by temperament interactions observed for the anatomical parameters. However, breed influenced adrenal area ($P = 0.022$; A = 121.37 ± 4.4, B = 106.53 ± 4.8 mm²) as well as cortical area ($P = 0.043$; A = 91.06 ± 3.1, B = 80.53 ± 4.2 mm²). Concerning the pituitary gland, breed influenced ($P < 0.001$) both whole pituitary weight (A = 2.11 ± 0.1, B = 1.27 ± 0.04 g) and anterior pituitary weight (A = 1.65 ± 0.07, B = 0.97 ± 0.07 g). Breed type influenced anatomic parameters of the HPA axis whereas temperament influenced endocrinologic function of the adrenal cortex and medulla of beef steers.

Key Words: Temperament, Adrenal gland, Pituitary gland

W171 Identification of growth hormone-regulated genes in the bovine liver by a microarray analysis. H. Jiang* and S. Eleswarapu, *Virginia Polytechnic Institute and State University, Blacksburg.*

The objective of this study was to identify the genes that are regulated by growth hormone (GH) in the bovine liver. Liver total RNA from three cows before and 7 days after administration of 500 mg recombinant bovine GH in a slow-release formula were subject to a microarray analysis, using the Affymetrix GeneChip® Bovine Genome Arrays that contained 23,000 bovine transcripts. On average, 6,837 (or 30%) of the transcripts were detected in the RNA samples. Analysis of the microarray data using GeneSifter revealed a set of 418 transcripts that were at least 1.5-fold different ($P < 0.05$) in abundance between pre- and post-GH liver samples. Among the 418 transcripts, 392

displayed increased whereas 26 showed decreased expression after GH administration. These differentially expressed transcripts included insulin-like growth factor-I (IGF-I), acid-labile subunit of the IGF-binding protein complex, and hepatocyte nuclear factor 3 gamma, genes that were previously known to increase their expression in response to GH treatment, and IGF binding protein-1 (IGFBP-1), whose expression was previously known to be decreased by GH administration. The pre- and post-GH differences in the expression of these four transcripts were further confirmed by ribonuclease protection assays. The majority of the 418 differentially expressed transcripts were not known to respond to GH treatment before; they therefore represent new candidate genes that mediate GH action in the bovine liver.

Key Words: Growth Hormone, Microarray, Cattle

Production, Management and the Environment III

W172 Effectiveness of ocular thermography for the determination of body temperature in livestock: A multi-species analysis. S. Willard*¹, P. Ryan¹, D. Sykes¹, M. Crenshaw¹, R. Vann², R. Randel³, T. Welsh³, S. Bowers¹, M. Jones¹, and A. Chromiak¹, ¹Mississippi State University, Mississippi State, ²Brown Loam Experiment Station, Raymond, MS, ³Texas Agricultural Experiment Station, Overton and College Station, TX.

The eye may represent a measurement location from which an assessment of body temperature could be obtained. Applications for such measurements, if effective, include the non-invasive acquisition of body temperatures in a variety of species or as a rapid test for identifying sick (febrile) animals. The objectives of this study were to randomly sample livestock to determine whether digital infrared thermal imaging (DITI) of the eye is correlated with rectal temperature (RT). Total numbers of observations by species or breed were as follows: beef steers ($n=127$), dairy cattle ($n=180$; $n=150$ cows and 30 calves), horses ($n=119$; $n=60$ mares and 30 foals) and gilts ($n=120$). Regression analysis and associative correlations between maximum eye temperature (MET) and RT were determined. MET was lower ($P < 0.05$) than RT in beef steers, dairy cattle, mares and gilts, but did not differ ($P > 0.10$) for foals. Beef steers: measurements from two studies indicated high correlations between MET and RT ($R=0.80$ and 0.78 ; $P < 0.01$), yet when studies were combined the correlation was moderate ($R=0.55$; $P < 0.01$). Dairy cattle: cows exhibited a lower correlation ($R=0.31$; $P < 0.01$) than calves ($R=0.52$; $P < 0.01$), and when combined the correlation was lower ($R=0.29$; $P < 0.01$). Horses: mares exhibited a moderate correlation ($R=0.41$; $P < 0.05$) between MET and RT, however for foals correlations were not significant ($R=0.16$; $P=0.22$). When mares and foals were combined the correlation was moderately strong across all horses ($R=0.65$; $P < 0.01$). Gilts: the relationship between MET and RT was not significant ($R=-0.06$; $P=0.50$). The dynamic range of RT and MET obtained was narrow for dairy cattle (1.3 and 3.1 °C) and gilts (1.2 and 4.4 °C) and broader for beef steers (3.7 and 6.1 °C) and horses (2.2 and 5.6 °C), respectively. These data indicate that the effectiveness of ocular thermography as an assessment of body temperature may be species, breed and age dependent, and, when significant, were generally moderately correlated with RT overall. Nevertheless, ocular DITI may have application in screening for animals that are lower or higher than an expected normal range.

Key Words: Thermography, Eye, Temperature

W173 Description and summarization of reticular core-body temperatures obtained from an automatic temperature recording system. J. M. Bewley*¹, D. C. Batson², and M. M. Schutzi¹, ¹Purdue University, West Lafayette, IN, ²MaGiiX Inc., Post Falls, ID.

Automatic temperature recording may be used for dairy management and allow early detection of disease, estrus, heat stress, and the onset of calving. The MaGiiX™ Cattle Temperature Monitoring System (CTMS, MaGiiX Inc., Post Falls, ID) utilizes a passive bolus equipped with a temperature sensor, a panel reader placed at a parlor entrance or exit to query the bolus, and a software package to collect, analyze, and view data. The biologically inert bolus resides in the cow's reticulum and is queried each time the cow passes the reader (e.g. two or three times per day after milking). Ambient temperature (AT) and humidity (AH) are also measured for each observation. Reticular temperatures (RT) were monitored for a period of ten months (3/20/2005-1/24/2006) for a moderate-sized dairy in Montana milking 3 times daily. Unadjusted mean RT for 37,684 observations during this period was 103.0°F (± 0.9). A mixed model including the effects of milking, date, AT, AH, and random cow, was used to compare the effects of morning, afternoon, or evening milking on RT. The RT differed by milking ($P < 0.001$) with LS Mean RT of 103.0°F (± 0.04), 102.8°F (± 0.04), and 103.2°F (± 0.04) for morning, afternoon, and evening milkings, respectively. The RT was weakly correlated with AT ($r=0.050$, $P < 0.001$), temperature humidity index ($r=0.051$, $P < 0.001$), and AH ($r=-0.023$, $P < 0.001$). Interpreting high RT to identify cows for further examination or monitoring is problematic. Strictly designating cows with RT greater than 103.5°F, 104.0°F, or 104.5°F as being elevated resulted in 19.0%, 6.7%, and 2.6% of cows identified, respectively. Contrastingly, 1.6% of cows were identified as having a high RT using a cut-off of +2 standard deviations while only 0.4% were identified using a cut-off of +3 standard deviations. Within milking variation (SD) of RT was correlated ($p < 0.01$) with within milking, average AT ($r=0.103$), and AH ($r=-0.226$), and within milking SD of AT ($r=0.127$).

Key Words: Temperature monitoring, Disease detection, Biosensors

W174 Qualitative assessment of the irrigation water from separated and aerated flushed dairy manure. M. Hollmann^{*1}, K. F. Knowlton¹, C. M. Parsons¹, and T. N. Rensch², ¹Virginia Polytechnic Institute and State University, Blacksburg, ²Integrity Nutrient Control Systems, Inc., Chambersburg, PA.

The objectives were to monitor for one year final irrigation water after separation of solids, and settling and aeration in three tanks on a 140-cow flushed freestall dairy with sawdust bedding. The flushed slurry was separated (screen sizes 0.79 and 3.18 mm). The liquid flowed into a 400 m³ settling basin, then via gravity into a tank (2.3 Dm³), and was pumped into the next two successive tanks (2.3 and 4.3 Dm³). The third tank provided the flush and irrigation water. An aerator (pump volume: 5 kg O₂/h) supplied air at a surface depth of 45 cm in each tank. On 21 dates volumes and constituents of the flushwater were determined, and the effects of period (Nov. to Apr. 2005, Apr. to July 2005, Aug. to Dec. 2005) on its composition were analyzed using Proc GLM in SAS. The manure system was primed with 5 Dm³ fresh water at startup (July 2004). Daily fresh water input ranged from 34 to 56 m³. Concentrations of solids and nutrients were lowest in the first period. The tanks were pumped down dramatically in Apr. Total, total suspended, volatile, and volatile suspended solids concentrations rose 3, 9, 4, and 8-fold in period two (13.7, 10.9, 9.4, and 8.5 g/l), and dropped in period three (7.0, 3.6, 3.9, and 3.0 g/l, respectively). Total P (63, 253, 147 mg/l), total Kjeldahl N (425, 986, 594 mg/l), and chemical oxygen demand (2.5, 13.5, and 5.4 g/l) were lowest in period one, and highest in period two. Nitrate (0.62 mg/l), nitrite (6.73 µg/l), and pH (8.0) did not change. Dissolved O₂ (1.40, 0.35 and 2.05 mg/l) and oxidation-reduction potential (84, -110, and 47 mV) were lowest in period two. Low initial concentrations were likely due to dilution. After perturbation it took four months for solid and nutrient concentrations to decline and stabilize. Continued sampling will be used to assess whether the values observed since Aug, 2005 are sustainable values for this system.

Key Words: Aeration, Manure composition, Irrigation

W175 Chemical parameters, particle and nutrient removal with separation, settling, and aeration in flushed dairy manure. M. Hollmann^{*1}, K. F. Knowlton¹, C. M. Parsons¹, and T. N. Rensch², ¹Virginia Polytechnic Institute and State University, Blacksburg, ²Integrity Nutrient Control Systems, Inc., Chambersburg, PA.

Data were collected for one year from a working manure system consisting of a mechanical screen separator, gravitational settling basin (SB), and three aerated storage tanks in series. The manure from 140 lactating dairy cows was flushed with ~ 40,000 L recycled wastewater four times per day. The blend was separated to solid and liquid portions by a mechanical solid-liquid manure separator consisting of two concave screens, pore size 0.79 mm (screen 1) and 3.18 mm (screen 2). The liquid portion flowed into a SB and by gravity into the first aerated tank (pump power: 5 kg O₂/h). The wastewater was pumped into sequential aerated tanks, with the third tank supplying the flush water. Composite samples of flushed slurry and effluents from the separator, SB, and tanks 1, 2, and 3 were taken every other week (n=14) and then monthly (n=7). Weighted results were analyzed using Proc Mixed with site and date in the model and date as a repeated measure. Mechanical separation of the blend, including the solids and nutrients from the flushwater, reduced total (TS) and volatile solids (VS) by 19 and 25%, total Kjeldahl N (TKN) by 9%, total P (TP) by 18%, and chemical oxygen demand (COD) by 17%. The SB reduced TS by 11%, VS by 12%, and TKN and TP by 10%. The combined effect of aeration and settling in tanks 2 and 3 decreased TS and VS

by 22% and 24%, respectively. Nitrates, TKN, and TP were reduced by 49%, 14%, and 13%. Ortho-P and nitrite concentrations remained steady. The combined tanks reduced COD by 21%, while dissolved oxygen increased from 0.4 to 1.1 mg/l, and the oxidation-reduction potential rose from -230 to 16 mV. Separation of flushed dairy manure with subsequent settling and aeration effectively removed particles and nutrients from the wastewater. Aeration improved dissolved oxygen content and oxidation-reduction potential.

Key Words: Aeration, Manure composition and treatment, Separation

W176 Prediction of ammonia emission from dairy cattle manure based on milk urea N: The relationship of milk urea nitrogen to urine urea nitrogen excretion. S. A. Bugos^{*}, E. J. DePeters, D. Ledgerwood, and J. G. Fadel, *University of California, Davis.*

Ammonia emission from dairy cattle manure occurs when urea excreted in urine reacts with urease produced by microorganism in feces, on barn floors and in soil. The objectives of this study were to assess the relationship between urinary urea N excretion (UUN; g/d) and milk urea N concentration (MUN; mg/dl) and to test whether the relationship was affected by stage of lactation and dietary CP content. Twelve lactating multiparous Holstein cows were randomly selected and blocked into three groups of four cows intended to represent early (123 ± 26 DIM; mean ± SD), mid (175 ± 3) and late (221 ± 12) lactation. Cows within stage of lactation were randomly assigned to a treatment sequence within a split-plot Latin square balanced for carryover effects. Stage of lactation formed the main plots (squares) and dietary CP levels (14, 16, 18 and 20 % diet DM) the subplots. Graded amounts of urea were added to the basal TMR to linearly increase dietary CP content of rations while maintaining the concentration of all other nutrients similar among treatments. The experimental periods were 7 d in length, with d 1 to 6 used for adjustment to diets and d 7 used for total collection of urine and feces as well as milk and blood sample collection. Dry matter intake and yield of milk, fat, protein, lactose and urea N declined progressively with lactation stage. The concentration of urea in milk, plasma and urine and urea output in milk and urine increased in response to a linear increase in dietary CP content. The relationship between UUN and MUN differed among lactation stages. The following equations were obtained for early and late lactation and mid lactation cows, UUN = 18.43 (± 2.03) × MUN - 0.16 (± 0.06) × MUN² and UUN = 14.95 (± 0.59) × MUN, respectively. The observed MUN values ranged between 5 and 26 mg/dl for midlactation cows and between 7 and 32 mg/dl for early and late lactation cows. Milk urea N may be a useful tool to predict the amount of urea N excreted in urine as an estimate of ammonia volatilization potential from dairy cattle manure.

Key Words: Milk urea nitrogen, Urine urea nitrogen Excretion, Ammonia emission

W177 Prediction of ammonia emission form dairy cattle manure based on milk urea N: The relationship of milk urea nitrogen to ammonia emission. S. A. Burgos^{*}, N. Marcillac, J. G. Fadel, F. M. Mitloehener, and E. J. DePeters, *University of California, Davis.*

The objectives of this study were to determine the effect of stage of lactation and dietary CP level on the composition of and NH₃ emission from dairy cattle manure and to evaluate the potential of milk urea N concentration (MUN) as a predictor of NH₃ emission from dairy cattle manure. Twelve lactating multiparous Holstein cows were randomly selected and grouped by lactation stage (four early, mid and late lactation) and fed linearly increasing dietary CP levels (14, 16, 18

and 20 % diet DM) by supplementation of a basal TMR with graded amounts of urea. The experimental design was a split-plot Latin square with stage of lactation forming the main plots and dietary CP content the subplots. The experimental periods were 7 d in length, with d 1 to 6 used for adjustment to diets. Composite urine and fecal samples were taken from urinary and fecal 24-h total collection periods of d 7 of the experimental period. A flux chamber system was used to measure NH₃ emission over a 24- h period from slurries prepared by combining feces and urine in the proportions in which they were excreted for each treatment. The proportion of urine and the initial concentration of urea N in slurry increased linearly with dietary CP content, while the DM varied inversely. There were no differences in initial slurry NH₃ concentration. Ammonia emission increased linearly (2.75, 3.99, 5.75 and 7.97 g N/h) with treatments. Cumulative N emission from fresh slurries represented 12% of N intake of cows in the basal TMR and increased linearly up to 20% for cows fed the highest CP level and progressively with lactation stage (14, 15 and 16% for early, mid and late lactation, respectively). The relationship between ammonia emission and MUN was linear over the range of MUN values observed and was not different between stages of lactation. The following equation is proposed to predict NH₃ emission from dairy cattle manure based on MUN: NH₃ emission (g N/h) = 0.3 (± 0.02) × MUN (mg/dl).

Key Words: Milk urea nitrogen, Urine urea nitrogen excretion, Ammonia emission

W178 Effect of frequency of irrigation in growth and vermicompost chemical parameters of red earthworm (*Eisenia* spp). J. A. Hernandez¹, S. Pietroseoli^{1*}, A. Faria¹, R. Canelon², R. Palma², and J. Martinez¹, ¹Facultad de Agronomia, La Universidad del Zulia, Maracaibo, Zulia, Venezuela, ²Proyecto FONACIT, Maracaibo, Zulia, Venezuela.

A semi-commercial scale experiment was conducted to evaluate the effect of irrigation frequency on the growth of red earthworms (*Eisenia* spp.) and the chemical properties of the resulting vermicompost. The experiment was conducted in Zulia state, Venezuela. Frequency of irrigation tested were none (N), once (O) or twice (T) a week. Earthworms (2000/m²) were deposited in 1-m² concrete containers (199.0 ± 0.39 mg/earthworm). The N containers were covered to avoid water loss. Each container was considered an experimental unit. Bovine manure (0.15m³) was used as substrate. At the beginning of the trial, all treatments received 24 L of water. Biomass was measured every 24 days, and the first 40 earthworms found in the top of each container were weighed. Cocoon production was determined at 42 days by counting cocoons that were found in five 240 cm³ sub-samples of substrate. Final biomass was determined at day 92, weighing all earthworms located in two quarters of each container. Vermicompost was chemically characterized for OM, P, K, Ca, Mg, Zn, Fe, Mn, and Cu concentrations and pH and electrical conductivity were measured. Humidity of the substrate was established every 21 days through a gravimetric method. A completely randomized design with 5 observations per treatment was used. Statistical differences were established for biomass at day 84, with the heaviest earthworms observed in N (193.26 ± 0.22 mg/earthworm) and the lightest in O (111.05 ± 8.77 mg/earthworm). Cocoon production differed (*P* < 0.05) between T (69.2 ± 0.03 cocoons/240 cm³) and O (33.4 ± 4.86 cocoons/240 cm³), whereas N was similar to the others treatments (48.9 ± 1.41 cocoons/240 cm³). No differences were established for final earthworm biomass and the chemical characteristics of vermicompost. Frequency of irrigation affected biomass and cocoon production

of red earthworms. It is suggested that covering the containers is a practical management practice to supply sufficient humidity under hot conditions to obtain adequate earthworm performance. Collateral benefits include reduction of labor required for irrigation activities.

Key Words: Earthworm, Irrigation frequency, Biomass

W179 Distribution of phosphorus and nitrogen when dairy manure is separated into solids and liquids. Z. Wu* and D. Burns, Pennsylvania State University, University Park.

The distribution of P and N when dairy manure is separated into solids and liquids was determined using an 850-cow farm. Manure in the collection pit was pumped under agitation to a stationary screw press separator (Fan Separator GmbH; Germany) and subjected to double screens with 3 and 1 mm pore openings. The farm used manure solids for bedding, and when bedding material was needed the exhaust plate of the screw press separator was set up to produce drier solids (23% DM, bedding). At all other times the press was set to result in solids that were less dry and used for field spreading (19% DM, spreading). On 7 occasions the separator was operated to produce solids for bedding or spreading for 20 min, resulting in 14 collections. For each collection, the amount of DM of the manure processed (influent) was estimated from volume, specific gravity, and DM content. The amount of DM of separated solids was calculated from wet weight and DM content, and the amount of DM of liquids was calculated by difference. Distribution of N and P in solids and liquids was calculated based on these DM amounts and nutrient concentrations. Approximately 97% of the P and N in processed manure was accounted for in separated solids and liquids. The recovery in solids was 48.2 and 51.4% for DM, 12.5 and 15.1% for P, and 22.7 and 25.7% for N, when manure was processed to produce solids suitable for bedding and spreading, respectively. Increasing the tightness of the screw separator reduced the recovery of DM, P, and N in solids, and most of the P and N in dairy manure were associated with liquids after separation.

Table 1.

Item	Bedding	Spreading	SEM	<i>P</i>
Influent DM, kg	353.0	361.6	10.2	0.58
Solid DM, kg	168.3	185.6	3.3	0.01
Liquid DM, kg	184.7	175.8	7.6	0.45
Influent P, kg	2.54	2.53	0.08	0.94
Solid P, kg	0.30	0.38	0.01	0.01
Liquid P, kg	2.16	2.08	0.07	0.46
Influent N, kg	10.07	10.16	0.30	0.84
Solid N, kg	2.22	2.60	0.07	0.01
Liquid N, kg	7.82	7.30	0.27	0.23
DM recovery in solids, %	48.2	51.4	0.7	0.01
P recovery in solids, %	12.5	15.1	0.5	0.01
N recovery in solids, %	22.7	25.7	0.7	0.02

Key Words: Manure, Phosphorus, Nitrogen

W180 Effects of essential oils on viability of *Escherichia coli* O157:H7 in treated beef cattle manure slurries and on prevalence from treated feedlot surfaces. J. E. Wells*, E. D. Berry, and V. H. Varel, USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.

Escherichia coli O157:H7 is commonly found in cattle waste and its survival in manures is a concern for the environment and food safety.

To determine the potential antimicrobial effects of different plant essential oil additives on this zoonotic pathogen, a selected strain of *E. coli* O157:H7 with known tolerance to the manure environment was inoculated into beef cattle manure slurry treatments (n = 3 reps/trt). Fresh feces were collected from pens of cattle fed a finishing ration (83% rolled corn), blended with urine and plant essential oil additives, and inoculated with streptomycin-resistant *E. coli* O157:H7 strain ATCC 43895. On d 0, a 1 g sample from each inoculated slurry was diluted and viable counts were determined by plating onto agar medium with streptomycin. Viable counts were determined daily until no longer detectable. In mixed slurries without additives, the decreases in viability of *E. coli* O157:H7 (death rate, 0.427 log₁₀ colony forming units per gram feces per day) were similar and no viable counts were recovered after 12 d. Death rates of *E. coli* O157:H7 were 5.5-fold faster ($P < 0.05$) in manure slurries treated with thymol and were 2.8- to 2.9-fold ($P < 0.05$) faster in manure slurries treated with terpineol, geraniol, plinol, and glidox when compared to the non-treated control slurries. In further studies, terpineol and thymol applications were evaluated on feedlot surfaces (3 pens/trt) to control *E. coli* O157 prevalence over a 4-wk period in summer 2005. Terpineol application did not affect *E. coli* O157 prevalence in soil samples compared to untreated pens, but thymol application reduced prevalence by more than 50% ($P < 0.05$). These experiments suggest that some essential oils may control pathogens in cattle waste slurries and on feedlot surfaces. Additional studies with these compounds in the feedlot are needed to determine if higher concentrations and/or season affect pathogen prevalence.

Key Words: Cattle manure, Pathogens, Essential Oils

W181 Evolution of ¹⁵N abundance in cattle manure in relation to cumulative ammonia losses. A. N. Hristov*¹, L. Campbell¹, and J. H. Harrison², ¹University of Idaho, Moscow, ²Washington State University, Puyallup.

The objective of this experiment was to investigate the relationship between ¹⁵N abundance of cattle manure and cumulative ammonia losses during storage. Fresh spot fecal and urine samples were collected from randomly selected lactating dairy cows fed on the same diet from seven commercial dairy farms in the Pacific Northwest (15 cows/farm). Composite fecal and urine samples were transported to the laboratory and used to study ammonia losses in a closed system *in vitro* apparatus. Feces were mixed with urine (2:1 ratio) and incubated for 14 days. Cumulative ammonia loss was estimated based on daily emissions and daily manure and ammonia samples were analyzed for ¹⁵N abundance. Overall ammonia losses varied significantly among manure samples averaging 341±81.9 mM in 14 days (minimum and maximum of 130 and 749 mM, respectively). Cumulative ammonia losses curves were fitted to an exponential rise to a maximum model of the type: $f=y_0+a*(1-\exp(-b*x))$ ($R^2 = 0.991$ to 0.999). The average rate of ammonia released from manure was 0.06±0.010 mM/d (minimum and maximum of 0.03 and 0.10 mM/d, respectively). Average ¹⁵N abundance ($\delta^{15}N$) of ammonia emitted from manure was -19.9±0.92‰. Due to the loss of highly depleted in ¹⁵N ammonia, the ¹⁵N abundance of the residual manure increased ($P < 0.001$) from an average of 4.6±0.47‰ (day 1) to 7.6±0.34‰ (day 14 of the incubation). Simple correlations between cumulative ammonia losses and ¹⁵N abundance of manure N ranged from $r = 0.70$ to $r = 0.92$ ($P = 0.005$ to $P < 0.001$). The relationship between manure $\delta^{15}N$ and the cumulative ammonia loss was linear ($P < 0.001$): Cumulative ammonia loss = -406.2 (SE = 67.73) + 102.3 (SE = 7.76) manure $\delta^{15}N$ (farm was a random effect). This study demonstrated that ¹⁵N abundance of the ammonia emitted

from cattle manure during storage is relatively constant and $\delta^{15}N$ of aged manure could potentially be used to predict ammonia emissions from cattle manure.

Key Words: Ammonia emission, Cattle manure, Stable isotope

W182 Environmental perspective of nitrogen use efficiency in dairy farms. H. Arriaga¹, M. Pinto¹, P. Merino¹, and S. Calsamiglia*², ¹NEIKER A.B. Basque Institute for Agricultural Research and Development, Basque Country, Spain, ²Universitat Autònoma de Barcelona, Faculty of Veterinary, Barcelona, Spain.

In intensive farming areas of the European Union, reduction of N losses from animal husbandry is a major concern. A survey was conducted on 64 Basque commercial dairy farms from July-2003 to April-2004 to determine the efficiency of N utilization in dairy farms. Data on management practices, including herd size (ranged from 19 to 300 lactating cows), production level (ranged from 5541 to 12166 kg/cow/year), DMI (ranged from 14.9 to 26.7 Kg/cow/day), feeding system (TMR, grass silage based non-TMR and purchased complete feed), number of feeding groups (one or two) and slurry spread area (ranged from 9 to 215 Ha), and samples of ration ingredients, milk tank, faeces and urine were collected from lactating cows in each farm and analyzed for N content. The CNCPS 5.0 model was used to estimate daily faecal and urinary excretion volumes. Mean N utilization efficiency (NUE) was 26.1% (SD = 3.0), ranging from 19.2% to 32.3%. Highest NUE was achieved with 3.8 kg/d of CP and 22.4 kg/d of DM intakes. Milk yield was positively correlated to NUE ($r^2 = 0.30$). Feeding systems and having different feeding groups did not influence NUE. A multivariate regression model with overall N excretion at farm level (NEFL) as a dependant variable indicated that NEFL expressed in g/d was dependent on the number of animals per farm ($r = 0.22$) and CP intake ($r = 0.34$), and NEFL per Ha (g/d/ha) was mostly dependent on herd size and slurry spread area. At average NUE, NEFL ranged from 366.8 g/d/ha to 935.9 g/d/ha. It is concluded that NUE may be improved by adjusting CP intake and increasing average milk production per cow. At farm level, an environmental approach requires NUE interpretation together with slurry spreading area and the number of cows per farm to minimize N excretion.

Key Words: Nitrogen efficiency, Environment

W183 The effects of floor space on pig growth performance and carcass characteristics in a commercial wean-to-finish facility. B. A. Peterson*¹, M. Ellis¹, B. F. Wolter², R. Bowman², J. M. DeDecker¹, and M. J. Ritter¹, ¹University of Illinois, Urbana, ²The Maschhoffs, Inc., Carlyle, IL.

The effects of floor space on growth performance and carcass characteristics of pigs housed in a commercial wean-to-finish production system were evaluated in a study that used 1740 crossbred barrows from four commercial genotypes. The study was carried out as a randomized complete block design with five floor space treatments: 0.57, 0.61, 0.65, 0.69, and 0.73 m²/pig. Pigs were housed in groups of 29 and pen sizes were adjusted to the desired floor spaces. At weaning (17 ± 1 d), pigs were individually weighed and formed into outcome groups of five pigs based on similar genotype and weight and randomly assigned to one of the five floor spaces. The study was carried out between weaning and ~127 kg BW. Pigs were weighed at weaning and wk 4, 8, 12, 14, 16, 18, and 19 post-weaning and ~127 kg BW. An eight-phase-feeding program formulated to meet or exceed NRC (1998) recommendations was used and pigs had ad libitum access

to feed and water. Feed delivered to each feeder was recorded. At an average pen weight of 127 kg, the entire pen was shipped to a commercial abattoir for harvest and carcass measurements. From weaning to wk 19 post-weaning, pigs at 0.73 and 0.69 m²/pig had higher ADG (871, 862, 853, 848, 830 g/day for 0.73, 0.69, 0.65, 0.61, and 0.57 m²/pig, respectively), ADFI (1.88, 1.85, 1.82, 1.82, 1.81 kg/day for 0.73, 0.69, 0.65, 0.61, and 0.57 m²/pig, respectively) and were heavier (122.4, 121.6, 120.1, 119.4, 117.2 kg for 0.73, 0.69, 0.65, 0.61, and 0.57 m²/pig, respectively) than pigs at 0.65, 0.61, and 0.57 m²/pig. Floor space had no effect on morbidity and mortality. Pigs at 0.57 m²/pig had less backfat and higher percent lean than those at 0.65, 0.69, and 0.73 m²/pig. These results suggest that 0.69 m²/pig is the optimum floor space for maximizing pig growth performance in wean-to-finish systems which is less than commonly recommended floor spaces.

Key Words: Pigs, Growth performance, Floor space

W184 Association of number of services and reservice intervals with reproductive performances in female pigs on commercial farms. Y. Takai* and Y. Koketsu, *Meiji University, Kawasaki, Kanagawa, Japan.*

Increased number of services and prolonged reservice intervals (RI) lowered herd productivity. Our objectives were to observe a reservice occurrence and RI; farrowing rate and subsequent pigs born alive (PBA) by the number of services and RI; and an interaction between the number of services and parity with the reproductive performances. We used 115,731 serviced and 94,086 farrowed female pig records from 117 farms in 2002 in this study. A service was defined as one or more mating events in a 10-d time period. The number of services were categorized into three groups: first, second, and third or later-services. Six groups of RI were formed: 11 - 17, 18 - 24, 25 - 38, 39 - 45, 46 - 107, and 108 - 150 d. Farrowing rate and PBA by the number of services and the RI groups were compared using the statistical mixed models. All models included farm and mated mo as a random effect. The proportions of the serviced female pigs by first, second, and third or later-services were 88.6, 9.7, and 1.7%, respectively. Farrowing rate decreased from 83.7 to 48.4% as the number of services increased from first to third or later-services ($P < 0.05$). The second-service group had 0.4 or more PBA than the first-service group at parity 1 and 2 ($P < 0.05$). No difference in PBA was found between the number of service groups at parity 0 and ≥ 3 . The mean of the RI was 44.4 ± 0.3 d. The proportions of the RI 18 - 24 and 39 - 45 d groups were 39.3 and 12.3%, respectively. As parity increased from 0 to ≥ 6 , the proportions of the RI 18 - 24 d group increased from 37.6 to 44.1%, while the proportions of the RI 39 - 45 d group decreased from 13.3 to 8.9% ($P < 0.05$). The RI 18 - 24 d group had a lower farrowing rate than the RI 25 - 38 d group ($P < 0.05$), but had farrowing rates similar to the RI 11 - 17, 39 - 45, 46 - 107, and 108 - 150 d groups. No difference in PBA was found between the RI groups. In conclusion, increasing farrowing rate at first service, and minimizing the RI in reserviced females improved herd productivity.

Key Words: Days to reservice, Return to service

W185 Variability and repeatability of gestation length across parity associated with reproductive performance in a cohort of gilts on commercial farms. Y. Sasaki* and Y. Koketsu, *Meiji University, Kawasaki, Kanagawa, Japan.*

Assistance to sows and piglets during farrowing and early lactation enables producers to decrease perinatal mortality. It is useful for producers to estimate gestation length (GL) and the due birth dates to farrowing in individual sows, because early inductions of parturition cause high neonatal mortality. The objectives were to observe the GL across parities; repeatability and correlation of the GL between consecutive parities; and the associations between GL and three litter size variables (total pigs born, pigs born alive, and dead piglets). An observational study over 6 yr was conducted by using 94 farms containing 67,028 farrowed records of 14,140 gilts born during 1999. Variance components analysis was used to determine repeatability of GL. Partial correlation analysis was done using total pigs born as a controlled variable. The GL was categorized into seven groups: ≤ 112 , 113, 114, 115, 116, 117, and ≥ 118 d. Mixed models were used to analyze the associations between GL and the litter size variables. Random effects were farm, farrowing yr, the four periods of three-mo intervals, and the yr x the four periods. The means of GL across parities were from 115.2 to 115.4 d. The GL ranged from 105 to 125 d. The proportions of sows with GL 114, 115, and 116 d in all farrowing events were 19.2, 30.8, and 22.2%, respectively. A difference of frequency distributions of GL across parities was not found. The GL between consecutive parities from 1 to 6 were correlated ($0.41 \leq r \leq 0.58$; $P < 0.05$). The repeatability of GL was 0.47. Sows with GL 113 - 116 d had greater pigs born alive than those with GL ≤ 112 and ≥ 117 d ($P < 0.05$). Sows with GL ≤ 112 d had greater dead piglets than those with GL ≥ 113 d ($P < 0.05$). The GL became shorter, as total pigs born increased. Sows farrowed ≥ 14 pigs had 0.7 d shorter GL than those with ≤ 8 pigs ($P < 0.05$). High repeatability and correlations in the GL were found in this study. Keeping records of GL at each parity is recommended to estimate subsequent GL.

Key Words: Management, Parturition, Sows

W186 Lifetime assessment of sows mated 4 to 6 days after weaning in commercial breeding herds. Y. Hoshino* and Y. Koketsu, *Meiji University, Kawasaki, Kanagawa, Japan.*

Our objectives were to examine weaning-to-first-mating interval (WMI) across parities; probability of sows being mated 4 - 6 d postweaning at subsequent parity; repeatability and correlations in WMI between consecutive parities; and an association between lactation length (LL) and probability of sows being mated 4 - 6 d postweaning. An observational cohort study over 6 yr was conducted by using 94 farms containing 58,144 WMI records of 14,140 gilts born during 1999. Five groups of WMI were formed: 0 - 3, 4 - 6, 7 - 20, 21 - 27, and ≥ 28 d. Spearman rank correlation analysis was done. Variance components analysis was used to determine repeatability of the WMI groups. Mixed models were used to analyze the associations of the WMI groups and LL with the probability of sows being mated 4 - 6 d postweaning at subsequent parity. Random effects were farm, farrowing yr, the four periods of three-mo intervals, and the yr x the four periods in all models. The overall proportion of WMI 4 - 6 d group in all WMI groups was 81.8%. As parity increased from 1 to ≥ 7 , the means of WMI decreased from 9.7 to 5.8 d, and the proportion of WMI 4 - 6 d increased from 67.0 to 90.4% ($P < 0.05$). The WMI 4 - 6 d group had the highest farrowing rate, and had greater subsequent pigs born alive than the WMI 7 - 20 d group ($P < 0.05$). The correlation coefficients

of WMI between consecutive parities were low ($0.11 \leq r \leq 0.18$; $P < 0.05$). The repeatability of WMI was low (0.08). The probabilities of sows being mated 4 - 6 d postweaning at subsequent parity in the WMI 0 - 3, 4 - 6, 7 - 20, 21 - 27, and ≥ 28 d were 82.6, 88.4, 73.9, 75.6, and 69.6%, respectively. The probability of sows being mated 4 - 6 d increased from 59.8 to 83.0% as LL increased from 8 to 31 d ($P <$

0.05). These results indicated that sows in any WMI group were more likely to be mated 4 - 6 d postweaning at subsequent parity. Increasing LL at subsequent parity can be used for sows with prolonged WMI to increase the probability of sows being mated 4 - 6 d postweaning at subsequent parity.

Key Words: Farm management, Weaning-to-first-mating interval

Ruminant Nutrition: Analytical Techniques

W187 Can the chemical composition of the whole body of a goat be estimated from parts of its body? I. A. M. A. Teixeira^{*1,4}, K. T. Resende¹, J. M. Pereira Filho², M. M. Salin¹, R. A. Gomes¹, R. C. Canesin¹, and L. O. Tedeschi³, ¹Universidade Estadual Paulista/FCAV, Jaboticabal, SP, Brazil, ²Universidade Federal de Campina Grande, Patos, PB, Brazil, ³Texas A&M University, College Station, ⁴FAPESP, São Paulo, SP, Brazil.

Two trials were conducted to determine which part of the empty body of Boer x Saanen male kids can be used to predict chemical composition of the whole body. In the first trial, kids were fed *ad libitum* and were slaughtered at 5, 10, and 15 kg BW. Eighteen animals were allocated to one of three nutritional levels (*ad libitum* and restricted to 30 and 60% of the *ad libitum*), within six groups. When the animal in the *ad libitum* nutritional level reached 15 kg BW, all animals in the group were slaughtered. In the second trial, kids were fed *ad libitum* and slaughtered at 15, 20, and 25 kg BW. Similar to trial 1, twenty-one animals were allocated to three nutritional levels into seven groups. The animals in a group were slaughtered when the animals in the *ad libitum* nutritional level reached 25 kg BW. The following body parts were used: head plus feet, hide, organs (all viscera, blood and abdominal fat), neck, shoulder, ribs, loin, leg, whole 9 to 11th ribs and right half carcass. The means of chemical composition obtained for each treatment (body and body parts), within slaughter weight and nutritional level, were subjected to principal component and cluster analyses. The whole 9 to 11th ribs and neck had the highest accuracy in predicting the body composition of the kids. The removal of the whole 9 to 11th ribs to measure body composition damaged the retail price of the carcass. Our experiment indicated the composition of the neck was as accurate as the whole 9 to 11th ribs to estimate body composition. Additionally, fat concentration in the neck was accurate to predict the composition of all body nutrients and energy. Therefore, we recommend the use of the neck to estimate the body composition.

Key Words: Indirect method, Multivariate, Neck

W188 Calibration of a respiratory chamber for calorimetry studies. N. Rodriguez^{*1}, W. Campos¹, and M. Lopez², ¹Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, ²Consejo Superior de Investigaciones Científicas, Granada, España.

The influence of CO₂ on O₂ determination by a paramagnetic analyzer was performed using mixtures of O₂, CO₂ and N₂ with the following proportions: 21:0:79; 21:0.5:78.5; 21:1:78 and 21:1:78. These gases were injected in the analyzers for four minutes and thereafter six samples were analyzed. This procedure was performed five times. The effect of CO₂ on O₂ determination was calculated by regression. To calibrate the system (analyzers + acrylic respiration chamber) atmospheric air, CO₂ (99.99%), CH₄ (99.99%) and N₂ (99.99%) were injected in the chamber for six h by a rate of 68.51L/min, 0.35L/min,

0.04L/min and 1.10L/min, respectively. These flows reproduce the respiratory exchanges of a lamb of 65 kg (nitrogen was used to reduce the O₂ concentration inside of the system). After the six h, atmospheric air was injected by a rate of 70L/min for more 14 h. The concentrations of gases inside the chambers and of atmospheric air that was inflowing were analyzed every eight minutes during the whole procedure (20 h). The volumes of the injected gases were determined by gravimetric method. The gases cylinders were weighted before and after the injection, then the following densities were considered: 1.964776786g/l for CO₂, 0.716205357g/l for CH₄ and 1.250892857g/l for N₂. The injection of gases mixtures in the oxygen analyzer resulted on the following equation: [O₂] = [O₂] - (0.0053X₂ + 0.0117X). This shows the necessity of using correction factors for the influence of CO₂ on O₂ determination by analyzers that use a paramagnetic principle. The system correction factors were 1.0379, 1.1885 and 1.0009 for determination of the volume of CO₂, CH₄ and O₂, respectively. It shows that the efficiency of gases determination was almost 100% suggesting a good performance of the system. To confirm those results measures of heat production of 12 lambs fed *ad libitum* with hay and concentrate (50%) were determined by open circuit respiratory exchanges. The values recorded varied from 330 to 539kJ/kg^{0.75} with an average of 434kJ/kg^{0.75} after 20 h of measurements for each animal. These values are similar to those found in the literature which suggest a good operation of the system.

Key Words: Respirometry, Calorimetry, Chamber

W189 Lipe, an external natural marker for digestibility studies. E. Saliba, N. Rodriguez^{*}, and D. Pilo-Veloso, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil.

Lignin from wood of eucalyptus was isolated and purified giving a hydroxyphenyl propane polymer called LIPE. It has been tested as an external marker of fecal production in digestibility trials. In rabbits, sheep and swine, dry matter digestibility, voluntary feed intake and fecal output were compared using LIPE and total fecal collection. Feed intake was not affected by marker, and fecal recuperation for rabbits was 99.3%, for sheep 96.9%, and for swine 102.6%. The LIPE marker was used to test fecal production, digestibility and metabolic energy content (ME) of various feed ingredients, compared with chromic oxide and total fecal production in chickens. Estimates of digestibility and ME content using LIPE were similar than those obtained with total fecal collection ($P > 0.05$). An experiment with Nelore esophageal fistulated steers was ran on pasture of *Brachiaria brizantha* CV. Marandu. Chromic oxide (CO) and LIPE were used to estimate fecal excretion and intake comparing different periods of adaptation to markers, three (CO3 and LIPE3) and 7 d (CO7 and LIPE7). Dry matter intake was estimated to be 2.12%, 2.09%, 2.16% and 2.10% of LBW for treatments CO3, LIPE3, CO7 and LIPE7, respectively, ($P > 0.05$) which are normally expected values. Fecal excretion estimated by LIPE was constant after 48 hours of initial dosage. When estimated

by chromic oxide it was constant after 72h. An experiment with four dry cows in metabolic crates using LIPE as a marker, fecal production was measured as total collection (a), estimated by LIPE in a sample of homogenized total feces (b) and by LIPE in a single spot sampling (c). Mean values of DM fecal excretion were 4.61kg (a), 4.47kg (b) and 4.46(c) with a CV of 7.3% ($P>0.05$). Studies of Nuclear Magnetic Resonance and Electronic Microscopy showed that original and fecal LIPE have the same ultra structure and identical spectra meaning that there was no modification during the passage through the intestine. The use of LIPE as a not expensive, not hazardous to the health or environment natural external marker, requires very simple preparation for analysis and can be accurately and rapidly assayed by Infra Red Spectroscopy.

Key Words: Marker, Digestibility, External

W190 Effect of choice of microbial marker and variation in solid-to liquid-associated bacteria proportion in duodenal contents on the estimation of duodenal bacterial nitrogen flow. B. Vlaeminck^{*1}, R. J. Dewhurst², and V. Fievez¹, ¹*Ghent University, Belgium*, ²*Lincoln University, New Zealand*.

Using data from four dairy cows fed diets varying in forage:concentrate ratio (80:20, 65:35, 50:50 and 35:65), we evaluated to what extent variation in solid- (SAB) and liquid-associated bacteria (LAB) proportions in duodenal bacteria affect the estimation of duodenal flow of bacterial N (BN). Differential centrifugation was used to separate SAB and LAB from rumen contents, collected four hours after the morning feeding. Adenine, cytosine and odd and branched-chain fatty acids (OBCFA) were determined both in SAB and LAB and used to estimate BN flow, using marker:N ratios. Differences in marker:N ratios between SAB and LAB were evaluated by a paired t-test and effects of bacterial marker and isolate on BN were tested using mixed model analysis. Marker:N ratios significantly differed between SAB (0.043, 0.059 and 0.090 g/g for cytosine, adenine and OBCFA, respectively) and LAB (0.062, 0.087 and 0.096 g/g). Average duodenal flow estimates of BN were 168, 246 and 209 g/d when SAB:LAB ratios of 0:1, 1:0 or 0.71:0.29 (as estimated from the OBCFA pattern of duodenal bacteria) were assumed and using cytosine as bacterial marker. Using adenine as bacterial marker, daily duodenal flows for these SAB:LAB ratios were 222, 335 and 283 g/d, whereas the effect of varying SAB:LAB ratio was considerably lower when using OBCFA as marker (220, 239 and 233 g/d). The results suggest that, depending on the marker used, changes in the proportions of SAB and LAB can have a substantial impact on estimated duodenal flow of bacterial N. However, differences among markers are also obvious, with current results suggesting OBCFA to be a more appropriate bacterial marker due to small differences in OBCFA:N ratio between SAB and LAB.

Key Words: Bacterial markers, Rumen

W191 Effect of centrifugal force on the recovery of markers in ruminal bacterial samples. A. N. Hristov^{*} and S. Zaman, *University of Idaho, Moscow*.

The objectives of this experiment were to: (1) study the effect of centrifugal force during preparation of samples from ruminal bacteria on ¹⁵N recovery and distribution between supernatant and pellets; and (2) compare the recovery of ¹⁵N with that of total purines. Three ruminally cannulated lactating dairy cows were used as donors of ruminal inoculum. The cows were fed a 60% forage:40% concentrate diet. At the day of the experiment and before the morning feeding, the

ruminal contents of the cows were labeled with (¹⁵NH₄)₂SO₄. Samples of ruminal contents were collected 30 min thereafter and filtered through a 100 μm fabric. The filtrate was used to prepare samples from the fluid-associated bacteria (FAB) and the solids retained on the fabric were used to harvest the solid-associated bacteria (SAB) after blending with buffer. Fluid samples containing FAB or SAB were centrifuged at 800 × g (Low) and aliquots of the supernatant were further centrifuged at 5,000, 15,000, and 24,000 × g (High). Ruminal phases (supernatants and pellets) from these centrifugations were analyzed for N, ¹⁵N, and total purines. Data were analyzed as a 4 (centrifugal force) × 2 (ruminal phase) factorial blocked by donor cow. ¹⁵N enrichment of FAB samples was greater ($P < 0.001$) and that of SAB lower ($P = 0.004$) in the supernatant than in the centrifugal pellets. For both FAB and SAB, concentration and recovery of N and ¹⁵N recovery were greater ($P < 0.001$) in the pellets than in the supernatants. Centrifugal force had no effect on ¹⁵N enrichment, N content, and ¹⁵N recovery of FAB or SAB supernatant or pellets ($P = 0.208$ to 0.930). The amount of N recovered in FAB pellets increased linearly ($P = 0.014$) with increasing the centrifugal force from Low to High. The distribution of marker between centrifugal pellets and supernatant from sonicated Low ruminal fluid was similar for ¹⁵N or purines (average ratio of 5:1; $P = 0.941$). These results indicate that centrifugal force has no effect of marker distribution or recovery during preparation of samples from ruminal bacteria.

Key Words: Centrifugal force, Ruminal bacteria, Marker

W192 Relationship between in situ dry matter disappearance and gas production technique. A. Taghizadeh^{*} and M. Hatami, *Tabriz University, Tabriz, East Azarbayjan, Iran*.

In vitro gas production technique and in situ dry matter disappearances were used to measure the gas production and disappearance of Iranian treated and untreated corn silage by formaldehyde and urea as test feeds. The corn silage samples were chopped to 2 cm length. Treatments contain CS: untreated corn silage, CSF: CS + 4 g/kg DM formaldehyde, CSU: CS + 10 g/kg DM urea, and CSFU: CS + 4 g/kg DM formaldehyde + 10 g/kg DM urea. The production of gas and in vitro DM disappearances of test feeds were measured in each vial after 0.0, 2, 12, 24 and 48 h of incubation. The results were analyzed using completely randomized design (CRD) in each incubation time with Duncan's multiple range test used for the comparison of means. Feeds were the only sources of variation considered. The in vitro gas production data and in situ DM and CP disappearances were in triplicate fitted to an equation of $p=a+b(1-e^{-ct})$; where (p) is the gas production and DM and CP at time, t, (a+b) is the fermentation of soluble and the insoluble (but with time fermentable) fraction, (c) is the fractional rate at which b is fermented per hour. The gas production of soluble and insoluble fraction (a+b) for CS, CSF, CSU and CSFU was (ml/g) 241.8, 240.0, 225.0 and 238.1, respectively. The fractional rate (c) was (%/h) 0.028, 0.023, 0.025 and 0.027, respectively. The DM soluble fraction (a) for CS, CSF, CSU and CSFU was (%): 3.81, 8.52, 7.79 and 6.62, respectively. The insoluble (but with time fermentable) fraction (b) was (%): 74.99, 63.4, 60.41 and 63.3, respectively. There was a close relationship between In Situ disappearance results and the gas production in incubation times ($p<0.01$). The relationship of DM disappearance and gas production results in CS, CSF, CSU and CSFU were obtained ($P<0.05$): 98.64, 98.09, 97.33 and 98.77, respectively. The high relationship of ruminal DM disappearance and gas production data showed that In situ disappearance technique can be proper replacement assay for gas production technique.

Key Words: Gas, Dry matter, Disappearance

W193 Relationship between in vitro dry matter disappearance and gas production technique. A. Taghizadeh*, M. Hatami, and G. A. Moghaddam, *Tabriz University, Tabriz, East Azarbayjan, Iran.*

In vitro gas production technique and in vitro dry matter disappearances was used to measure the gas production and disappearance of Iranian treated and untreated corn silage by formaldehyde and urea as test feeds. The corn silage samples were chopped to 2 cm length. Treatments contain CS: untreated corn silage, CSF: CS + 4 g/Kg DM formaldehyde, CSU: CS + 10 g/Kg DM urea, and CSFU: CS + 4 g/Kg DM formaldehyde + 10 g/Kg DM urea. The production of gas and in vitro DM disappearances of test feeds were measured in each vial after 0.0, 2, 12, 24 and 48 h of incubation. The results were analyzed using completely randomized design (CRD) in each incubation time with Duncan's multiple range test used for the comparison of means. Feeds were the only sources of variation considered. The in vitro DM disappearances and Gas production data were in triplicate fitted to a equation of $p=a+b(1-e^{-ct})$; where (p) is the gas production at time, t, (a+b) is the fermentation of soluble and the insoluble (but with time fermentable) fraction, (c) is the fractional rate at which b is fermented per hour. The gas production of soluble and insoluble fraction (a+b) for CS, CSF, CSU and CSFU was (ml/g) 241.8, 240.0, 225.0 and 238.1, respectively. The fractional rate (c) was (%/h) 0.028, 0.023, 0.025 and 0.027, respectively. and insoluble fraction (a+b) for CS, CSF, CSU and CSFU was (%) 70.33, 71.5, 80.94 and 71.65, respectively. The fractional rate of fermentation (c) was (%/h) 0.04, 0.0389, 0.0322 and 0.0401, respectively. There was a close relationship between in vitro disappearance results and the gas production in incubation times ($p<0.01$). The relationship of DM disappearance and gas production results in CS, CSF, CSU and CSFU were obtained ($P<0.05$): 88.11, 86.6, 87.01 and 87.12, respectively. The high relationship of ruminal DM disappearance and gas production data showed that in vitro disappearance technique can be proper replacement assay for gas production technique.

Key Words: Gas, Dry matter, Disappearance

W194 Relationship between in vitro gas production of ethanol extracted residue and NDF of corn silage and unfractionated corn silage. M. Hatami and A. Taghizadeh*, *Tabriz University, Tabriz, East Azarbayjan, Iran.*

In vitro gas production technique was used to measure the gas production of ethanol extracted residue (ETR) and NDF of corn silage and unfractionated (whole) corn silage. The corn silage samples were chopped to 2 cm length. Treatments contain UCS: unfractionated (whole) corn silage, ETR: residue insoluble in 90% ethanol, NDF: Isolated cell wall. The production of gas and in vitro DM disappearances of test feeds were measured in each vial after 2, 4, 8, 12, 16, 24, 36, 48, 72 and 96 h of incubation. The results were analyzed using completely randomized design (CRD) in each incubation time with Duncan's multiple range test used for the comparison of means. Feeds were the only sources of variation considered. The in vitro DM disappearances and gas production data were in triplicate fitted to a equation of $p=a+b(1-e^{-ct})$; where (p) is the gas production at time, t, (a+b) is the fermentation of soluble and the insoluble (but with time fermentable) fraction, (c) is the fractional rate at which b is fermented per hour. The gas production of soluble and insoluble fraction (a+b) for UCS, ETR and NDF was (ml/g) 241.8, 261.8 and 239.3, respectively. The fractional rate (c) was (%/h) 0.028, 0.0235, and 0.0268, respectively. There was a close relationship between in vitro gas production of UCS, ETR and NDF in incubation times ($P<0.01$). The relationship

of gas production results in UCS with ETR and NDF were obtained ($P<0.05$): 96.25 and 98.85, respectively. The high relationship of gas production data in UCS with ETR and NDF showed that obtained information of UCS can be proper replacement for required information of gas production of ETR and NDF.

Key Words: Gas, NDF, Corn silage

W195 Relationship between dry matter and crude protein disappearance using in situ technique. A. Taghizadeh* and M. Hatami, *Tabriz University, Tabriz, East Azarbayjan, Iran.*

In situ technique was used to determine of ruminal disappearance of dry matter (DM) and crude protein (CP) of Iranian treated and untreated corn silage by formaldehyde and urea as test feeds. The corn silage samples were chopped to 2 cm length. Treatments contain CS: untreated corn silage, CSF: CS + 4 g/Kg DM formaldehyde, CSU: CS + 10 g/Kg DM urea, and CSFU: CS + 4 g/Kg DM formaldehyde + 10 g/Kg DM urea. The disappearance of dry matter and crude protein of test feeds were measured at 0.0, 2, 4, 6, 12, 24, 36, 48, 72 and 96 h of incubation. The results were analyzed using completely randomized design (CRD) in each incubation time with Duncan's multiple range test used for the comparison of means. Feeds were the only sources of variation considered. The in situ DM and CP disappearances data were in triplicate fitted to a equation of $p=a+b(1-e^{-ct})$; where (p) is the disappearance at time, t, (a) is intercept and ideally reflects the fermentation of soluble and readily available, (b) is fermentation of the insoluble (but with time fermentable) fraction, (c) is the fractional rate at which b is fermented per hour. The DM soluble fraction (a) for CS, CSF, CSU and CSFU was (%): 3.81, 8.52, 7.79 and 6.62, respectively. The DM insoluble (but with time fermentable) fraction (b) was (%): 74.99, 63.4, 60.41 and 63.3, respectively. The DM fractional rate (c) was (%/h) 0.0256, 0.0247, 0.0292 and 0.0288, respectively. The CP soluble fraction (a) for CS, CSF, CSU and CSFU was (%): 5.61, 7.25, 9.21 and 8.8, respectively. The CP insoluble (but with time fermentable) fraction (b) was (%): 66.11, 55.55, 67.78 and 58.31, respectively. The CP fractional rate (c) was (%/h) 0.0306, 0.0277, 0.0232 and 0.0322, respectively. There was a close relationship between in situ DM and CP disappearance results in incubation times ($p<0.05$). The high relationship of DM and CP disappearance results in CS, CSF, CSU and CSFU were obtained (%) ($P<0.05$): 98.85, 99.42, 99.07 and 99.49, respectively. The high relationship of ruminal DM and CP disappearance data showed that in situ DM disappearance can be proper replacement assay for in situ CP disappearance.

Key Words: In situ, Dry matter, Crude protein

W196 Comparison of using a reflux apparatus or ANKOM Fiber Analyzer with sequential or direct analysis to evaluate the fiber content in various feeds. D. H. Kleinschmit*, D. J. Schingoethe, A. R. Hippen, and K. F. Kalscheur, *South Dakota State University, Brookings.*

Two types of apparatuses, a reflux apparatus (RA) and the ANKOM Fiber Analyzer (AFA), are currently being used for the fiber analyses of feeds. In addition, the measurement of the ADF concentration in feeds may be conducted by sequential analysis (S) following an NDF extraction or directly (D) with the original feed. The objectives of this study were to evaluate NDF content of various feeds using RA or AFA and ADF content using RA or AFA with D or S (RAD, AFAD, RAS, and AFAS). PROC Mixed was performed on each feed, with models: NDF = apparatus + residual, or ADF = apparatus + method + apparatus

× method + residual. The samples used were two sources of alfalfa hay (1 and 2), corn silage (1 and 2), dried distillers grains plus solubles (1 and 2), grain mixes (1 and 2), and TMR (1 and 2), and one source of soybean meal, soybean hulls, whole cottonseed, sunflower seeds, and feces. Six replicates were used for each analysis. With the exception of soybean meal and sunflowers, the NDF content was determined to be greater ($P < 0.05$) in samples analyzed with RA compared to AFA. Acid detergent fiber for alfalfa-1 (30.9 vs. 29.5%), feces (33.2 vs. 31.1%), soybean meal (8.7 vs. 5.9%), soybean hulls (47.0 vs. 45.7%), and TMR-1 (22.3 vs. 20.7%) was greater ($P < 0.05$) when measured with AFA versus RA. In addition, the ADF in alfalfa-1 (32.0 and 28.4%), corn silage-1 (27.8 vs. 25.6%) and 2 (28.0 vs. 26.5%), feces (34.0 vs. 30.3%), grain mix-2 (8.2 vs. 5.4%) soybean meal (9.0 vs. 5.6%), soybean hulls (46.9 vs. 45.8%), and TMR-1 (21.6 vs. 19.8%) and 2 (23.8 vs. 19.2%) was greater ($P < 0.02$) with D versus S. An interaction ($P < 0.05$) between apparatus and method was observed in corn silage-2, soybean meal, and soybean hulls, such that the decrease in ADF from AFAD to AFAS in these samples was much greater compared to the decrease in ADF from RAD to RAS. In conclusion, analysis with RA vs. AFA yielded increased values for NDF in most of the samples analyzed and decreased ADF in some of the samples. Analyzing samples with S decreased ADF in most feeds compared to D.

Key Words: Feed analysis, Feeds, Detergent fiber analysis

W197 A comparison of soluble true protein assays using three precipitating agents and filter pore sizes. D. A. Ross*, J. B. Robertson, and M. E. Van Amburgh, *Cornell University, Ithaca, NY.*

Protein in feeds for ruminants is separated into two primary categories based on solubility and the soluble pool is characterized by true protein

(TP) versus non-protein nitrogen (NPN). Tungstic acid (TA) is the preferred precipitating (PPT) agent as it chelates smaller peptides than trichloroacetic acid (TCA) but does not filter efficiently. The objective of this study was to improve the efficiency of the TP assay. Two criteria for improvement were identified. The PPT agent needs to chelate smaller peptides and the filtration step requires improvement in recovery of the chelated peptides. Nine feeds (1 alfalfa hay, 1 alfalfa silage, 3 feathermeals, 2 soy products and 2 hay crop silages), rumen fluid and trypticase were analyzed using three PPT agents: TA (Licitra et al., 1996; 16-h; 1.18 % final dilution.), a Stabilized TA (STA; phosphate buffered; 16-h; 1.11 %) and TCA (1-h; 10 %). Three different filters were also evaluated under vacuum for all PPT agents: 20, 6 and 1 um pore size filter papers. For each PPT and filter combination, N was determined for TP recovered on the filter and NPN in the filtrate. All samples were analyzed in duplicate. Results are expressed as percent of sample N recovered as TP or NPN and compared using GLM in SAS and Tukey's method to separate means. Among all filter combinations STA recovered 2.65 % more N in the TP than did TA ($P < 0.0001$) and 4.35 % more N than TCA ($P < 0.0001$). Trypticase, because of the range in peptide size, was considered the negative control and demonstrated the greatest range in precipitable TP values: 0.025, 21.0 and 33.09 % (TCA, TA and STA, respectively; $P < 0.005$). Without trypticase STA recovered 1.7 % more N in the TP than did TCA ($P < 0.0001$). The overall N recovery averaged 97.8 %. The 1 um pore filter recovered 0.5 % more TP than did the 6 um and 1.3 % more than the 20 um ($P < 0.0001$) while the 6 um recovered 0.8 % more TP than the 20 um ($P < 0.003$). In summary, the STA assay using either a 6 or 1 um filter under vacuum is more efficient than the current method.

Key Words: Tungstic acid, Stabilized tungstic acid, TCA

Ruminant Nutrition: Calves & Heifers – Dairy

W198 Rearing of dairy calves Sahiwal × Holstein fed with Arachis pintoï and sugar cane. J. Avellaneda-Cevallos*¹, P. Cansing-Yépez¹, W. Vera-Benavides¹, O. Montañez-Valdez², S. González-Muñoz³, J. Vargas-Burgos¹, J. Tuarez-Cobena¹, and R. Vivas-Moreira¹, ¹Unidad de Investigación Científica y Tecnológica, Facultad de Ciencias Pecuarias, Universidad Técnica Estatal de Quevedo, Quevedo, Ecuador, ²Centro Universitario del Sur, Universidad de Guadalajara, Guadajarara, México, ³Colegio de Postgraduados, Texcoco, México.

The substitution (0, 25, 50 and 75%) of the DM and the total protein (TP) of a commercial balanced (B) for the foraging peanut (P) (Arachis pintoï) more sugar cane (S) (Saccharum officinarum) was evaluated. It was used 20 Sahiwal x Holstein, veals with weight initial average of 72.5±4 kg. The treatments were: BS, B (100% of the requirement total protein (TPR) in DM) + S; BSP25, 75% of B + P (25% of the TPR in DM) + S; BSP50, 50% of B + P (50% of the TPR in DM) + S; BSP75, 25% of B + P (75% of the TPR in DM) + S. A totally at random experimental design was used. The daily gain of weight (DWG), consumption of DM (DMC), feed conversion (FC), consumption of TP (TPC) and economic analysis was evaluated. Three experimental periods were evaluated (1-30, 31-60 and 61-90 d) and a total (1-90 d). The DWG per period and total (g d-1) were not different ($p > 0.05$). In the total period the averages of DWG were 0.587, 0.627, 0.549 and 0.584; for the levels of substitution 0, 25, 50 and 75% of PT, respectively. The DMC in the periods 31-60 d and total was bigger

($p < 0.05$) when the diet contained less P. The FC was not affected ($p > 0.05$) for the substitution. The TPC in the periods 1-30, 31-60 and total was superior ($p < 0.05$) in the treatments with bigger quantity of P. There were better economic profit with BSP75 (223.94 dollars and 74.14% of profitability). It was concluded that the P is a potential source of protein that allows to improve the productive and economic efficiency of ruminant in growth.

Key Words: Arachis pintoï, Substitution, Saccharum officinarum

W199 Effects of applying exogenous, non-starch polysaccharidases to pre-weaning starter diet on performance of Holstein calves. G. R. Ghorbani¹, A. Jafari¹, A. H. Samie¹, and A. Nikkhal², ¹Isfahan University of Technology, Isfahan, Iran, ²University of Manitoba, Winnipeg, MB, Canada.

This study aimed to assess the effect of applying exogenous, non-starch polysaccharidases (ENP) to pre-weaning starter diet on starter intake, nutrient digestibility, and calf growth. Eighteen Holstein calves (9 males and 9 females; 47.9 ± 2.5 BW; mean ± SD) were grouped by sex and monitored for 84 d in a randomized complete block design with repeated measures. One male calf on EB was noticed unhealthy at week-3 and excluded from the trial. Treatments included pre-weaning starters with 1) no enzyme additives (C), 2) enzyme additive A (EA, 0.6 ml/kg DM), and 3) enzyme additive B (EB, 1.9 ml/kg DM). The

respective activity ($\mu\text{mol/ml/min}$) of exo-cellulase, endo-cellulase, and xylanase were 1437, 788 and 7476 for EA; and 1446, 1350 and 5091 for EB. Both pre- and post-weaning starters contained 56% rolled barley grain, 8% whole cottonseed, 8% cottonseed meal, 26% soybean meal, and 2% minerals and vitamins supplement (DM basis). Calves were offered milk (10% of BW) twice daily for 49 d. From 49 to 55 d, the daily milk offer was halved and calves were fully weaned at 56 d. No enzyme additives were added to post-weaning diet. Grab fecal samples were taken at 28, 56, and 84 days of age, for two consecutive days at each sampling. The acid insoluble ash was used as an internal marker to measure nutrient apparent total tract digestibility. Weaning criterion (WC) or the calf age at a daily intake of 680 g starter was estimated using regression equations. Data were analyzed with Proc Mixed of SAS with the best fitted covariance structures. The ENP did not affect the average starter intake, growth rate, and WC. The EA enhanced ($P < 0.05$) the apparent total tract digestibility of NDF and ADF at wk-4, when compared to C. The apparent fiber digestibility at wk-12 was lower in calves on EB than those on EA and C. Overall, the use of ENP in pre-weaning, calf starter did not appear to have a significant impact on calf growth in this study. Future research is warranted using a combination of cell-wall and cell-content polysaccharidases.

Table 1. Effects of exogenous polysaccharidases on nutrient digestibility and calf performance

Item	Treatment (T)			SEM _{C,EA}	SEM _{EB}	Fixed effect, P	
	C	EA	EB			T	T \times Week
Body weight, kg	73.2	69.5	74	2.1	2.3	0.73	0.82
Average daily gain, g	519	508	555	26.7	29.8	0.51	-
Starter intake, g/d	1281	1260	1278	24.9	27.9	0.99	0.25
Weaning criterion, d	40.5	42.5	41.0	0.8	0.9	0.51	-
Dry matter digestibility ¹ , %	80.3	78.6	79.3	1.0	1.1	0.61	0.29
NDF digestibility, %	63.2 ^a	60.5 ^a	55.7 ^b	1.4	1.6	0.02	0.006

¹Nutrient digestibility measured at 28, 56, and 84 d of age, for 2 consecutive d at each occasion.

Key Words: Exogenous non-starch polysaccharidases, Dairy calves, Growth

W200 Physical form of starter concentrate for young Holstein calves. G. R. Ghorbani¹, M. Bagheri Varzaneh¹, and A. Nikkiah^{*2}, ¹Isfahan University of Technology, Isfahan, Iran, ²University of Manitoba, Winnipeg, MB, Canada.

Controversy exists as to optimal physical form or abrasiveness of starter diet for young calves. Our objective was to evaluate starter intake, growth rate, body weight (BW) and weaning criterion (WC) as affected by starter physical form. Sixteen (8 males and 8 females) Holstein calves (20 ± 3 d initial age and 45.6 ± 2.3 kg BW; mean \pm SE) were grouped by age, gender, and BW; and assigned to either a conventional ground starter (GS) or a commercial pelleted starter (PS) until 10 weeks of age. Calves within each sex assigned randomly to treatments in a repeated measures design. Ground starter was produced by grinding all dietary ingredients using an on-farm hammer mill with a standard screen size of 1 mm. The pellets were produced after grinding of the starter meal, and averaged 11 mm

in length and 4.4 mm in diameter. The two starters (21.8% CP, 1.7 Mcal/kg NEg, 2.2 Mcal/kg NEm) were similar in type and inclusion rate of starter ingredients, and were different only in physical form. Both starters contained 34.5% corn grain, 18% barley grain, 34% soybean meal, 6% wheat bran, 2% sugarcane molasses, 2% alfalfa hay, 1.5% zeolite, and 2% minerals and vitamins supplement, on a DM basis. Calves were offered milk by 10% of their BW until 7 weeks of age and by 8% of BW during week 8, and weaned at a BW of 75 kg. The average daily gain, WC or the age at a daily consumption of 680 g starter, and age at 75 kg BW were estimated using polynomial regression equations. Data were analyzed using MIXED procedure of SAS (v. 9.1, 2003) with appropriate covariance structures. The initial BW values were used as a covariate to further control the experimental error for ADG, BW, and starter intake. The weekly starter intake and BW, growth rate, and WC were not significantly altered ($P > 0.30$) by treatments (Table 1). The average daily starter intake, however, tended to be greater ($P < 0.10$) for calves fed PS than for calves fed GS (851 vs. 716 ± 48 g/d). Calves fed both treatments required the same time to attain 75 kg BW. The conventional GS appeared as effective in promoting adequate starter intake and growth rate for early weaning of dairy calves as the commercial PS.

Table 1. Effects of offering ground starter (GS) or pelleted starter (PS) on calf performance

Item	Starter diet		SEM	Treatment effect
	GS	PS		P value
Initial body weight, kg	45.8	45.4	2.3	0.90
Final body weight, kg	78.2	78.8	1.9	0.80
Total body weight gain, kg	32.6	33.2	1.9	0.82
Average daily gain, g	741.3	783.0	37.7	0.45
Starter intake, g/d	716.5	851.6	48.6	0.07
Weaning criterion, d	50.8	47.6	2.5	0.31
Age at 75 kg BW, d	64.3	64.1	2.8	0.95

Key Words: Starter diet, Physical form, Holstein calf

W201 The effect of milk replacer fat source on calf growth and health. T. J. Earleywine*, T. E. Johnson, H. B. Perry, and B. L. Miller, Land O'Lakes, Inc., Webster City, IA.

Calf milk replacer fat source was evaluated to determine the effect on performance and scour data when fed to Holstein bull calves. A total of 54 calves with an initial weight of 47.6 kg were randomly assigned according to body weight and blood gamma globulin concentration to three all-milk protein milk replacer treatments: 1) 22% CP / 20% fat from edible lard; 2) 22% CP / 20% fat from edible lard and butterfat (1:1); or 3) 22% CP / 20% from butterfat. Calf milk replacer was fed averaging 775 g per calf, daily. Milk replacers were medicated (28 g neomycin/kg, 14 g oxytetracycline/kg). Calves were individually housed in crates and fed equal amounts 2 times daily at 700 and 1615 hours. No starter was fed during this 28 day trial. Weight gain, feed efficiency, daily scour scores (1-4 score: 1=normal, 2=loose, 3=water separation, 4=3 with severe dehydration) and scour days were calculated weekly for the four week trial period. Calves fed milk replacer containing edible lard had reduced ($P < 0.05$) incidence and severity of scours. Edible lard is an excellent fat source for milk replacer fed calves.

Table 1. Treatment

Item	1	2	3	C.V.
BW gain, kg	11.11	11.50	10.47	23.46
CMR, DM, kg	21.44	21.58	20.54	5.34
Feed/gain	2.01	1.93	2.88	25.34
Scour score	1.21 ^a	1.28 ^{ab}	1.35 ^b	14.73
Scour score	1.21 ^a	1.28 ^{ab}	1.35 ^b	14.73
Scour score	1.21 ^a	1.28 ^{ab}	1.35 ^b	14.73

^{a,b,c} Means within a row differ ($P < 0.05$)

Key Words: Calf, Milk replacer, Fat source

W202 The effect of milk replacer composition on calf growth and health. B. L. Miller*, T. E. Johnson, H. B. Perry, and T. J. Earleywine, *Land O'Lakes, Inc., Webster City, IA.*

The composition of calf milk replacers was evaluated to determine the effect on performance and scour data when fed to Holstein bull calves. A total of 90 calves with an initial weight of 44.5 kg were randomly assigned according to body weight and blood gamma globulin concentration to five milk replacer treatments: 1) 22% CP / 20% Fat all milk protein (positive control); 2) 20% CP / 10% Fat w/ 60% of protein from soy flour (negative control); 3) 22% CP / 20% Fat all milk protein - 3% pectin; 4) 22% CP / 20% Fat all milk protein - 1.1% psyllium; or 5) 22% CP / 20% Fat w/ 50% of protein from protein modified soy flour. Calf milk replacer was fed averaging 775 g per calf, daily. Milk replacers were medicated (28 g neomycin/kg, 14 g oxytetracycline/kg). Calves were individually housed in individual elevated stalls and fed 2 times daily at 700 and 1615 hours. No starter was fed during this 28 day trial. Weight gain, feed efficiency, daily scour scores (1-4 score: 1=normal, 2=loose, 3=water separation, 4=3 with severe dehydration) and scour days were calculated weekly for the seven week trial period. Calves fed psyllium gained more weight ($P < .05$) and were more efficient ($P < .05$) than calves fed soy containing milk replacers. Calves fed pectin, psyllium or protein modified soy flour had a reduced ($P < .05$) scour severity.

Table 1. Treatment

Item	1	2	3	4	5	C.V.
BW gain, kg	14.89 ^{ab}	10.59 ^c	14.81 ^{ab}	15.50 ^a	13.72 ^b	13.66
CMR, DM, kg	21.49 ^{ab}	21.66 ^a	21.66 ^{ab}	21.59 ^{ab}	21.22 ^b	2.36
Feed/gain	1.46 ^{ab}	2.09 ^c	1.49 ^{ab}	1.40 ^a	1.60 ^b	14.81
Scour score	1.45 ^b	1.58 ^b	1.27 ^a	1.21 ^a	1.30 ^a	15.05
Scour days	9.13 ^{bc}	11.41 ^c	5.38 ^a	4.07 ^a	6.81 ^{ab}	56.10

^{a,b,c} Means within a row differ ($P < 0.05$)

Key Words: Calf, Milk replacer, Psyllium

W203 Short- and medium-term effects of an enhanced-growth feeding program in dairy calves. M. Terré*¹ and A. Bach^{1,2}, ¹*IRTA-Unitat de Remugants, Barcelona, Spain*, ²*ICREA, Barcelona, Spain*.

Seventy-eight female dairy calves (BW 42.9 ± 4.79 kg and age 9.9 ± 4.61 d) were arranged in 2 groups to compare the short- (up to 72 d) and medium-term (up to 212 d) effects of an enhanced (EF) and a conventional (CF) growth feeding programs. After 1 week of

adaptation to a milk replacer (MR), the CF calves were fed 4.3 l/d of MR (25% CP and 19% fat) from 1-27 d, and 2.15 l/d from 28-34 d at 11.2% DM, and the EF calves were offered the same MR at 18% DM: 4 l/d from 1-6 d, 6 l/d from 7-13 d, 7 l/d from 14-20 d, 6 l/d from 21-27 d, and 3 l/d from 28 to weaning day at 34 d of study (50 d of age). Individual calf starter (20.7% CP) consumption was recorded daily from the beginning of the study until 58 d of age. Then, calves were placed in groups of 6 and received a TMR (with different composition depending on age) until 212 d of age. Calves were weighed weekly until 72 d of age and bimonthly until they were 212 d old. Serum urea and NEFA concentrations were determined at 23, 37, 51, 58 and 72 d of age. Days on medical treatments were recorded until 72 d of age. Body weight of EF calves was greater ($P < 0.01$) than that of CF calves at weaning (74.8 vs 70.1 ± 1.57 kg, respectively) and at 212 d of age (224.4 vs 218.8 ± 1.57 kg, respectively). Starter intake was greater ($P < 0.001$) in CF than in EF calves (1.02 vs 0.55 ± 0.058 kg/d, respectively) during the preweaning period, and TMR consumption tended ($P = 0.05$) to be greater in CF than in EF calves (2.8 vs 2.5 ± 0.11 kg/d, respectively) from 59 to 72 d of age. Serum urea concentration was greater ($P < 0.01$) from 37 to 58 d of age in EF than in CF calves, and serum NEFA concentration was greater ($P < 0.01$) from 51 to 58 d of age in EF than in CF calves. The use of oral rehydratant support tended ($P = 0.12$) to be greater in EF than CF calves, but the use of medical treatments did not differ. Calves in EF struggled at weaning as suggested by the increase in serum NEFA and urea concentration that week, but at 212 d of age still maintained the advantage in BW over CF calves achieved during the preweaning period.

Key Words: Calves, Growth, Replacer

W204 No effects of daily concentrate intake on ruminal environment in milk fed calves. N. B. Kristensen*, J. Sehested, S. K. Jensen, and M. Vestergaard, *Danish Institute of Agricultural Sciences, Tjele, Denmark.*

Eight Holstein calves (44 ± 1 kg BW at birth) implanted with ruminal cannulae (20 mm ID) at $d 7 \pm 1$ after birth were used to investigate the effects of milk allowance on concentrate intake and ruminal fermentation patterns. Calves were allocated to one of four treatments (3.0, 4.7, 6.4 or 8.1 L skim-milk-based milk-replacer/d; 130 g solids/L milk). All calves had free access to a barley-based starter concentrate (319 g starch/kg), artificially-dried hay, and water. Ruminal samples were collected every 2 h for 24 h at wk 2, 3, 4, and 5. Ruminal pH was measured immediately and ruminal fluid was stabilized with metaphosphoric acid for later analysis. Concentrate intake was affected by a treatment times wk interaction ($P < 0.01$). The smallest concentrate intake was found with 6.4 L milk/d (17 g/d in wk 2 increasing to 389 g/d in wk 5) and the greatest concentrate intake was found with 3.0 L milk/d (310 g/d in wk 2 increasing to 1,601 g/d in wk 5 [SEM = 150]). Daily gain from wk 2 to 5 (714 ± 35 g/d) was not affected ($P = 0.49$) by treatment. The average (5.8 ± 0.1) and the minimum (5.4 ± 0.1) ruminal pH within a sampling period were not affected ($P > 0.24$) by treatment or wk. Hours/d with ruminal pH below 6.2 (18 ± 2 h/d), 5.8 (14 ± 2 h/d), and 5.4 (6 ± 2 h/d) were not affected ($P > 0.18$) by treatment or wk. The total VFA concentration was affected by week ($P < 0.01$) and increased from 71 ± 9 mmol/L in wk 2 to 133 ± 9 mmol/L in wk 5. All data for calves with concentrate intakes above 25 g/d showed no relationship between concentrate intake level and severity of ruminal environment. The implication is that starch-based concentrates in general might be harmful to the juvenile rumen of milk-fed calves

and more attention should be paid to formulating rumen-friendly starter concentrates.

Key Words: Calves, Concentrate, Ruminal fermentation

W205 Delayed introduction of a low-starch concentrate induces normal ruminal development in dairy calves at weaning. N. B. Kristensen*, J. Sehested, S. K. Jensen, and M. Vestergaard, *Danish Institute of Agricultural Sciences, Tjele, Denmark.*

Traditional starch-rich concentrates for milk-fed calves induces an acidotic ruminal environment even with small daily intakes. A new feeding regimen including use of low-starch concentrate was formulated and tested for impact on ruminal environment and development in 2 to 10 wk old calves. Eight Holstein calves (48 ± 1 kg BW at birth) implanted with ruminal cannulae (20 mm ID) at $d 7 \pm 1$ of age were allocated to one of two feeding regimens. Calves on control treatment (CON) had free access to a barley-based concentrate (319 g starch/kg) from wk 1. Calves on alternative treatment (ALT) had no access to concentrate until wk 4 when they got free access to a low-starch concentrate (68 g starch/kg). All calves had free access to artificially-dried grass hay, and water and were fed skim-milk-based milk-replacer (4.6 L/d in wk 1 to 2, 6.4 L/d in wk 2 to 7, and 3.2 L/d in wk 7 to 8). Every wk, 8 ruminal samples/calf were collected from 0730 to 2400. There were no treatment effects on ADG (802 ± 35 g/d) or total solid feed DMI (concentrate + hay; 78 ± 4 kg). On ALT compared with CON, average ruminal pH was higher (6.39 vs. 6.04 ± 0.09 , $P < 0.05$) and minimum ruminal pH was higher (6.14 vs. 5.57 ± 0.09 , $P < 0.01$). A relatively large treatment x wk interaction was found for all VFA data. Especially from wk 2 to 4 the butyrate profile and the ruminal butyrate concentration was smaller ($P < 0.001$) for ALT (1 to 3 ± 1 mmol/L) compared with CON (6 to 9 ± 1 mmol/L). However, when concentrate was introduced to ALT calves ruminal butyrate increased to a higher ($P < 0.001$) level (12 to 19 ± 1 mmol/L) compared with CON (8 to 13 ± 1 mmol/L). No differences between treatments in ruminal mass, length, shape and aggregation of ruminal papillae were detected at wk 10. Our results show that it is possible to formulate rumen-friendly low-starch concentrates without compromising growth or ruminal development in milk-fed calves.

Key Words: Calves, Concentrate, Ruminal fermentation

W206 Performance of dairy heifer calves fed milk replacers with equal protein and fat levels but utilizing different fat sources. B. Braman*¹, S. Hayes¹, H. Chester-Jones², D. Ziegler², J. Linn³, and B. Ziegler⁴, ¹*Milk Products, Chilton, WI*, ²*University of Minnesota, Waseca*, ³*University of Minnesota, St. Paul*, ⁴*Hubbard Feeds, Mankato, MN*.

One-hundred-eleven 2 day-old dairy heifer calves (BW 41.8 kg \pm 0.54 kg) were randomly assigned to one of 3 all-milk protein milk replacer (MR) treatments to evaluate the effect of fat source on pre- and post weaning calf performance. All MR contained 24% protein: 20% fat and only differed by fat source. Fat treatments were: 1) Animal fat (AF); 2) Vegetable blend of 80% palm oil and 20% coconut oil (VF); and, 3) AF plus a blend of medium chain tri-glycerides containing 1% caproic, 69% caprylic, 1% capric and 29% lauric acids fed at 5 g/calf daily (AFA). Milk replacers were fed at 0.28 kg (as-fed) in 1.99 L water 2X daily for the first 35 days, and then 1X daily from day 36 to weaning at 42 d. Calves were offered an 20.9% CP (DM basis) texturized calf starter throughout the study. Fresh water was available daily at all times. Total DMI from MR for 42 d averaged 20.9 kg/calf.

Feed DMI to 42 d tended to be higher for calves fed AF (26.38 kg) vs. those fed AFA (23.95 kg; $P < .08$) with the VF calves being similar to other groups (24.19 kg). Daily gains to 42-d were similar ($P > 0.05$) averaging 0.65, 0.62 and 0.62 kg for calves fed AF, VF, and AFA, respectively. There were no differences ($P > .05$) in post weaning gain and gain/feed from d 42 to 56, which averaged 0.95, 0.45; 0.95, 0.47; 0.96 and 0.47 kg for calves in the AF, VF and AFA groups respectively. Overall 56-d daily gain and gain/feed were not affected by treatments ($P > .05$) averaging 0.73, 0.53; 0.70, 0.54; 0.70 and 0.54 kg for calves fed AF, VF, and AFA, respectively. Fecal scores taken daily throughout the study were not affected by treatment ($P > .05$). Under the conditions of this study feeding a common milk replacer with varying fat sources did not affect pre- and immediate post weaning calf performance.

Key Words: Dairy calves, Milk replacer fat sources, Performance

W207 Pre- and post weaning performance of dairy heifer calves fed texturized or pelleted calf starters with or without intake enhancing flavors. B. Ziegler*¹, R. Larson¹, H. Chester-Jones², D. Ziegler², J. Linn³, and S. Hayes⁴, ¹*Hubbard Feeds, Mankato, MN*, ²*University of Minnesota, Waseca*, ³*University of Minnesota, St. Paul*, ⁴*Milk Products, Chilton, WI*.

One-hundred-fourteen 2 day-old dairy heifer calves (av. BW 40.6 ± 0.77 kg) were randomly assigned to one of 5 calf starter (CS) treatments (av. CP 21.4% DM basis) to evaluate DMI and pre- and post weaning calf performance. Calves were housed in 2.29×1.17 m individual calf pens within a frame-steel curtain side-wall naturally ventilated calf barn. Treatments were: 1), texturized control (TCS); 2), pelleted control (PCS); 3), PCS with chocolate flavor (PCSC); 4), PCS with whey flavor (PCSW); and, 5), PCS with sweet start flavor (PCSS). Calf starters were offered free choice throughout the study. All calves were fed a medicated 20% protein:20% fat milk replacer in two equal feedings at 0.28 kg (as-fed) plus 1.99 L water for 35 d and once a day from 36 d to weaning at 42 d. Fresh water was available at all times. Pre-weaning 42 d ADG was higher ($P < .01$) for calves fed TCS than calves fed PCSS (0.62 vs. 0.49 kg). Daily pre-weaning gain for calves fed PCS (0.57 kg), PCSC (0.55 kg), and PCSW (0.56 kg) were intermediate. Pre-weaning CS DMI was not different between treatments, however, calves fed PCSS tended ($P < .09$) to eat less than calves on the other treatments. Post weaning DMI and ADG from 43-56 d were lowest ($P < .02$) for calves fed PCSS. Overall 56-d DMI, CS intake and total gain were lowest ($P < .04$) for calves fed PCSS. Gain/feed was highest ($P < .01$) for calves fed TCS. Average daily gain and gain/feed for 56-d were 0.70, 0.56; 0.64, 0.50; 0.65, 0.52; 0.63, 0.51; 0.53 and 0.48 kg for calves fed TCS, PCS, PCSC, PCSW, and PCSS, respectively. Under conditions of this study heifer calves tended to utilize a texturized CS more effectively than those fed pelleted starters. The addition of flavors to PCS did not improve calf performance and in the case of PCSS was detrimental to calf growth.

Key Words: Dairy calves, Calf starters, Performance

W208 Performance of Holstein dairy heifers fed concentrate diets containing dried distillers grains or urea. R. Larson*¹, B. Ziegler¹, J. Linn², D. Ziegler³, and H. Chester-Jones³, ¹*Hubbard Feeds, Mankato, MN*, ²*University of Minnesota, St. Paul*, ³*University of Minnesota, Waseca*.

Ninety Holstein dairy heifers (av. BW 100.9 ± 1.30 kg) were used in an 84-d study to evaluate feed intake and performance from 13 to

24 weeks of-age. Post weaned heifers were randomly assigned to 5 replicate pens (6 heifers/pen) each of 3 grower diets containing an 18% CP (DM basis) concentrate mix limit-fed up to 2.27 kg/heifer daily with free-choice hay. Concentrate mixes were: 1), Cracked-corn and soybean meal-based pellet (C); 2), Cracked corn and dried distillers grain (DG; 1.45 kg DG/heifer; CDG) and 3), Cracked-corn and urea-based pellet (22.7 g urea/heifer; CUP). During the first 28 d of the study, heifers fed CDG tended to have ($P < .10$) faster daily gains (0.93 kg) than those fed CUP (0.85 kg) but similar ($P > .10$) to those fed C (0.87 kg). Gain/feed for the same period was similar across heifer groups ($P > 0.2$) averaging 0.27 kg. There were no heifer performance differences ($P > 0.2$) from d 29 to 56 or 57 to 84 d. Final BW and body condition score were 181.05 kg, 3.68; 184.65 kg, 3.68; 180.18 kg and 3.72 for heifers fed C, CDG, and CUP diets, respectively. Overall heifer performance for the 84 d study was not affected by concentrate mix fed ($P > 0.3$). Average daily hay intake was 2.42 kg/heifer over 84 d with a range from 1.41 kg/heifer during d 1 to 28 up to 3.46 kg/heifer from 57 to 84 d. Total gain, total DMI and gain/feed for 84 d were, 79.68, 355.45, 0.23; 83.15, 346.85, 0.24; 80.27, 346.39, and 0.23 kg/heifer for those fed C, CDG, and CUP diets, respectively. The study found that limit feeding a concentrate mix to 2.27 kg/day with free choice hay for post weaned dairy heifers from 13 to 24 weeks of age supported good growth rates. Using DG or urea as alternative protein sources in concentrate mixes were acceptable options.

Key Words: Dairy heifers, Distillers grains and urea, Performance

W209 Performance of Holstein dairy heifers full vs. limit fed whole-shelled corn and protein pellet diets with differing fiber levels. H. Chester-Jones^{*1}, D. Ziegler¹, R. Larson², B. Ziegler², and J. Linn³, ¹University of Minnesota, Waseca, ²Hubbard Feeds, Mankato, MN, ³University of Minnesota, St. Paul.

Ninety-six dairy heifers were used in a 112-d study to evaluate feed intake and performance from 9 to 25 weeks of-age. Heifers (av. 93.0 ± 1.76 kg BW) were randomly assigned to 1 of 4 grower diets; 6 heifers/pen, 4 pens/treatment. Treatments were: 1), 16% CP whole-corn (WC) and pellet (P) mix (6.5% ADF) limit-fed to 2.72 kg/calf (as-fed) for 84-d and to 2.27 kg/calf daily from 85 to 112 d with a 20.9% CP free-choice (FC) alfalfa hay (WCP); 2), 18% CP WCP mix full-fed (FF) to 84-d with no hay and up to 2.27 kg/calf daily with FC hay from 85 to 112d (PFC); 3), 18% CP higher fiber WCP (11.3% ADF) FF to 84-d with no hay and limit fed with FC hay from 85 to 112 d (PHF) and 4), 18% CP lower fiber WCP (6.5% ADF) FF as in 2 (PLF). For the period 1 to 84-d, heifers fed WCP (av. 2.32 kg hay/heifer daily) had the lowest ($P < .01$) daily gain (1.04 kg) and gain/feed (0.23 kg) vs. FF diets, which averaged 1.26 kg and 0.28 kg, respectively. From d 85 to 112, heifers fed WCP had the highest ($P < .01$) DMI and greater ADG (0.97 kg; $P < .03$) compared to those fed PFC (0.70 kg) and PLF (0.64 kg) with PHF heifers being intermediate (0.83 kg). Final BW (230.81 kg) and BCS (3.72) for WCP heifers were 5.3% and 6.1% lower than the other heifer groups, respectively. Total gain over 112-d for WCP heifers (114.78 kg) was lower ($P < .03$) than PFC (126.69 kg) and PHF (128.21 kg), and tended to be lower ($P < .09$) than PLF (123.43 kg) heifers. Daily gain and gain/feed for the 112-d study were 1.03, 0.21; 1.13, 0.25; 1.15, 0.25; 1.10 and 0.22 kg for WCP, PFC, PHF, and PLF, respectively. The study indicated that limit-feeding concentrate grower diets with access to FC hay in group pens from 9 to 25 weeks of-age resulted in a more consistent heifer performance when compared to FF concentrates without hay followed by a period of limit feeding concentrates with FC hay.

Key Words: Dairy heifers, Full vs. limit-fed concentrates, Performance

W210 Rumen fermentation patterns of dairy heifers fed restricted amounts of high and low forage diets. M. L. Moody^{*}, G. I. Zanton, and A. J. Heinrichs, Pennsylvania State University, University Park.

Feed costs are the largest single component of a dairy heifer enterprise and need to be optimized in relation to maintaining satisfactory growth rates while maximizing feed efficiency. Normally, high forage (HF) diets are fed to dairy heifers for *ad libitum* consumption. Alternatively, low forage (LF) diets can be fed at restricted intakes to reach optimal ADG that maximize the nutritional efficiency of growing dairy heifers while minimizing costs. The objective of this experiment was to investigate the rumen fermentation of diets with differing forage:concentrate ratios with corn silage (CS) as the sole forage source. A HF TMR, (77% CS, 23% grain; 10.8% CP, 40.5% NDF) and a LF TMR, (67% grain, 33% CS; 12.3% CP, 38.3% NDF) were fed to 4 rumen cannulated Holstein heifers (BW 298 ± 16 kg) in a crossover design for two 21d periods. The treatment rations were fed on a restricted basis to provide 0.21 Mcal ME intake per kg EBW^{0.75}. Actual N intake was 105.9 HF and 114.0 LF ± 0.7g ($P < 0.02$). Rumen contents were sampled on d19, removed on d21 and *in situ* determinations were made on d15-21 on CS and treatment rations. Low forage rations resulted in an increased rate of *in situ* digestion when compared to HF (4.4 LF vs. 2.2 HF ± 0.3%/h; $P < 0.04$), but no differences were observed in CS digestibility. Mean rumen pH tended to be lower for LF (5.9 LF vs. 6.2 HF ± 0.06; $P < 0.07$). Total VFA concentrations were not different between treatments (139.8 LF and 126.4 HF ± 5.8 mM; $P > 0.2$) nor were the concentrations of acetic, propionic, or butyric acids altered between treatments (all $P > 0.1$). Mean rumen ammonia concentration was not different between treatments (5.9 LF vs. 4.3 HF ± 0.5 mg%; $P > 0.1$). Total rumen contents, both wet and dry amounts, were lower for LF ($P < 0.05$). We determined that feeding LF rations at restricted intakes to growing dairy heifers, while more rapidly digestible, results in minimal changes in rumen fermentation patterns.

Key Words: Forage:concentrate, Dairy heifers, Rumen fermentation

W211 The effects of restricted feeding a high concentrate or high forage ration for similar weight gains on structural growth in Holstein heifers. G. I. Zanton^{*} and A. J. Heinrichs, The Pennsylvania State University, University Park.

Forages typically compose most of the ration that is fed to growing dairy heifers as opposed to concentrates. However, there is a large inefficiency associated with this method of feeding due to lower digestibility of most forages, greater metabolic protein and energy requirements associated with digesting forage, and higher feed costs per unit of energy as compared to concentrates. The physiological potential exists to replace a significant proportion of the forage DM in a ration with concentrate DM, reducing the inefficiency associated with raising dairy heifers while maintaining similar ADG. The objective of this experiment was to evaluate heifer growth characteristics when given a high concentrate (HC) or a high forage (HF) ration at restricted intakes to achieve a similar ADG. Both the HC and the HF rations contained the same ingredients, but in differing proportions, yielding two treatment rations containing 75 or 25 percent of the ration dry matter as forages (grass haylage and corn silage). Treatment rations were delivered individually in a TMR twice daily to 21 heifers per

treatment for similar levels of ADG for 35 weeks. Body weights and structural measurements were taken twice weekly and gains were computed as the linear regression of the measured value of interest against the days on trial. Initial (142 kg ± 5) and final BW (343 kg ± 5) were not different between treatments ($P>0.20$) and ADG were similar between treatments (822 HC vs. 830 HF g/d ± 10; $P>0.20$). Less DM was consumed by the heifers fed HC than for HF (5.41 HC vs. 5.95 HF kg/d ± 0.11; $P<0.01$) at similar ADG leading to significantly

improved feed efficiency for the heifers receiving HC ($P<0.01$). Daily gains of skeletal measurements were not different between treatments. Reproduction and first lactation data are also being monitored. From these results we conclude that feeding a HC ration leads to similar growth performance when the level of intake is restricted to achieve a controlled ADG.

Key Words: Dairy heifers, Forage:concentrate, Growth

Ruminant Nutrition: Feedstuff Digestibility & Nutritive Value

W212 Prediction of the nutritive value of maize stover using near infrared reflectance spectroscopy. S. Fernandez-Rivera*, G. Gebremariam, J. Hanson, and D. Negassa, *International Livestock Research Institute, Addis Ababa, Ethiopia*.

Our objective was to develop equations to calibrate near infrared reflectance spectroscopy (NIRS) instruments for predicting the nutritive value of maize stover. Two maize cultivars were grown in three replicates in one location in 2001, two cultivars in 12 farms in four locations in 2001 and eight cultivars in three replicates in one location in 2003. Stem, blade, husk and husk-less stover samples were taken at silk, dent and mature stages and analyzed for DM, OM, CP, NDF, ADF, ADL, true in vitro OM (TIVOMD) and NDF (NDFD) disappearance. They were scanned in a FOSS NIR System Model 5000 and absorbance was determined from 1100 to 2498 nm at intervals of 2 nm. Calibration results from principal component analyses using a mathematical treatment 1, 4, 4, 1 are presented in Table 1. Prediction equations were validated using an independent set of samples with n=232, 232, 231, 112, 48, 186 and 186 for OM, CP, NDF, ADF, ADL, TIVOMD and NDFD, respectively. Validation R^2 and SE of predictions were 0.98 and 0.61 for OM, 0.98 and 0.29 for CP, 0.89 and 3.93 for NDF, 0.94 and 1.78 for ADF, 0.87 and 0.62 for ADL, 0.86 and 3.10 for TIVOMD and 0.85 and 4.35 for NDFD. The NIRS equations developed can be used to predict the nutritive value of maize stover with acceptable levels of precision, but the precision is lower for NDF and NDFD than for OM, CP, ADF, ADL and TIVOMD.

Table 1.

Parameter	OM	CP	NDF	ADF	ADL	TIVOMD	NDFD
n	447	454	453	223	94	349	351
SEC	0.49	0.29	3.15	1.54	0.46	2.60	4.31
R^2	0.99	0.99	0.93	0.98	0.94	0.90	0.86
SECV	0.56	0.33	3.51	1.92	0.53	0.88	4.75

SEC=SE of calibration, SECV=SE of cross-validation

Key Words: Crop residues, Maize, NIRS

W213 Estimation of the nutritive value of cereals and wheat by products with or without oregano and rosemary supplementation. A. Caputi Jambrenghi¹, F. Giannico*¹, M. A. Colonna¹, C. A. Marano¹, L. Marvulli¹, G. Cappiello², and G. Vonghia¹, ¹University of Bari, Bari, Italy, ²Breeder Association of Taranto, Taranto, Italy.

Durum wheat is mainly imported in South Italy despite its production in the Apulian region. The new EU Common Agricultural Policy provides the same subsidy for any crop which respects good economic

and environmental conditions; hence the identification of crop systems which give a better yield and the choice to grow soft wheat and barley. Herbs and natural extracts typical of the Mediterranean area like oregano and rosemary act as antimicrobials, antioxidants and immunostimulators but their effects on rumen fermentation have been little investigated. The aim of the study was to evaluate the effect of sun dried oregano (OR) and rosemary (RO) (10 g/kg feed) on the nutritive value of local cereals (soft and durum wheat, barley, triticale) and derivatives from flour-milling (wheat middlings and bran). In vitro gas production was assessed by the Menke and Steingass (1988) technique, checked until 72 h and expressed as ml/g DM. The metabolizable energy (ME; MJ/kg DM) was calculated as: $1.06 + 0.157GP + 0.084CP + 0.22CF - 0.081CA$, where GP is 24 h net gas production (ml/g DM), CP, CF and CA are crude protein, fat and ash (% DM), respectively. Data were processed by ANOVA according to a 6 (n. of feeds tested) x 3 (control, OR or RO supplementation) experimental model. Student's t test was used to compare differences between means. OR increased soft wheat ($P<0.01$) and wheat middlings ($P<0.05$) GP. The GP of barley was significantly depressed by OR and RO ($P<0.01$). The ME values showed the same trend: OR improved the ME of soft wheat ($P<0.01$) and of wheat middlings ($P<0.05$), while OR and RO markedly decreased the ME of barley ($P<0.01$). Durum wheat, triticale and wheat bran were not influenced by the herb supplementation. In conclusion, OR and RO affect rumen fermentation, but their effect on the activity of cellulolytic and amylolytic bacteria needs further study.

Key Words: Cereals and wheat by products, Nutraceuticals, In vitro gas production

W214 Nutritive evaluation of different types of frost damaged wheat for ruminants: I. Chemical characterization, II. energy values, III. protein and carbohydrate subfractions, IV. rumen degradation kinetics, and V. modeling nutrient supply. P. Yu*, V. Racz, L. White, J. J. McKinnon, and D. A. Christensen, *University of Saskatchewan, Saskatoon, SK, Canada*.

In 2004, more than 50% of wheat was frost damaged (frozen) in Canada resulting in millions of tons of frozen wheat. There is an urgent need to fully evaluate the nutritive value of frozen wheat for ruminants. The objectives were to compare chemical characterization, rumen digestive behavior, and potential nutrient supply to ruminant animals between normal wheat and different types of frozen grain wheat. Results showed that the frozen wheat was lower in starch, non-structural CHO, NPN and higher in crude fat, ADF and NDF, lignin, ADIN and NDIN. The frozen wheat was lower TDN and energy values (DE3X, ME3X, NEL3X for dairy; ME, NEm, and NEg beef cattle). Partitioning protein and carbohydrate (CHO) fractions showed that the frozen wheat

was lower in extremely rapidly degradable CP (PA) and intermediately degradable CP (PB2) and higher in fast degradable CP (PB1), and unavailable CP (PC). The frozen wheat had lower intermediately degradable CHO (CB1), higher slowly degradable CHO (CB2) and unavailable CHO (CC). The *in situ* results showed that the frozen wheat had a different pattern ($P<0.05$) in rumen degradation kinetics of DM, CP and starch. The nutrient modeling results showed that total truly digested protein value (DVE) in the small intestine in the frozen wheat tend to be lower ($P=0.10$) (89 vs. 110 g kg⁻¹ DM) using the DVE/OEB system and total metabolizable protein (MP) (95 vs. 108 g/kg DM) in the frozen wheat was significantly lower ($P<0.05$) using the NRC (2001) model. The degraded protein balance was all negative [-6.1 vs. -0.4 (DVE/OEB); -18.6 vs. -15.5 g kg⁻¹ DM (NRC, 2001) for the normal and frozen wheat]. In conclusion, the frozen wheat differed in chemical characterization, energy values, protein and carbohydrate fractions, *in situ* degradation behavior and potential nutrient supply from the normal wheat. The cold weather caused wheat to significantly reduce nutrient contents and availability and thus reduce nutrient supply to ruminants.

Key Words: Frozen wheat, Protein and energy evaluation, Modeling nutrient supply to ruminants

W215 In vitro digestibility of wet sorghum distillers grain. C. R. Richardson¹, J. H. Mikus¹, D. W. Boyles², A. T. Moore*¹, J. E. Vander Dussen³, H. P. Hagaman¹, and B. S. May¹, ¹Texas Tech University, Lubbock, ²LDJ Nutrition, Lubbock, TX, ³Rajen Dairy, Clovis, NM.

Two experiments were conducted to determine the *in vitro* dry matter digestibility (IVDMD) of wet sorghum distillers grain (WSDG) in a 90% concentrate diet, using established rumen fluid incubation procedures. In experiment 1, triplicate samples were used to evaluate WSDG at inclusion levels of 0,5,10 and 15%. The WSDG substrates were incubated in an artificially buffered rumen fluid solution for 12, 24, and 48 h. Treatments were all run in triplicate. Linear contrasts were different for times of 12 ($P=0.022$) and 48h ($P=0.007$). At 12h, the control diet had a slightly higher IVDMD than the incubation diets containing 5 or 10% WSDG (55.55, 53.76 and 53.14, respectively). When WSDG was added at 15% of the diet, IVDMD increased to 58.32%. Contrasts were not different for the 24h incubation time. At 48h, similar values for IVDMD were found for the control, 5 and 10% treatments (80.46, 78.12 and 79.12%, respectively). An increase in IVDMD was found at the 15% level of WSDG (81.88%). A second IVDMD experiment was conducted to further evaluate the digestibility of WSDG at the 24h incubation time. Five replications per treatment were used in this experiment. Other procedures were the same as used in the first experiment. Quadratic ($P<0.0001$) contrasts were different. Results were similar to those found in experiment 1 at the 24h incubation time (61.92, 58.76 and 61.76%) for the control, 5 and 10% levels. An increase in IVDMD was again found at the 15% inclusion level with WSDG (69.10%). Results from these IVDMD evaluations indicate that the WSDG can be used in 90% concentrate diets with little change in IVDMD at levels at 5 and 10%, but with possible improvement in digestibility when added at the level of 15%.

Key Words: Sorghum, Distillers grain, Digestibility

W216 Monitoring the fate of gamma irradiated soybean meal proteins in the rumen. P. Shawrang¹, A. Nikkhab*¹, A. A. Sadeghi², and G. Raisali³, ¹Tehran University, Karaj, Iran., ²Islamic Azad University, Tehran, Iran., ³Nuclear Research Center for Agriculture and Medicine, Iranian Atomic Energy Organization, Karaj, Iran.

The aim of this study was to evaluate effects of gamma irradiation on ruminal DM, CP and true protein degradability and intestinal CP digestibility of soybean meal (SBM). Gamma irradiation (g-irradiation) was carried out in a cobalt-60 irradiator. Three SBM samples (25% moisture content) were irradiated in a gamma cell at doses of 25, 50 and 75 kGy. Duplicate nylon bags of untreated or g-irradiated SBM were suspended in the rumen of four Holstein cows for up to 48 h. Intestinal CP digestibility was measured using mobile nylon bag technique. Proteins of untreated and treated bag residues were fractionated by sodium dodecyl sulphate-polyacrylamide gel electrophoresis. Fitting *in sacco* data to non-linear degradation model showed that the water soluble fractions decreased linearly ($P<0.001$) and the potentially degradable fractions of DM and CP increased linearly ($P<0.001$) by g-irradiation. Effective degradability of DM and CP decreased linearly ($P<0.001$) with increases in irradiation dose. Gamma irradiation at doses of 25, 50 and 75 kGy decreased effective degradability of CP at a ruminal outflow rate of 0.05/h by 18, 31 and 42% units, respectively. Gamma irradiation increased linearly ($P<0.001$) intestinal mobile bag digestibility of ruminally undegraded CP. At doses of 25, 50 and 75 kGy, CP digestibility increased by 4, 13 and 19% units, respectively. Electrophoretic analyses of untreated, 25, 50 and 75 kGy g-irradiated SBM protein residues revealed that three of subunits of β -conglycinin were degraded completely after 2, 4, 8 and 12 h, respectively. In untreated SBM, the acidic and basic subunits of glycinin were degraded in the middle of the incubation period, but in g-irradiated SBM were not degraded even after 48 h of incubation. In conclusion, SBM proteins appeared to be effectively protected from ruminal degradation by g-irradiation at doses higher than 25 kGy.

Key Words: Soybean meal, Gamma irradiation, Protein degradation

W217 Monitoring the fate of gamma irradiated canola meal proteins in the rumen. P. Shawrang¹, A. Nikkhab*¹, A. A. Sadeghi², A. Zareh¹, and G. Raisali³, ¹University of Tehran, Karaj, Iran, ²Islamic Azad University, Tehran, Iran, ³Nuclear Research Center for Agriculture and Medicine, Iranian Atomic Energy Organization, Karaj, Iran.

This study was completed to evaluate effects of gamma irradiation on ruminal DM and CP degradation parameters of canola meal (CM). The DM of CM was determined by freeze drying a 1 g sample in duplicate. Based upon this value, sufficient water was added to increase the moisture content of CM to 200 g/kg. Gamma irradiation was carried out in a cobalt-60 irradiator. Three samples were irradiated in a gamma cell at doses of 25, 50 and 75 kGy in the presence of air. Duplicate nylon bags of untreated or irradiated CM (2-mm particle size) were suspended in the rumen of four dry Holstein cows for up to 48 h and resulting data were fitted to non-linear degradation model to calculate effective rumen degradation (ERD). Intestinal CP digestibility was measured using mobile nylon bag technique. Proteins of untreated and treated bag residues were fractionated by gel electrophoresis. The ERD of DM and CP decreased linearly ($P<0.001$) with increases in irradiation dose. There was a linear decrease in the water soluble fraction and a linear increase in the potentially degradable fraction

of CP ($P < 0.001$). Gamma irradiation at doses of 25, 50 and 75 kGy decreased ERD of CP at rumen outflow rate of 0.05/h by 19, 27 and 32 % units, respectively. Gamma irradiation increased linearly ($P < 0.001$) intestinal mobile bag digestibility of ruminally undegraded CP. At doses of 25, 50 and 75 kGy, CP digestibility increased by 5, 7 and 9%, respectively. Electrophoresis results of untreated, 25, 50 and 75 kGy g-irradiated CM protein residues showed that napin subunits of untreated CM disappeared completely within the shortest, whereas cruciferin subunits were degraded in the middle of incubation period. In gamma irradiated CM, napin subunits were degraded in the middle of incubation and cruciferin subunits were degraded in the longest incubation period. In conclusion, CM proteins appeared to be effectively protected from ruminal degradation by gamma irradiation at doses higher than 25 kGy.

Key Words: Canola meal, Gamma irradiation, Protein degradation

W218 Effect of microwave irradiation on ruminal starch and protein degradation characteristics of barley grain. A. Nikkha^{*1}, A. A. Sadeghi², and P. Shawrang¹, ¹Tehran University, Karadj, Iran, ²Islamic Azad University, Tehran, Iran.

The present study was designed to evaluate the effects of 800 W microwave irradiation for 2, 4 and 6 min on ruminal crude protein (CP) and starch degradation characteristics of barley grain (BG). Duplicate nylon bags of untreated and microwave treated BG were suspended into the rumen of three Holstein steers from 0, 2, 4, 6, 8, 12, 16, 24 and 48 h, and data was fitted to exponential model to calculate degradation parameters of CP and starch. Intestinal CP digestibility was measured using mobile nylon bag technique. Proteins of untreated and treated bag residues were fractionated by gel electrophoresis. There were significant differences ($P < 0.05$) between CP degradation characteristics of untreated, 2, 4 and 6 min microwave treated BG. Microwave treatments decreased wash-out fraction and increased potentially degradable fraction of CP. The degradation rate of the latter fraction decreased as processing time increased. As a consequence, the effective CP degradability of 2, 4 and 6 min microwave treated barley at an outflow rate of 0.05/h decreased by 18, 19 and 23% units compared to untreated BG, respectively. Wash out fraction, potentially degradable fraction and degradation rate of starch was affected with microwave irradiation. Effective rumen degradability of starch decreased ($P < 0.05$) as microwave processing time increased. Microwave irradiation increased ($P < 0.05$) intestinal mobile bag digestibility of ruminally undegraded CP of BG. From electrophoretic analysis, two major Hordein fractions contain B-Hordein and C-Hordein was observed. In untreated BG, all of Hordein fractions were disappeared after 6 h of incubation, but in microwave treated BG, C-Hordein were not degraded until 12 h of incubation in the rumen.

Key Words: Barley grain, Microwave irradiation, SDS-PAGE

W219 Effect of ethanol treatments of soybean meal on rumen escape of soybean meal protein. A. A. Sadeghi¹, A. Nikkha^{*2}, and P. Shawrang², ¹Islamic Azad University, Tehran, Iran, ²Tehran University, Karaj, Iran.

Effects of ethanol treatment on the degradation kinetics of ruminal *in sacco* DM and CP of soybean meal (SBM) were determined. Soybean meal samples were soaked in 500, 600 or 700 mL/L ethanol solutions for 2 h. Duplicate nylon bags of untreated or treated SBM were

suspended in the rumen of four dry Holstein cows for up to 48 h, and resulting data were fitted to non-linear degradation model to calculate degradation parameters. Intestinal CP digestibility was measured using mobile nylon bag technique. Proteins of untreated and treated bag residues were fractionated by sodium dodecylsulfate-polyacrylamide gel electrophoresis. There were significant differences ($P < 0.05$) for DM and CP degradation parameters between untreated and ethanol treated SBM. Regardless of the concentration, ethanol treatments applied to SBM decreased the water soluble fraction, the estimated rate of CP degradation, and effective degradable protein compared to untreated SBM. The lowest estimated rate of CP degradation and the calculated effective degradable protein were observed when SBM was treated with 600 mL/L ethanol solution. Extending the ethanol concentration over 600 mL/L to SBM was considered excessive. Ethanol treatment increased ($P < 0.05$) intestinal mobile bag digestibility of ruminally undegraded CP. At concentration of 500, 600 and 700 mL/L, digestibility of CP increased by 4, 12 and 13% units, respectively. Electrophoretic analyses of untreated, 500, 600 and 700 mL/L ethanol treated SBM protein residues revealed that three of the subunits of β -conglycinin were degraded completely after 2, 6, 8 and 8 h, respectively. In untreated SBM, the acidic and basic subunits of glycinin were degraded in 8 and 12 h of incubation, but in treated SBM were not degraded even after 48 h of incubation. It was concluded that treatment of SBM with 600 mL/L ethanol solution had the greatest potential to increase rumen undegradable protein.

Key Words: Soybean meal, Ethanol treatment, Protein degradation

W220 Nutritional value of tropical fruit processing by-products. J. M. I. Sánchez^{*1,2} and C. Herrera^{1,3}, ¹Universidad de Costa Rica, San José, Costa Rica, ²Centro de Investigación en Nutrición Animal, San José, Costa Rica, ³Escuela de Zootecnia, San José, Costa Rica.

Dairy cattle production systems under grazing conditions are usually energy deficient, mainly lacking non fiber carbohydrates (NFC). The production of tropical fruit juices and purees are important economic activities in extensive areas of the world. They provide substantial amounts of high moisture and energy by-products for dairy cattle feeding. To analyze the nutritional value of fresh green bananas, ripe banana peels, pineapple peels, whole cantaloupes and citrus pulp, a total of 40 samples was taken. Dry matter, CP, NDF, ADF, lignin, ether extract and ash were analyzed. Protein fractions were analyzed, while NFC and energy was estimated according to NRC (2001). Data was analyzed by a completely randomized experimental design. Means were compared using Scheffe's multiple range test. Green bananas, whole cantaloupes and citrus pulp had energy contents higher than 1.6 Mcal/ kg of DM of NE_L 3X. More than 53% of the energy content in analyzed by-products was provided by sugars, pectin and starch. This can promote ruminal microbial growth and degradable protein utilization, increasing the feeding system efficiency. Non fiber carbohydrates levels for green bananas and citrus pulp were 79.6 and 72.4% of DM, respectively. Lush pastures usually have high levels of ruminal degradable protein; feeding proper amounts of NFC could improve the utilization of that protein. For by-products other than banana peels, lignin concentration was similar to what is found in common temperate and tropical pastures. Moreover, banana peels had one of the lowest energy contents and the highest proportion of protein fraction C.

Table 1.

By-product ¹	DM	CP	NDF	Lignin	NFC	NE _L (3X)	NE _M	NE _G
	% of DM					Mcal/kg DM		
Green bananas	20.1 ^c	5.1 ^a	11.3 ^a	4.3 ^a	79.6 ^b	1.71 ^b	1.82 ^b	1.18 ^b
Banana peels	11.3 ^b	8.2 ^a	34.1 ^c	14.5 ^c	45.9 ^a	1.22 ^a	1.31 ^a	0.68 ^a
Pineapple peels	9.8 ^b	6.3 ^a	49.8 ^d	8.5 ^b	40.7 ^a	1.20 ^a	1.29 ^a	0.69 ^a
Cantaloupes	6.3 ^a	17.6 ^b	23.0 ^b	3.8 ^a	46.0 ^a	1.81 ^b	1.92 ^b	1.24 ^b
Citrus pulp	24.2 ^d	6.9 ^a	18.3 ^b	9.0 ^b	72.4 ^b	1.62 ^b	1.71 ^b	1.08 ^b

a,b,c,d Means in a column with different superscripts are different ($P \leq 0.05$)¹ Average of eight samples

Key Words: Nutritional value, Energy sources, Tropical fruits

W221 Intestinal digestibility of ADIN in grazed forages and agro-industrial by-products. M. J. Marichal*, A. I. Trujillo, and M. Carriquiry, *Facultad de Agronomía, Montevideo, Uruguay.*

Intestinal digestibility of ADIN (ID-ADIN) was determined in seven grazing forages (3 legumes and 4 grasses) collected in different harvest dates (HD), and 8 agro-industrial byproducts. Forages evaluated were alfalfa (AA, HD=7), birdsfoot trefoil (BT, HD=7), red clover (RC, HD=4), corn (CO, HD=2), oat (OA, HD=2), ryegrass (RG, HD=2) and sorghum (SG, HD=1). Byproducts were: wet and dried brewers' grains (WBG and DBG), malt sprouts (MS), dried sorghum distillers' grains (DSDG), raw and defatted rice bran (RRB and DRB), and raw and defatted hominy feed (RHF and DHF). Intestinal digestibility was estimated by the mobile bag technique (Incubations: rumen: 16h, acid pepsin-HCl solution: 2.5h, intestine: 24h) in two dry Holstein cows fed alfalfa hay. Data were analyzed in a completely randomized design. ADIN represented 5 to 15% of CP for forages, and 2 to 38% of CP for byproducts. In average, forages presented lower ($P < 0.001$) ID-ADIN than byproducts (29.9 vs 51.0 ± 1.9%). There was an effect of family ($P < 0.001$) and specie ($P < 0.001$) of forage, and industrial procedure in byproducts ($P < 0.001$). The ID-ADIN of forages ranged from 0 to 50% and was greater for grasses than for legumes (35.0 vs 22.8 ± 3.2%). For legumes, ID-ADIN was greater ($P < 0.002$) for RC and BT than for AA and tended ($P = 0.07$) to be greater for RC than for BT (36.8^a, 24.9^a and 6.6^b ± 4.15 for RC, BT and AA, respectively). The ID-ADIN of grasses was similar ($p > 0.65$) for the four species evaluated (34.0, 35.3, 32.8, and 38.0 ± 7.74% for CO, OA, SG and RG, respectively). For byproducts, ID-ADIN ranged from 0 (MS) to 99% (WBG). The DBG resulted in lower ($P < 0.001$) ID-ADIN than WBG (71.6 vs 99.0 ± 1.0%) and fat extraction appear to reduce ($P < 0.001$) ID-ADIN in rice bran (43.0 vs 30.0 ± 1.0% for RRB and DRF) and hominy feed (49.0 vs 41.0 ± 1.0% for RHF and DHM). The DSDG presented a similar ID-ADIN (74.5 ± 1.0%) than DBG. Results confirm ID-ADIN is highly variable. It would be advisable to continue to generate data on ID-ADIN to make adjustments when appropriate.

Key Words: ADIN, Intestinal digestibility, Ruminants

W222 In situ ruminal degradation of the residue of the wine-producing industry and different agroindustrials by-products. R. H. de T. Buschinelli de Goes*, R. de C. M. Tramontini, S. T. Cardim, F. Morotti, G. D. Almeida, J. Ribeiro, L. A. Oliveira, and C. de L. Schecaira, *Universidade Estadual de Maringá-DZO, Umuarama, PR, Brazil.*

The ruminal degradation of the dry matter (DM) and the crude protein (CP) for the residue of the wine-producing industry, residue of the

industry of cookies, of the compress sunflower cake and of the soybean hulls, it was evaluated by the in situ technique, using three rumen fistulated zebu steers at pasture. The foods were grounded through 2mm screen and incubated directly in the rumen in nylon bags, in the times of 48, 36, 24, 18, 12, 06, 03, and 0 hours. The values about the potential degradation (PD) for the disappearance of DM, in the different incubation times were adjusted by a no-linear regression by Gauss-Newton's method, according to the equation $PD = A + B \cdot (1 - \exp(-ct))$, being PD = potential degradability, A = soluble fraction, B = potentially degradable fraction, c = degradation rate of the fraction B, and t = time of incubation. The effective degradability was calculated by the formula: $ED = a + (b \cdot c) / (c + k)$, where k = rate of passage of 5%/h. The soluble fraction of the wine-producing residue was from 21.61 and 19.84 % to DM and CP, with rate degradation of 4.2 and 7.67%/h, what resulted in effective degradabilities of 54.36 and 50.03 for DM and CP, respectively. The cookie residue presented main characteristic the high soluble fraction for the protein of 53.87%; the degradation rate relatively high for to DM and CP (8.7 and 14.6% for h) and the effective degradabilities arrived values of 79.87 and 37.73% for DM and CP, respectively. The potentially degradable fraction for compress sunflower cake, was of 26.17 and 40.15%, that it presented effective degradability by 50.97 and 38.65%, for to DM and CP. The compress sunflower cake presents high oil tenor (10%) what might have interfered in the degradation of this food. The main characteristic of soybean hulls was the high potentially degradable fraction for the protein (77.55%). Ruminal degradation of the studied nutrients foods presented medium values, with low soluble contents and of the extensive degradations of the insoluble fraction.

Key Words: Sunflower cake, Cookies, Soybean hull

W223 Effect of Grain Prep® surfactant on ruminal in situ degradability of flaked corn dry matter and starch. A. N. Hristov*¹, S. Zaman¹, K. Huber¹, and D. Greer², ¹University of Idaho, Moscow, ²AgriChem, Inc., Ham Lake, MN.

The effect of Grain Prep® surfactant (GP) on ruminal in situ degradability of flaked corn DM and starch was studied in two trials at commercial feed preparation facilities. Incoming corn was automatically conditioned using the Grain Prep Auto Delivery System to average moisture contents of 24 (Trial 1) and 23% (Trial 2). The application rate of GP was 22 ppm (as is basis). Control corn was treated with water alone. In Trial 1, the flaked corn was stored in ice and transported to the laboratory. To evaluate the effect of ageing on flaked corn DM and starch degradability, processed corn in Trial 2 was incubated in insulated containers for 0, 4, 8, and 16 h, after which time the grain was cooled in ice and transported to the laboratory. The temperature (°C) of the aged flakes was: 86, 58, 41, and 30 (Control) and 82, 59, 43, and 27 (GP), respectively. Three replications per treatment were analyzed for in situ degradability. Three ruminally cannulated lactating dairy cows fed 60% forage:40% concentrate diet were used for the in situ trial. Flaked corn samples were incubated in the rumen for 0, 2, 4, 6, 16, and 24 h. Passage rate of 0.06/h was used to estimate effective degradability (ED). In Trial 1, GP increased, compared with the control, the soluble fraction and ED of DM ($P = 0.05$ and $P < 0.001$) by 17.2 and 8.6%, respectively. Effective degradability of cornstarch was increased ($P < 0.001$) by 6.7%. In Trial 2, across flake ageing time, the concentration of soluble DM and starch were increased by GP by 15 and 24% compared with the control ($P = 0.003$ and $P < 0.001$). The ED of DM and starch were also increased ($P < 0.001$ and $P = 0.001$) by 3 and 4%, respectively. Flake ageing time decreased ($P < 0.001$; quadratic effect) solubility and ED of corn DM

and starch. In conclusion, GP applied at 22 ppm increased flaked corn degradability in the rumen, primarily through increasing the soluble fractions of DM and starch.

Key Words: Corn grain, Surfactant, Ruminant degradability

W224 Influence of corn hybrid on kernel traits. F. W. Harrelson*, G. E. Erickson, T. J. Klopfenstein, L. A. Nelson, and D. S. Jackson, *University of Nebraska, Lincoln.*

Extensive research has shown that processing corn can improve performance of feedlot cattle, however much less research has shown how effective using different corn hybrids can be on improving performance. Recent research, using 7 hybrids, suggests performance can be impacted by hybrid differences. A study was designed using 60 commercial hybrids, representing 22 different companies, previously used by the University of Nebraska for hybrid performance testing, to identify kernel traits that may be used as indicators of feeding value to cattle. Twelve separate physical and production traits, derived from three procedures, were measured on each hybrid. These traits were based on data gathered from growing the corn, weighing 1000 kernels, a Stenvert hardness test, and *in situ* digestibility. Since *in situ* digestion mimics ruminal digestion, any relationships between DM disappearance (DMD) and physical corn traits are of primary interest. Most corn production traits were negatively correlated or not correlated to physical traits making them less indicative of cattle performance compared to some lab techniques. Test weight (weight/volume) was negatively correlated ($r = -0.53$) to DMD ($P < 0.03$) indicating that a denser kernel is less digestible. This interaction complicates the relationship between farmers and feedyard managers when basing feed quality on this common measurement. The revolutions per minute (RPM) of the Stenvert machine, which indicates hardness based on grinding a corn sample, was also negatively correlated ($r = -0.7$) to the DMD ($P < 0.01$). This indicates that kernels requiring more force to grind are more digestible in the rumen, which is contradictory to previous research. A 10% change in DMD was observed between the most and least digestible hybrid. This trial indicates that many physical kernel traits can be helpful in determining feeding value of corn hybrids for cattle.

Key Words: Corn, Digestibility, Quality

W225 Effect of replacing barley grain with cork oak acorn (*Quercus Suber L.*) on digestibility, nitrogen balance and growth of goat kids. G. B. Aziza*¹, A. Hedi², K. Hajer², and M. Rabia², ¹*Institut National Agronomique Tunis, Mahrajène Tunis, Tunisia,* ²*Ecole Supérieure d'Agriculture Mateur, ESA Mateur, Tunisia.*

Oak acorn has been studied as an alternative energy source, replacing some grain in rabbit, broiler and sheep concentrate diets. However, the impact of oak acorn supplementation on diet utilisation by goats has not been studied. Such research would be useful in the Mediterranean mountainous areas because of the availability of oak acorn in bulk (October-January) and their use in the smallholder farming system goats. This study examined the effect of replacing barley grain with cork oak acorn (*Quercus Suber L.*) on apparent digestibility *in vivo*, nitrogen (N) balance and growth of goat kids. Voluntary intake of acorn was studied. Ten Boer kids (26.5 ± 0.5 kg) were individually housed in metabolism cages and were randomly divided into two equal groups. Kids in each group received individually 500 g oat hay and 600 g of concentrate containing barley grain (control diet) or oak acorn (experimental diet). The digestibility and growth experiment

lasted 60 days. In the following 3 weeks, voluntary intake of acorn containing concentrate was measured on kids receiving experimental diet. Digestibility coefficients of dietary constituents (DM, OM, and CP) were reduced ($P < 0.001$) as a result of acorn substitution for barley. Nitrogen retention (g/day) was positive for acorn diet (4.94 g) but lower ($P < 0.001$) than for control diet (8.74). No differences ($P > 0.05$) in CF digestibility and daily gain were observed between the two groups of kids. Voluntary intake of acorn containing concentrate reached 1400 g/day without any observable toxicity sign. In conclusion, complete substitution of barley grain with cork oak acorn did not affect performance of growing kids. This alternative could decrease the cost of animal origin products.

Key Words: Oak acorn, Kids, Digestibility

W226 Apparent digestibility, voluntary feed intake and performance of goat kids fed olive cake ensiled with different feedstuffs. F. T. Sleiman*¹, R. E. Issa¹, S. H. Ibrahim², M. G. Uwayjan¹, S. K. Hamadeh¹, I. Toufeili¹, and M. T. Farran¹, ¹*American University of Beirut, Beirut, Lebanon,* ²*University of Dohuk, Dohuk, Kurdistan, Iraq.*

Feed intake and apparent digestibility of olive cake (OC) ensiled with urea (U), molasses (M), wheat bran (WB) and yellow corn (YC) were studied using 18 goat kids (23.5 kg BW) in a completely randomized design. The study consisted of a 4-wk trial including a 1-wk collection period using the following treatments: I) 100% OC, II) 99.4% OC + 0.6% U, III) 87.5% OC + 10% M + 0.5% U + 2% water, IV) 82.9% OC + 12% WB + 0.1% U + 5% water, V) 71.5% OC + 21.3% YC + 0.2% U + 7% water, and VI) 72% OC + 12% WB + 10% M + 6% water. Each kid received 0.5 kg/d concentrate (14% CP on DM basis), in addition to ad libitum feeding of the experimental silages. Means were separated using Duncan Multiple Range test. Change in BW of kids was not significantly different ($P > 0.05$) among experimental silages. The highest BW gain was recorded for treatment VI (35g/h/d). Silage (S) DMI was not significantly different ($P > 0.05$) among treatments, averaging 105, 93, 72, 158, 154 and 219 g/h/d for treatments I, II, III, IV, V and VI, respectively. The apparent digestibility of DM, NFE, NDF, and ADF of treatment V was significantly higher ($P < 0.05$) than that of treatment IV (83.2, 90.3, 61.5 and 64.4 vs 70.5, 82.5, 32.8 and 34.4%, respectively). The CP digestibility of treatment III was significantly higher ($P < 0.05$) than that of VI (82.6 vs 74.4%). The CF and EE digestibilities of all silage treatments were not significantly different ($P > 0.05$). Results of this study indicate that ensiling OC with the used levels of ground YC, WB and M improved apparent digestibility of fiber fractions, SDMI and animal performance.

Key Words: Apparent digestibility, Olive cake, Goat kids

W227 Effect of *Pleurotus florida* on digestibility of wheat stubble and date palm leaf in sheep. F. Kafilzadeh*¹, A. Kabirifard², and H. Fazaeli³, ¹*Razi University, Kermanshah, Kermanshah, Iran,* ²*Research Center of Agriculture and Natural Resources, Boushehr, Iran,* ³*Research Center of Animal Science, Karaj, Iran.*

This study was conducted to investigate the effect of *Pleurotus florida* on the voluntary feed intake and digestibility of wheat stubble and date palm leaf. The experiment was carried out in a complete randomized design with eight Shall male sheep (four replicate for each treatment), 41.5±1.5 kg initial live weight and 2 yr old. The treatments were: 1) Untreated wheat stubble (UTWS); 2) Mycelial treated wheat stubble (MTWS), 3) Fungal treated wheat stubble after the first harvesting of

mushroom (FTWS), 4) Untreated date palm leaf (UDPL), 5) Mycelial treated date palm leaf (MTDPL), and 6) Fungal treated date palm leaf after the first harvesting of mushroom (FTDPL). Total tract digestibility of DM and OM of the MTDPL (34.7 & 37.2% respectively) were significantly ($P < 0.05$) increased in comparison with the UTDPL (27.8 & 31.8% respectively). The OM digestibility of the MTWS (38.8%) was also significantly ($P < 0.05$) higher when compared to UTWS

(32.7%). The digestibility of DM and OM of the FTDPL (26.5 and 30.0% respectively) were lower ($P < 0.05$) than those of MTDPL, But were not significantly ($P > 0.05$) different from those found in the UTDPL. However no significant difference ($p > 0.05$) in digestibility of OM and DM was observed when FTWS was compared with MTWS.

Key Words: Pleurotus Florida, Wheat stubble, Date palm leaf

Ruminant Nutrition: Forage & Fiber

W228 Ingestive behavior of dairy goats and feedlot lambs fed sugar cane silage. C. Q. Mendes, I. Susin*, A. V. Pires, L. G. Nussio, R. C. Araujo, L. V. Gerage, and M. F. Ribeiro, *Escola Superior de Agricultura Luiz de Queiroz (ESALQ)/University of São Paulo (USP), Piracicaba, São Paulo, Brazil.*

A high concentration of ethanol, present in sugar cane silage, may reduce voluntary feed intake affecting animal performance. Two trials were performed to evaluate the ingestive behavior of dairy goats and feedlot lambs fed diets based on fresh sugar cane or sugar cane silage. Thirty-nine Saanen goats (Trial 1) and thirty Santa Ines ram lambs (Trial 2) were assigned to a complete randomized block design. Animals were fed 50:50 (concentrate:roughage ratio) TMR rations. Roughage source was fresh chopped sugar cane (FSC), sugar cane silage without additive (SCS) or sugar cane silage treated with *Lactobacillus buchneri* (SCS+Lb, 5×10^4 cfu/g wet basis), corresponding to the experimental treatments FSC, SCS and SCS+Lb, respectively. During the feeding trial two sessions of 24 h were used to determine feeding behavior where eating and ruminating times were observed and recorded every 5 minutes. The parameters calculated were: dry matter intake (DMI, kg/day), NDF intake (kg/day), total time (min/day) and rate (min/g DM and min/g NDF) of eating, ruminating and chewing. In Trial 1, DMI was higher ($P < 0.01$) for goats fed FSC diet (2.77 kg/d) when compared to silage diets (2.12 and 2.23 kg/d for SCS and SCS+Lb, respectively). There were no differences on eating, ruminating and chewing times. Eating and chewing rates were similar among diets. However, rumination rate (min/g DM) was higher ($P < 0.05$) for goats fed silage diets (0.18, 0.25 and 0.25 min/g DM for FSC, SCS and SCS+Lb, respectively). In Trial 2, there was no difference on DMI among diets. Lambs spent similar time for ruminating and chewing activities. However, eating rate (min/g NDF) was lower for SCS and SCS+Lb diet when compared to FSC diet (0.43, 0.29 and 0.29 min/g DM for FSC, SCS and SCS+Lb, respectively). Sugar cane silages reduce DMI and increase rumination rate of dairy goats and decrease eating rate (min/g NDF) of feedlot lambs.

Key Words: Ethanol, Hair sheep, Silage additives

W229 Effects of dietary fiber from forage of advanced maturity on performance of lactating goats. R. H. Branco¹, M. T. Rodrigues^{*2}, M. M. C. da Silva², C. A. F. Rodrigues³, V. Viana², F. D. O. Morbi², R. da Silva Matos², and M. de Souza Duarte², ¹Instituto de Zootecnia, Sertãozinho, São Paulo, Brasil, ²Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brasil, ³Sadia, Concórdia, Santa Catarina, Brasil.

Although the term quality is ambiguous when applied to the forage in ruminant nutrition it is highly correlated with intake and digestibility. Both chemical and physical changes occur in forage as a result of plant maturity affecting, as a consequence, the dynamics of digestion and passage of rumen digesta, resulting in filling effects, reduction of feed

intake and decrease of milk production. The effect of the inclusion of neutral detergent fiber levels from forage (fNDF) with advanced maturity (86.24% NDF; 6.47% CP) was evaluated in goat diets. Feed intake, digestibility of dry matter and of nutrients, nitrogen balance, milk production, efficiency of use of metabolizable energy consumed (ME), and feeding behavior were used as dependent variables. Five dairy goats were assigned to a 5 x 5 Latin square design, using dietary fNDF levels of 20, 28, 35, 43 and 49% as independent variables. The intakes of dry matter (DMI), of nutrients, and of net energy (NEI) were reduced ($p < 0.05$) as fiber was added to ration. Conversely, intake of NDF increased ($p < 0.01$) suggesting ability for accommodation of fiber in the rumen despite the negative effect on intake. The fNDF level influenced ($p < 0.05$) the digestibility coefficients of dry matter, organic matter, crude protein and nonfibrous carbohydrates. Intake of nitrogen (g/day) was influenced in a quadratic manner with no effect on retained nitrogen. Quadratic effects were observed for the nitrogen excreted in the feces and urine, and a linear effect on nitrogen produced in the milk. No influence of fNDF levels was observed for milk constituents (fat, protein and lactose). A quadratic effect of fiber in diet was observed for milk yield with higher values obtained at 28% of fNDF. The levels of forage fiber studied did not influence values of efficiency of use of ME consumed for milk production. A variation on feeding behavior was noticed by increased time of rumination and mastication with a reduction on idle time as fiber from forage increase in diets.

Key Words: Dairy goats, Energy, Intake

W230 Influence of level of dietary forage fiber on intake and nutrient utilization of dairy goats. R. H. Branco^{*1}, M. T. Rodrigues², C. A. F. Rodrigues², M. M. C. da Silva², F. L. de Araújo², V. Viana², and V. R. Paiva², ¹Instituto de Zootecnia, Sertãozinho, São Paulo, Brasil, ²Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brasil.

Forage is a major constituent in most ruminant diets and exerts an economic impact on diet formulation due to the fact of contributing to reduce cost of available energy. Tropical forages are known for presenting both high concentration of fiber and to undergo the process of lignification at early stages of development. As a consequence it is observed a significant reduction on feed intake caused by variation on kinetics of degradation and passage in the rumen determining the available energy for microbial growth and efficiency, affecting the host performance. The present study evaluated the effect of increasing levels of dietary fiber from forage (fNDF) on lactating goats by using Tifton hay (*Cynodon* spp.) as the forage source, containing 78.54% NDF and 11.44% CP. Five goats were assigned to a 5x5 Latin square design using the levels of 19, 27, 35, 42 and 48 % of fNDF as the independent variables. Intake of dry matter (DM), of crude protein (CP), ether extract (EE), non-fiber carbohydrate (NFC), total digestible nutrients (TDN), and net energy of lactation (NEL) altered ($p < 0.05$) by increasing levels of ration fNDF. Intake of NDF did not differ among

treatments as expressed as both kg/day or as a percentual of body weight, averaging 1.2% BW. Varying fNDF levels of diets did not influence apparent digestibility of DM, OM, NDF, CP and NFC ($p > .05$). A linear reduction was observed in milk yield as fiber level in ration was increased. Milk constituents did not alter by altering levels of fiber on ration. Similarly there was no influence of fDNF levels of diets on feeding behavior. The higher efficiency of using metabolizable energy consumed for milk yield was obtained by using 35% of fNDF.

Key Words: Forage, Goats, Fiber quality

W231 Evaluation of sorghum silage and grain with condensed tannin in the diet for ruminants. H. Carneiro^{*1}, S. Peregrino², and N. J. M. Matos², ¹*Empresa Brasileira de Pesquisa Agropecuária, Juiz de Fora, MG, Brazil*, ²*Universidade Federal Rural do Rio de Janeiro, Soropédica, RJ, Brazil*.

Plant breeding programs have produced hybrids with increased grain content to improve silage production and quality. One of the biggest problems in sorghum silage production is its grain content. Since the sorghum plant is prone to bird attack, the amount of grain can fall in the silage, compromising its nutritional quality. To reduce this negative impact, researchers have been producing cultivars with content of condensed tannin, which can reduce the palatability to birds of the grain. However, condensed tannins in the forage are thought to cause either adverse or beneficial effects on nutrient use, health and production. The ideal concentration of CT in forage ranges from 20-40 g/kg DM, and at this level it may bind with dietary proteins during mastication and protect it from microbial attack in the rumen. Superior value of the tannin mentioned will perhaps reduce the nutritional value and the biological availability of the dietary protein intake. To verify the interference of condensed tannin in the nutritional quality of sorghum silage, Embrapa Corn and Sorghum Research Center has developed the genotype CMSXS114(CT) and CMSXS165(WCT) without tannin lines exclusively to evaluate the CT in nutritional quality of diet. A completely randomized design, with two treatments and nine replications were submitted to analysis of variance and the means were grouped by using Tukey's test. Animals around 200 kg, were carry out during 90 days. There were no differences ($P < 0.05$) WCT = 0.395 kg and 0.417 kg for CT, among feed intake and weight gain during the experiment. Since the interference of condensed tannin was not shown in the nutritional quality of the sorghum silage and sorghum grain, it is necessary to disseminate its use to obtain other genotypes for commercialization, based on the fact that the CT interact with silage proteins, could protecting them against the action of the microorganisms in the rumen that release them for absorption in the intestine. In the conclusions, these results show that condensed tannin does not affect in vivo the dry-matter intake and weight gain and can be fed to ruminants the same way as sorghum without condensed tannin.

Key Words: Sorghum, Silage, Grain

W232 Development of an on-farm system to determine pef value of as fed forages and TMR. K. W. Cotanch^{*1}, R. J. Grant¹, C. S. Ballard¹, J. W. Darrah¹, H. M. Dann¹, and T. Takano², ¹*William H. Miner Agricultural Research Institute, Chazy, NY*, ²*Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan*.

Physically effective neutral detergent fiber (peNDF) is a valuable means of evaluating forage and ration (TMR) particle length to ensure

proper rumen function and animal health. Forage peNDF values are critical inputs in some ration balancing programs such as CPM 3.0 to predict microbial protein output. As defined by Mertens (1997), peNDF of a feed is the product of the NDF content and its physical effectiveness factor (pef; percentage of feed particles ≥ 1.18 -mm as determined by dry sieving). Currently there is no means of accurately determining pef on farm with as fed forages. A particle size separation box (Z-Box) had been developed for assessing particle distribution of forages, TMR, grain, and manure on farm. The objective of this study was to modify the Z-Box to predict pef of as fed forages. A series of sieves (9.53, 4.76, 3.18, 2.38 or 1.14-mm hole diameter) and sieving methods were evaluated across a range of forage types, particle lengths, DM contents and operators and compared to pef determined by dry sieving using a Ro-Tap Sieve Shaker (Ro-Tap). A vigorous, vertical shaking method using a sample size of 150 g divided into three separate shakes was found to accurately assess pef for a variety of forages and TMR. For corn silage (CS) and CS-based TMR ($n=102$), a 3.18-mm sieve resulted in pef values ranging from 91-109% of Ro-Tap pef (X) (Z-Box pef=1.0018X; $R^2=0.79$). For hay crop silage (HCS) ($n=30$) the 4.76-mm sieve resulted in pef values ranging from 92-105% of Ro-Tap pef (Z-Box pef=1.0002X; $R^2=0.93$). The Z-box pef was repeatable among operators evaluating CS ($CV=1.05\%$) and HCS ($CV=2.44\%$). Although further evaluation of the Z-Box across a wider range of forages and TMR is warranted, this tool appears to provide an accurate and repeatable assessment of pef on the farm.

Key Words: Physically effective NDF, Particle separation, Z-Box

W233 Effect of physically effective fiber on digestion and milk production of dairy cows fed diets containing barley or corn grains. W. Z. Yang^{*} and K. A. Beauchemin, *Research Center, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*.

Two studies were conducted to determine the effects of physically effective (pe) NDF content of dairy cow diets on intake, digestibility and milk production with varying type of grains. Barley and corn grains were each used in separate feeding studies. Each study was designed as a replicated 4 x 4 Latin square using eight lactating dairy cows. Alfalfa silage, chopped short (5/16") and long (3/4"), was the forage in both studies. In each study, four diets were formulated using the short and long silage combined with two forage:concentrate (F:C) ratios (35:65 or 60:40, DM basis), and TMR was offered ad libitum. The peNDF contents of the diets were determined using the Penn State Particle Separator with two sieves and a pan, and the NDF content of the diets. The peNDF contents ranged from 9.6 to 19.8% for barley diets, and from 10.7 to 17.5% for corn diets (DM basis). For diets containing barley, increasing peNDF of diets by increasing forage chop length did not affect ($P > 0.15$) DMI, milk yield or milk composition, but total tract NDF digestibility increased ($P < 0.05$) by 17%. In contrast, for diets containing corn, increased forage chop length had no effect ($P > 0.15$) on NDF digestion in the total tract, DMI, milk production or milk composition. Regardless of whether the diets contained barley or corn grains, increasing the peNDF content of the diet by increasing F:C ratio decreased ($P < 0.01$) DMI and milk yield by 10 and 7%, respectively, even though digestibility of NDF was increased ($P < 0.01$) by 21%. Increasing F:C ratio also reduced ($P < 0.01$) milk protein content (3.36 vs 3.14%) and milk protein yield (1.07 vs 0.94 kg/d), although milk fat content was increased (3.51 vs 3.83%; $P < 0.01$). The results suggest that increasing the peNDF content of the diet by increasing forage particle length or by increasing F:C ratio can improve total tract fiber digestion, but may not increase intake or milk production of cows in mid-lactation.

Key Words: Physically effective NDF, Grain source, Digestion

W234 Effects of feeding Roundup Ready® alfalfa on intake and milk production of dairy cows. D. K. Combs*¹ and G. F. Hartnell², ¹University of Wisconsin, Madison, ²Monsanto Company, St. Louis, MO.

The objective of this experiment was to assess if feeding Roundup Ready® (RR) alfalfa (*Medicago sativa*) affects feed intake, milk composition or milk production of dairy cows. RR alfalfa is genetically modified to express the CP4 EPSPS protein, i.e., the same protein found in other widely-grown RR crop plants. The RR alfalfa was grown, harvested, baled and fed using practices typical for commercial dry hay and dairy production. Three commercially-available hay lots, each a different conventional cultivar, were fed as reference substances. The reference hays had been grown in the same region, season, and year as the RR alfalfa hay and all four lots had crude protein and neutral detergent fiber values of approximately 18% and 40% of dry matter (DM), respectively. Multiparous Holsteins (n=16) were fed diets containing RR or reference alfalfa hay (ca. 40% of diet DM). Diets were mixed daily and offered to each cow twice daily. Diets contained at least 15.7% CP, 29% NDF, 0.95% Ca, 0.39% P and met or exceeded National Research Council (2001) diet guidelines for CP, Ca, P, salt, and vitamins A, D and E for multiparous lactating dairy cattle producing 40.9 kg of 4% FCM per day. Cows were milked twice daily and two morning and two evening milk samples were collected each period and analyzed for fat, true protein, solids-not-fat (SNF), and lactose. The experiment was conducted as a replicated 4 x 4 Latin square. Periods were 28 d and feed intake, milk yield, and milk composition were summarized over the last 14 d of each period. Data were analyzed using the MIXED procedure in SAS, and reported as least squares means with standard errors. There were no significant treatment related effects ($P > 0.05$) for milk yield (38.0 ± 2.0 kg/d), 4% FCM (34.7 ± 1.9 kg/d), milk fat percentage (3.44 ± 0.10 %), milk true protein percentage (2.98 ± 0.07 %), milk lactose (4.72 ± 0.07 %), SNF (8.52 ± 0.20 %), dry matter intake (24.4 ± 1.4 kg/d), and 4% FCM/DMI (1.42 ± 0.05). Milk production, milk composition, feed intake and feed efficiency were not different for lactating dairy cows fed RR and conventional alfalfa hays ($P > 0.05$).

Key Words: Dairy, Alfalfa, Forage

W235 Effects of supplying protein to primiparous beef heifers on forage intake and serum hormones and metabolites. J. L. Leupp*, G. P. Lardy, J. S. Caton, and M. L. Bauer, North Dakota State University, Fargo.

During last third of gestation, 35 primiparous Angus, Simmental, and Angus-crossbred heifers (526 ± 21 kg initial BW) were used in a completely randomized design to evaluate effects of supplying degradable intake protein (DIP) or undegradable intake protein (UIP) in diets based on low-quality grass hay (7.0% CP, DM basis). Heifers were assigned to one of four treatments and individually fed in Calan gates. Treatments were: negative control (CON; no supplement); positive control (POS; 100% beet pulp); DIP (77.6% beet pulp, 19.2% sunflower meal, and 3.2% urea); and UIP + DIP (UIP; 36.2% xylose-treated soybean meal, 30.8% beet pulp, 15.9% sunflower meal, 14.5% dried distillers grain, and 2.5% urea). Means were separated using orthogonal contrasts: CON vs. supplements, POS vs. DIP + UIP, and DIP vs. UIP. All treatments were balanced using the 1996 NRC computer model. Positive control, DIP, and UIP supplements provided similar NE_m (1.19 Mcal/kg^{0.75}) while DIP and UIP supplements provided similar DIP (0.10 g/kg^{0.75}). The UIP supplement provided

0.07 g/kg^{0.75} of UIP. No differences were observed for OM, hay CP, NDF, or ADF intake ($P \geq 0.64$). By design, total CP intake (0.080 vs. 0.055 ± 0.011 % of BW) tended to increase ($P = 0.06$) in supplemented heifers compared with CON. Protein supplemented heifers lost less ($P = 0.03$) weight than POS supplemented heifers (-38.8 vs. -15.5 ± 9.53 kg, respectively). Body condition score was not affected ($P \geq 0.15$) by treatment. Serum triiodothyronine and thyroxin were similar ($P \geq 0.61$) across treatments. Increased ($P < 0.001$) plasma urea N was observed with supplemented heifers compared with CON (3.51 vs. 2.30 ± 0.15 mM), DIP and UIP compared with POS (4.05 vs. 2.42 ± 0.15 mM), and UIP compared with DIP (4.56 vs. 3.54 ± 0.15 mM). Plasma NEFA concentration decreased (724 vs. 987 ± 85 μ Eq/L; $P = 0.01$) with supplemented heifers compared with CON heifers. Additional research is necessary to better understand DIP and UIP needs of primiparous beef heifers.

Key Words: Degradable intake protein, Primiparous heifers, Undegradable intake protein

W236 Fermentation, dry matter recovery, and aerobic stability of corn silage inoculated with *L. plantarum* or *L. buchneri*. V. Sewalt¹, A. Lamptey*¹, D. Sapienza², and D. Westerhaus¹, ¹Kemin Industries, Des Moines, IA, ²Sapienza Analytica, Slater, IA.

The effect of different inoculants on corn silage fermentation and aerobic stability was assessed in small silos under environmentally controlled conditions (18°C, 45% relative humidity). *Lactobacillus plantarum* (Kem LAC® silage inoculant, Kemin Industries, Des Moines, Iowa - **LP**) and *L. buchneri* (Biotal Buchneri™ 500, Lallemand Animal Nutrition, Milwaukee, Wisconsin - **LB**) were each applied at recommended application rates and compared to control silage. Chopped whole plant corn was ensiled in 500-g vacuum-sealed bags or 15-kg airtight plastic cylinders. Quadruplicate silos were prepared for each treatment, silo type, and sampling time (n=4). Silo bags were sampled during a 28-d time course for pH and VFA; cylinders were opened at 49, 95, or 120 d to determine DM recovery, pH, VFA, and aerobic stability. Treatment effects at each opening were established by ANOVA and single-degree of freedom comparison. Aerobic stability was established by regression of time of air exposure on silage temperature with comparison of intercepts and slopes. **LP** inoculant resulted in lower pH, higher lactic acid, and higher lactic:acetic ratio ($P < 0.05$) by d 4 than treatment with **LB** or control. The more rapid fermentation pattern with **LP** manifested itself in lower final pH, higher lactic:acetic ratio, and improved DM recovery ($P < 0.05$) over **LB** when opening the larger silos. Upon exposure to air, **LP** treated silage maintained the lowest temperature, remaining at or below ambient temperature for 7-8 days, indicative of satisfactory aerobic stability. **LB** silage had a higher initial temperature than **LP** ($P < 0.05$), but the rate of its temperature rise upon aerobic exposure was lower ($P < 0.05$) than **LP** and control. Although aerobic stability is a widely acclaimed advantage of the heterofermentative *L. buchneri*, the homofermentative *L. plantarum* in this study resulted in a more rapid fermentation pattern, better DM recovery, and yet satisfactory aerobic stability.

Key Words: Corn silage, *Lactobacillus*, Aerobic stability

W237 Influence of a silage inoculant containing ferulate esterase producing *Lactobacillus buchneri* strain PTA6138 on aerobic stability and ruminal degradation of corn silage. V. L. Nsereko*, B. K. Smiley, G. H. Hettinger, A. J. Spielbauer, K. J. Forrester, B. R. Harman, E. K. Harman, and W. M. Rutherford, *Pioneer Hi-Bred Int., Johnston, IA*.

Lactobacillus buchneri strain PTA6138 produces ferulate esterase (FE) and FE enhances enzymatic hydrolysis of plant fiber. Furthermore, *L. buchneri* inoculants improve aerobic stability of silage. First, we determined effects of our inoculant (X11C38) containing *L. buchneri* PTA6138 and *L. paracasei tolerans* PTA6135 on aerobic stability of whole plant corn silage (WPCS). Forage from four different hybrids (38.4, 32.1, 39.5, and 31.8 % DM) was harvested; each was ensiled with (X11C38; 1.2×10^5 cfu/g) or without inoculation, in quadruplicate laboratory silos (10 by 35cm) which were stored for 50 to 57d. Aerobic stability was determined by recording silage temp in a thermostable environment as described by Honig (1986; *Das Wirtschaftseigene Futter*. 21: 25-32.). Secondly, we investigated the influence of X11C38 on NDF digestibility (NDFD) of WPCS. Forage (DM, 33.7%) was harvested, treated as described above and ensiled in two separate 2-ton silos for 180 days. Silage samples were collected, dried and ground (6 mm). Fresh silage from each silo was fed to 3 ruminally cannulated steers in a cross-over experiment with 2 periods of 14d that included 10d for adaptation. The dried ground WPCS was incubated in situ in Dacron bags (50 micron pore size) for 48h in the rumens of all 6 steers in a split plot experiment with diet as the main plot and inoculation of in situ silage being the subplot. Inoculation with X11C38 extended the duration of aerobic stability for all 4 hybrids by 42 to 128h ($P < 0.05$). Feeding inoculated silage did not influence 48h in situ NDFD ($P = 0.84$) and no interaction between feeding and source of silage incubated in situ was detected ($P = 0.73$). However, inoculation with X11C38 improved 48h in situ ruminal NDFD by 6.9% units ($P = 0.019$). Inoculation of whole plant corn with X11C38 enhanced aerobic stability and NDFD of WPCS; NDFD was enhanced due to changes in the forage during ensiling.

Key Words: *Lactobacillus Buchneri*, NDFD, Ferulate esterase

W238 Influence of inoculating forage with ferulate esterase producing lactic acid bacteria on ensilage and ruminal degradation of fiber. V. L. Nsereko, B. K. Smiley*, W. M. Rutherford, A. J. Spielbauer, E. K. Harman, B. R. Harman, K. J. Forrester, and G. H. Hettinger, *Pioneer Hi-Bred Int., Johnston, IA*.

Ferulic acid (FA) cross-links restrict enzymatic degradation of cell wall polysaccharides in grasses (*Graminaceae*). By releasing FA from cell wall arabinoxylans, microbial ferulate esterases (FE) increase the susceptibility of plant cell walls to further enzymatic hydrolysis and increase the nutritive value of the forage. Because some lactic acid bacteria (LAB) produce FE, we investigated the effect of inoculating forage with FE producing LAB at ensiling on ruminal NDF degradation (NDFD). Among the 10000 LAB screened, approximately 500 produced FE; 8 of these were studied in more detail. The inoculants were *Lactobacillus buchneri* PTA6138 and NRRL B-30866; *L. crispatus* NRRL B-30868, 30869 and 30870; *L. reuteri* NRRL B-30867, *L. brevis* NRRL B-30865 and an unidentified *Lactobacillus* strain NRRLB-30871. Perennial ryegrass (*Lolium perenne*) was harvested and ensiled with or without (control) inoculation with each individual LAB, in triplicate laboratory silos. After a 30d fermentation period,

silages were analyzed for fermentation characteristics, and incubated in situ (6mm) in Dacron bags (50 μ pore size) for 48h in the rumens of 3 ruminally fistulated steers adapted to a diet of grass silage. Ruminal residues were composited across steers but within silo. Results were analyzed by oneway ANOVA, with treatment means compared by Dunnett's test. Compared with uninoculated silage, inoculating with *L. buchneri* strains PTA6138 and NRRL B-30866 increased silage pH and acetate ($P < 0.05$) and reduced lactate concentration ($P < 0.05$). Inoculation with NRRLB-30871 reduced silage pH ($P < 0.05$), but other LAB had no significant effect on fermentation. With the exception of NRRLB-30871, all inoculants improved ($P < 0.05$) NDFD by 5 to 7 units (9 to 11%). We conclude that inoculating forage with FE producing LAB at ensiling can improve ruminal NDFD. Because FE producing *L. buchneri* enhanced acetate concentrations, which increases aerobic stability, some FE producing LAB should enhance both the conservation and feeding value of ensiled crops.

Key Words: Ferulate esterase, Silage inoculant, NDFD

W239 Monitoring the fate of red clover and Alfalfa proteins during wilting, drying, ensiling and ruminal fermentation. A. A. Sadeghi¹, P. Shawrang², and A. Nikkhah^{*2}, ¹Islamic Azad University, Tehran, Iran, ²Tehran University, Karaj, Iran.

Effects of wilting, drying, and ensiling on protein degradation pattern in red clover (*Trifolium pratense* L.) and Alfalfa (*Medicago sativa* L.) were studied using sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE) technique. Red clover and Alfalfa were grown in field plots, clipped by hand (at the early bloom stage), and allotted to one of four treatments: wilting, semi-drying, drying and ensiling. Three 450-kg Holstein steers fitted with rumen fistulas were used for *in situ* incubations. Data were analysed using GLM proc of SAS (1996) as CRD design. The effective CP degradability values of red clover hay at rumen outflow rates of 0.02, 0.05 and 0.08/h were 791, 713 and 662 g/kg, and for Alfalfa hay were 827, 761 and 713 g/kg, respectively. Eight proteins were identified in the fresh samples of red clover and Alfalfa. We also found proteins with molecular weights of 18, 20, 25, 30, 38 and 42 kDa. From densitometrical scanning, in red clover and Alfalfa, total photosynthetic enzyme, RUBISCO (15 and 54 kDa) comprised 55 and 51% of total electrophoretically identified protein (TEIP) in the fresh sample, and the 54 kDa protein made up 12 and 14% of TEIP, respectively. Wilting had no effect ($P > 0.05$) on the relative amounts of forage proteins. Drying for 140 h in laboratory bench resulted in a 35 to 50% loss ($P < 0.05$) in the amount of individual proteins. The 25 and 30 kDa proteins were more ($P < 0.05$) susceptible, but 15 and 54 kDa proteins were least ($P < 0.05$) susceptible to hydrolysis during drying than were most other proteins. After 120 days ensiling, less than 35 and 15% of major proteins in fresh red clover and Alfalfa remained, respectively. Red clover proteins were less ($P < 0.05$) susceptible to proteases than Alfalfa proteins during ensiling. All protein subunits of red clover and Alfalfa hay and silage were extremely susceptible to hydrolysis during ruminal exposure. SDS-PAGE technique and densitometrical scanning could monitor and detect minor differences in the amounts of individual proteins during drying, ensiling and ruminal fermentation.

Key Words: Red clover and Alfalfa, Ruminal degradability, Electrophoresis

W240 Effect of regrowth interval in spring and autumn on intake and rumen fermentation in beef cattle offered zero-grazed grass.

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Six ruminally fistulated Holstein-Friesian steers (initial BW 435 ± 13.0kg) were used in two, 2 (treatment) x 2 (17d period) crossover design experiments to examine the effects of regrowth interval (RI), of a predominantly perennial ryegrass sward in spring (Experiment 1) and autumn (Experiment 2) on intake and rumen fermentation characteristics. Regrowth intervals were 38 (long) and 28 (short) days in spring and 45 (long) and 35 (short) days in autumn. Experimental periods consisted of 6d diet adaptation and 11d sampling. Grass was harvested daily in the morning and stored at 4°C prior to feeding. Grass was offered *ad libitum* at 08:30 h and 20:30 h until d 6 and at 0.95 *ad libitum* for the remainder of each period. Rumen fluid was collected on

d 9 of each period at 0, 2, 4, 6, 8 and 10 h post morning feed, to assess rumen fermentation characteristics. Analysis of variance procedures were carried out on the data using the PROC GLM procedure of SAS 9.1. *In vitro* dry matter digestibility (DMD) (g/kg) and crude protein (CP) (g/kg DM) values were 849 and 99 for the long and 849 and 116 for the short RI in spring. Corresponding values in autumn were 826, 165, 819 and 191. Total dry matter intake and rumen pH did not differ ($p>0.05$) due to treatment in either experiment. There was no effect of RI on volatile fatty acid (VFA) concentrations with spring grass ($p>0.05$) whereas in autumn the short RI had higher ($p<0.01$) levels of valeric acid. Rumen ammonia levels were significantly higher for the short RI than the long RI for both spring and autumn grass. Results indicate that allowing grass to grow for an additional 10 days in spring and autumn has little effect on feed intake or rumen VFA proportions but lowers rumen ammonia levels, potentially reducing nitrogen excretion to the environment.

Key Words: Cattle, Rumen fermentation, Grass maturity

Sheep Species

W241 Small Ruminant Nutrition System: A computer model to develop feeding programs for sheep and goats.

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A computer model to predict site specific nutrient requirements and feed biological values for sheep and goats was developed, based on the structure of the CNCPS for Sheep. This model, called Small Ruminant Nutrition System, uses animal factors (body weight, age, animal insulation, movement, milk production and composition, body reserves, mature weight, pregnancy) and environmental factors (current and previous temperature, wind, rainfall) to predict energy, protein, calcium and phosphorus requirements. Feed biological values are predicted based on carbohydrate and protein fractions and their digestion rates, forage, concentrate and liquid passage rates, microbial growth, and physically effective fiber. Dry matter intake is predicted separately for different sheep categories based on equations developed for sheep fed indoors and on pasture. Based on this information, the Small Ruminant Nutrition System predicts energy balance, which is used to predict body condition score and body weight variations in adult sheep and the amount of milk produced from mobilized body reserves in lactating sheep. In growing sheep, live weight gain, empty body gain, and the composition of the gain (fat, protein, water + minerals) are predicted based on the energy balance and on the relative size of the lambs. The Small Ruminant Nutrition System predicts rumen pH based on dietary effective fiber, rumen N and peptide balance, rumen and whole digestive tract digestibility of each nutrient, microbial and feed undegraded protein, metabolizable protein, and the energetic cost of urea production and excretion. Fecal and urinary excretions for each nutrient are predicted as well. Based on model evaluations, the Small Ruminant Nutrition System can be used to accurately predict growth, milk production, body condition score changes, and nutrient excretion in each unique production situation.

Key Words: Sheep, Goats, Nutrition model

W242 The effect of chicory, burr medic and safflower forages on milk fatty acid composition, especially conjugated linoleic acid cis9, trans11.

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The aim of this study was to evaluate the effect of feeding fresh forages on the fatty acid composition of sheep milk, with special emphasis on the content of conjugated linoleic acid (CLA) and its precursors. Three forage species were compared during flowering phase: chicory (CH, *Cichorium intybus*), burr medic (BM, *Medicago polymorpha*) and safflower (SA, *Carthamus tinctorius*). Thirty-six mature Sarda ewes in late-lactation (157±4 DIM) were blocked into three homogeneous groups (CH, BM and SA) by milk yield (1930±60 ml) and body weight (49.6±0.9 kg) and randomly allocated to the three experimental paddocks. Each paddock was divided into two plots that were rotationally grazed (grazing period 14 d). Sward height and standing biomass were evaluated at the beginning and the end of each grazing period. The botanical and chemical composition of the herbage at the beginning and the end of the grazing period were evaluated. Individual milk yield and composition were measured fortnightly from 28 April to 4 June. Milk yield and milk protein were not influenced by forage species. Fat content was significantly lower for SA than the other forages (5.78% vs 6.37% and 6.75% for SA, CH and BM respectively, $P<0.05$). Milk fatty acid composition was affected by the forage species. CLA content (mg/g of fat) was significantly higher in milk from SA (20.69 vs 15.98 and 15.17 for SA, CH and BM respectively, $P<0.01$). CLA content significantly decreased at the end of the season ($P<0.01$) probably due to the decrease of linoleic and linolenic acid in the forages. On the basis of these results, we conclude that it is possible to manipulate the milk fatty acid composition and in particular to enhance the content of beneficial fatty acids by the use of appropriate fresh forage-based regimens.

Key Words: Pasture, Sheep milk, Conjugated linoleic acid

W243 Effect of whole or ground moisture heat damaged cotton seed on apparent digestibility in Pelibuey sheep. A. Estrada-Angulo*, M. Uribe, J. F. Obregon, E. Vazquez, and J. C. Robles, *Universidad Autonoma de Sinaloa, Culiacan, Sinaloa, Mexico.*

The objective of this study was to determine the effect of substituting whole cottonseed (WCS) or ground cottonseed (GCS) with moisture heat damaged cottonseed (DCS) or ground moisture heat damaged cotton seed (GDSCS) on apparent digestibility in sheep. The experiment was conducted with four male Pelibuey sheep (24 kg) in a latin square 4 x 4 design. The diets were: 1) Control diet with 20% of WCS, 10% corn stover, 48.5% ground sorghum grain, 5% soybean meal, 10% molasses cane, 3% meat meal, 1% animal fat, and 2.5% mineral premix and vitamins; 2) Diet similar to diet 1, but with 20% of GCS substituting at WCS; 3) Diet similar to diet 1, but with 20% of DCS substituting at WCS; 4) Diet similar to diet 1, but with 20% of GDSCS substituting at WCS. The calculated analyses of diets were 15.54% of CP and 3.57 Mcal/kg of DE. The DM, OM and CF excreted in feces was not affected ($P=0.42$) by diet. The excretion of CP in feces was higher ($P=0.08$) for GDSCS (63.16 g/d) compared to other diets; the apparent digestibilities of DM (55.3, 56.1, 56.5, and 57.9% for WCS, GCS, DCS and GDSCS respectively), OM (56.8, 57.4, 57.6, and 58.8% respectively) and CF (47.4, 47.2, 47.6, and 50.8% respectively) were similar ($P>0.10$) among diets. The apparent digestibility of CP was higher ($P=0.03$) for WCS and DCS with 60.12 and 60.46% respectively. The energy digestibility was similar ($P=0.44$) among treatments. It is concluded that the DCS can be substituted with whole CS but the grinding of DCS negatively affected the apparent digestibility of CP in the digestive tract of Pelibuey sheep.

Key Words: Cottonseed in sheep, Apparent digestibility, Damaged cottonseed

W244 Effect of cottonseed and animal fat on growth performance and carcass traits in Pelibuey sheep. A. Estrada-Angulo*, E. Martinez, J. F. Obregon, F. G. Rios, and A. B. Perez, *Universidad Autonoma de Sinaloa, Culiacan, Sinaloa, Mexico.*

The objective of this study was to determine the effect of whole cottonseed and animal fat on growth performance and carcass traits in Pelibuey sheep. Sixty four Pelibuey sheep (males; average BW=14.3 kg) were maintained 84 days in a complete randomized block experiment design. The animals were weighed, blocked by weight into 16 groups of four animals each, placed in 16 ground floor pens (2 x 3 m), and assigned to one of four diets: 1) Diet with 12.23% CP and 2.9 Mcal DE/kg, containing 10.0% corn straw, 65% ground broom sorghum grain, 3.0% poultry meat meal, 5.0% soybean meal, 10.0% sugarcane molasses, 3.0% hydrolyzed animal fat, and 2.5% mineral premix (Control); 2) Diet similar to the control diet with 13.9% CP and 2.9 Mcal DE/kg, but containing 10.0% whole cottonseed, 2.0% animal fat, and 57.5% ground broom sorghum grain (WCS10); 3) Diet similar to Control with 15.54% CP and 2.9 Mcal DE/kg, but containing 20.0% whole cottonseed, 1.0% animal fat, and 48.5% ground broom sorghum grain (WCS20); 4) Diet similar to Control with 17.18% CP and 2.9 Mcal DE/kg, but containing 30.0% whole cottonseed, without animal fat, and 39.5% ground broom sorghum grain (WCS30). Feed was offered twice daily so that feed was available at all times. Carcass traits were recorded, the carcasses were dissected and main cuts were measured. Average daily gain (150, 172, 177, and 177 g/d for Control, WCS10, WCS20 and WCS30 respectively), end weight (27.2, 28.3, 29.1, and 28.5 kg), and feed/gain (4.9, 4.6, 4.6 and 4.4 respectively)

were increased ($P=0.05$) by the inclusion of cottonseed. Daily feed intakes (0.753, 0.796, 0.826, and 0.794 kg/day) were similar among diets. Cold carcass weight, carcass length and width, carcass dressing percentage, rib eye area, back fat, leg circumference, and primary cuts including long loin, short loin, rib, leg, shoulder and neck were not affected ($P>0.05$) by diet. We conclude that the inclusion of cottonseed plus animal fat increased production without affecting carcass traits and primary cuts in Pelibuey sheep.

Key Words: Cottonseed, Carcass, Pelibuey sheep

W245 Effect of whole moisture heat damaged cottonseed on growth performance and carcass characteristics in Pelibuey sheep. A. Estrada-Angulo*¹, R. Rodriguez¹, M. Mellado², J. F. Obregon¹, F. G. Rios¹, G. Contreras¹, and J. C. Robles¹, ¹FMVZ-Universidad Autonoma de Sinaloa, Culiacan, Sinaloa, Mexico, ²Universidad Autonoma Agraria Antonio Narro, BuenaVista, Saltillo, Coahuila Mexico.

The objective of this study was to compare five levels of whole moisture heat damaged cottonseed (DCS) on growth performance and carcass traits in Pelibuey sheep. Eighty Pelibuey sheep (males; average BW = 14.3 kg) were maintained for 56 days in a complete randomized block experiment design. The animals were weighed, blocked by weight into 20 groups of four animals each, placed in 20 ground floor pens (2 x 3 m), and assigned to one of five diets: 1) Diet with 15.54% of CP and 3.57 Mcal of DE/kg, containing 6.0% corn straw, 28% whole cottonseed (WCS), 44.5% whole corn grain, 5.0% soybean meal, 3.0% poultry meat meal, 10% sugarcane molasses, 1.0% hydrolyzed animal fat, and 2.5% mineral premix (Control); 2) Diet similar to the Control diet with 7% DCS plus 21% WCS (DCS7); 3) Diet similar to Control diet with 14% DCS plus 14% WCS (DCS14); 4) Diet similar to Control with 21% DCS plus 7% WCS (DCS21); and 5) Diet similar to Control with 28% DCS without WCS (DCS28). Feed was offered twice daily so that feed was available at all times. Carcass traits were recorded, and the carcass was dissected and main cuts were measured. Average daily gain (171, 182, 166, 178, and 174 g/d for Control group, DCS7, DCS14, DCS21 and DCS28 respectively), end weight (34.25, 35.13, 34.56, 34.3, and 34.16 kg), feed intake (0.917, 0.910, 0.942, 0.905, and 0.941 kg/d of DM), and feed/gain (5.45, 5.03, 5.7, 5.09, and 5.5 respectively) were similar ($P>0.05$) among diets. Hot carcass weight, carcass length and width, carcass dressing percentage, rib eye area, back fat, leg circumference, and primary cuts including long loin, short loin, rib, leg, shoulder and neck were not affected ($P>0.05$) by diet treatments. We conclude that the total or partial substitution of whole cottonseed by whole moisture heat damaged cottonseed did not affect production, carcass traits, and primary cuts in Pelibuey sheep.

Key Words: Cottonseed, Damaged cottonseed, Carcass sheep

W246 Carcass yield and loin tissue composition of feedlot lambs fattened with diest containing fish residue silage. A. G. da Silva Sobrinho*¹, S. M. Yamamoto¹, R. M. Vidotti², H. B. A. de Souza¹, A. C. Homem Junior¹, and R. S. B. Pinheiro¹, ¹Unesp-São Paulo State University, Jacoticabal, São Paulo, Brazil, ²CAPTAPC/Fishing Institute, São José do Rio Preto, São Paulo, Brazil.

Feeding confined lambs allows early slaughter with adequate carcass fat cover, and the use of alternative protein concentrates such as silages from the fish industry decreases environment impact and reduces

feeding costs, preserving the biological efficiency of nutrients. Eighteen 7/8 Ile de France 1/8 Polwarth lambs averaging 17 kg, confined in individual cages, were used in this study. Animals were distributed among the following treatments: T1- control diet; T2- 8% freshwater fish (*Oreochromis niloticus*) residue silage diet; and T3- 8% sea fish (*Lophius gastrophisus*) residue silage diet. In the production of fermented fish silage, *in natura* fish industry remains were ground and placed in plastic containers, with 7.50% sugarcane molasses, 2.50% natural yoghurt and 0.125% sorbic acid. Ingredients were homogenized and containers were hermetically sealed to produce lactic acid, a pH reducer and pathogen inhibitor. Fish residue silage partially replaced soybean meal, and each diet included 40% corn silage. Lambs were slaughtered at 32 kg of body weight, and analyses showed that fish residue diets did not affect ($P>0.05$) quantitative carcass traits, with cool and warm carcass weights of 14.95 and 14.52 kg, respectively, and biological and commercial yields of 55.31% and 47.47%, respectively, and weight lost by chilling of 2.92%. The mean loin eye area was 12.05 cm² and muscle and bone proportions 57.61 and 16.67%, respectively. The percentage of fat (19.77%), was lower in loins of lambs that received the control diet, in comparison to lambs fed the fish residue silage diets (T2 = 24.68% and T3 = 24.01%). The composition of the muscle *Longissimus lumborum* was not affected by the diets, with crude protein, ether extract and ash levels of 25.66%, 3.48% and 1.03%, respectively. The replacement of soybean meal with fish residue silage resulted in increased loin fat, with no effect on quantitative carcass traits.

Key Words: Carcass, Fish silage, Lambs

W247 Effects of using raw soybean on performance and carcass characteristics of feedlot lambs. F. S. Urano, A. V. Pires*, I. Susin, C. Q. Mendes, G. H. Rodrigues, R. C. Araujo, and I. U. Packer, *Escola Superior de Agricultura Luiz de Queiroz (ESALQ)/University of São Paulo (USP), Piracicaba, São Paulo, Brazil.*

The high energy and protein concentration present in soybeans makes them an attractive alternative feed for feedlot lambs. Sixty-four Santa Ines ram lambs (initial BW 20 ± 0.2 kg and 75 ± 2 days old) were used to evaluate the effects of using raw soybeans (RS) in high grain diets on growth efficiency, carcass characteristics and lamb cuts of feedlot lambs. A randomized complete block design, composed of eight blocks, was used. Lambs were blocked by initial weight and age and assigned to one of four treatments. Lambs were housed in 32 pens. All pens had two lambs. Pen was the experimental unit. Lambs were fed an isonitrogenous diet composed of 90% concentrate (grounded RS, soybean meal, grounded corn and minerals) and 10% coastcross hay (*Cynodon* spp) for 56 days. RS were added at 0, 7, 14 and 21% of the diet dry matter, corresponding to the experimental treatments RS0, RS7, RS14 and RS21, respectively. Data were analyzed using the GLM procedures of SAS. Treatment responses were determined using orthogonal polynomials (linear, quadratic or cubic). Dry matter intake and average daily gain (1.1, 1.0, 0.9 and 0.9 kg/lamb/day; 298, 275, 280 and 255 g/lamb for RS0, RS7, RS14 and RS21, respectively) decreased linearly ($P<0.05$) with the inclusion of raw soybeans. However, feed conversion, carcass characteristics and lamb cuts were not affected ($P>0.05$). Although the inclusion of RS adversely affected dry matter intake and average daily gain, even the highest level of its inclusion in the diet provided satisfactory feedlot lamb performance.

Key Words: Hair sheep, Performance, Santa Ines

W248 The effect of feeding yeast (*Saccharomyces cerevisiae*) on growth and white blood cell count as an indicator of the immune system in suckling lambs. F. Kafilzadeh* and M. Rahmani, *Saveh Azad University, Saveh, Iran.*

This experiment was carried out to determine the effect of feeding yeast (*Saccharomyces cerevisiae*) on average daily gain and the number of white blood cells (WBC) as an indicator of the immune system in suckling lambs. Twenty Shal suckling lambs were included in a completely randomized design. Lambs were assigned to one of the two treatments (with or without yeast) 15 days after birth. One gram yeast was given once daily in a 50 g concentrate mix to each lamb. Lambs were weighed at two week intervals until weaning time (3 months of age). Blood samples were taken at 45 and 90 days of age. There was a significant ($p<0.01$) increase in average daily gain in lambs fed yeast compared to lambs without yeast (205 g/d versus 162 g/d). There was no effect ($p>0.05$) of feeding yeast on WBC count. The frequency of diarrhea occurrence decreased markedly in the group fed yeast.

Key Words: *Saccharomyces cerevisiae*, Suckling lamb, Average daily gain

W249 Effects of ACTH and ascorbic acid application on phagocytic activity of neutrophil leukocytes in Akkaraman sheep. F. S. Hatipoglu*¹, C. Altinsaat², and N. Sulu², ¹*Akdeniz University, Burdur, Turkey,* ²*Ankara University, Ankara, Turkey.*

The aim of this study was to determine the effects of ascorbic acid (AA) and ACTH on phagocytic activity of neutrophil leukocytes (PI) of Akkaraman sheep. One year-old Akkaraman sheep (n=18) were assigned randomly to three experimental groups (TRT I=ACTH; TRT II=AA; TRT III=ACTH+AA; n=6 per group). Blood samples were taken one week before the experiment as control values. Sheep in TRT I, II, and III received 20 unit/kg/day ACTH, 100 mg/kg/day AA, and 20 unit/kg/day ACTH +100 mg/kg/day AA, respectively for 7 d. All sheep were fed ad libitum during the experiment. Control values for total leucocyte, neutrophil leukocyte and PI for TRT I, II, and III were 6.36 ± 0.45 , 6.26 ± 0.65 , and $6.31 \pm 0.78 \times 10^3/\mu\text{L}$ ($P>0.1$); and 1.77 ± 0.30 , 1.81 ± 0.39 and 1.86 ± 0.28 ($P>0.1$) $\times 10^3/\mu\text{L}$; and 2.07 ± 0.28 , 2.13 ± 0.25 and 2.09 ± 0.25 ($P>0.1$), respectively. Following a week of treatment period, values for total leucocyte, neutrophil leukocyte and PI for TRT I, II, and III were 7.92 ± 0.54 , 6.43 ± 0.44 , and $6.73 \pm 0.52 \times 10^3/\mu\text{L}$ ($P<0.05$); and 3.52 ± 0.57 , $1.92 \pm 0.42 \times 10^3/\mu\text{L}$ ($P<0.05$) and 2.33 ± 0.25 ; and 1.33 ± 0.36 , 2.25 ± 0.26 and 1.89 ± 0.28 ($P<0.05$), respectively. Thus, ACTH application increased the neutrophil leukocyte and total leukocyte count, and decreased the PI. However, AA administration reversed the action of ACTH. In conclusion, AA had a positive contribution on the phagocytosis efficiency of the neutrophil leukocytes in ACTH-exposed Akkaraman sheep.

Key Words: ACTH, Ascorbic acid, Phagocytic index

W250 Gonadal and epididymal sperm counts in growing Ossimi rams in Egypt. A. M. Osman*, *Assiut University, Assiut, Egypt.*

Ossimi is the most popular sheep breed in Egypt. Gonadal and epididymal sperm reserves were studied in 48 slaughtered Ossimi rams. Animals were classified into eight age groups (6, 7, 8 to 9, 12, 15, 18, 24 and >24 months). Testis and epididymis (caput, corpus and cauda) of one side were dissected and weighed separately, and their volumes were determined by water displacement. The whole

testis and regions of the epididymis were cut into small pieces, then homogenized with known volumes of saline using an electric mixer. Three drops sodium hydroxide (2%) and two drops eosin solution (3%) were added to 5 ml of the homogenate and gently mixed. Stained sperm heads were counted twice using a cytometer. Sperm were not detected in any organ at 6 months of age, while two animals at 7 months had sperm in only their testes. The average testicular weight, sperm per g tissue and total sperm per gonad in these two animals were 48.5 g, 23.6×10^6 sperm, and 1.14×10^9 sperm respectively. At 8 to 9 months, sperm were detected in all testes and epididymes. Testis weighed 51.3 ± 1.8 g, while sperm count per g tissue and per organ were $26.1 \pm 4.2 \times 10^6$ and $1.34 \pm 0.23 \times 10^9$ respectively. Total sperm in the epididymis was $1.64 \pm 0.19 \times 10^9$. Testes and total sperm development showed significant increases ($P < 0.01$) until 24 months. The maximum number of sperm per g tissue occurred at 15 months ($90.2 \pm 7.9 \times 10^9$). Epididymis (weight and total sperm) developed slowly from 7 to 12 months then rapidly until 24 months. Each region of the epididymis grew independently. Ratios of caput and corpus weights to whole epididymis were 41.3% and 20% respectively at 8 to 9 months. These ratios decreased to 39.7% and 13.6% respectively at 18 months. Ratios recorded for cauda increased from 38.7% to 46.7% respectively at the same ages. There were similar trends for sperm counts. At 24 months, cauda contained $45.15 \pm 7.9 \times 10^9$ sperm representing 80.7% of total epididymal sperm. Correlations between testis-epididymis weights and their sperm counts were significant ($P < 0.01$). These data may be of value when selecting rams for breeding.

Key Words: Ossimi rams, Testis, Sperm

W251 The effect of two management systems on milk composition in dairy ewes. S. A. Maestá, E. R. Siqueira, M. M. Stradiotto, C. C. Boucinhas, A. Piccinin, and R. M. S. Emediato*, *São Paulo State University, Botucatu, São Paulo, Brazil.*

Several factors that contribute to variation in production and quality of ewe milk have been described, such as environment, breed, age of ewe, lactation stage, number of lambs or milking techniques, sanitary condition and udder infections, herd management and nutritional level during gestation and lactation. The objective of this project was to evaluate two milk production systems and their effect on milk chemical composition using 87 Bergamasca ewes. Ewes in one group were separated from their lambs 48 h after birth, while ewes in the second group were kept with their lambs until the lambs were weaned at 60 days of age. All ewes were machine-milked for a period of 90 days. Milk samples were collected once a week for analyses of lactose, protein, fat and total solids using infrared. The analyses were carried out at the Milk Cattle Breeding Management Technology Center, ESALQ/USP, Piracicaba, São Paulo. The data were statistically analyzed using the GLM procedure of SAS. Differences in production of fat, protein, lactose and total solids contents during the whole lactation were observed between the two systems ($P < 0.05$). Fat content of the milk from the ewe group without lambs was higher (5.51%) than the ewe group with lambs (3.74%). Differences in protein content of the milk were also found; however, average protein values were within levels reported in previous studies.

Key Words: Dairy sheep, Milk constituents, Machine-milking

W252 Identification of quantitative trait loci affecting parasite indicator traits in a double backcross population of sheep. T. Sonstegard*¹, F. Iraqi², J. Mugambi², C. Van Tassell¹, F. Garcia³, O. Hanotte², S. Nagda², J. Gibson⁴, and L. Baker², ¹USDA, ARS Bovine Functional Genomics Laboratory, Beltsville, MD, ²International Livestock Research Institute, Nairobi, Kenya, ³FAO/IAEA Animal Production Unit, Vienna, Austria, ⁴University of New England, Armidale, NSW, Australia.

The natural genetic variability of the ruminant immune system provides a feasible means to control gastro-intestinal (GI) parasite infection. To initiate explanation of important allelic differences, a genome-wide analysis for quantitative trait loci (QTL) was initiated in a double backcross population generated by mating six F1 Red Maasai x Dorper Rams to both Red Maasai (resistant) and Dorper (susceptible) ewes. A total of 1,063 backcross lambs were monitored through two cycles of natural challenge on pasture. Only the phenotypic extremes (most resistant 10% and most susceptible 10%) for fecal egg count (FEC), packed cell volume (PCV) and the decline in PCV (PCVD) measured on 6-month-old lambs were genotyped ($N=371$ lambs). A preliminary half-sib regression analysis was done on chromosomes (Chr) 6, 8, 9, 10, 11, 13, 14, 16, 20, 23, and 26. Significant QTL ($f > 3.0$) were detected for FEC and PCV indicator traits on Chr 6, PCV on Chr 20, and live weight on Chr 26. The QTL detected on Chr 6 is located in the approximate genome position containing QTL found in cattle and other sheep populations for parasite indicator traits. These results are an initial step in developing breeding schemes based on marker-assisted selection that will introgress genomic regions controlling resistance from one breed to another.

Key Words: QTL, Parasites, Sheep

W253 An ovine whole-genome radiation hybrid map. C. H. Wu*¹, K. Nomura¹, T. Hadfield¹, J. E. Womack², and N. E. Cockett¹, ¹Utah State University, Logan, ²Texas A&M University, College Station.

A collaborative project between Utah State University and Texas A&M University has produced an ovine whole-genome radiation hybrid (RH) 5,000-rad panel consisting of 90 clones, with retention frequencies between 15-40%. Large DNA preparations (around 6 mg/clone) have been produced from each cell line and have been diluted to a working concentration of 25ng/ μ l. The panel has been distributed to four international laboratories. To date, 299 markers that have been previously assigned on the ovine and bovine linkage maps have been tested on the panel. One hundred fifty four (51.5%) of these markers produced resolvable patterns and will be typed across the whole panel. We will also screen primers developed from ovine BAC end sequencing and SNP projects across the panel. These data will be used to develop a framework/comprehensive RH map for sheep.

Key Words: Ovine, Whole-genome radiation hybrid, Comprehensive RH map

Teaching/Undergraduate and Graduate Education

W254 Factors associated with students' self-reported amount of learning in dairy science courses. R. R. Rastani* and M. A. Wattiaux, *University of Wisconsin, Madison*.

Our objective was to study factors that were associated with students' self-reported amount of learning in undergraduate courses offered by the University of Wisconsin– Madison, Department of Dairy Science. Data included departmental course evaluations (n=774) from Fall 2003 through Spring 2005 for 14 courses (8 required, 6 elective). The course evaluation consisted of 12 items that students answered anonymously on a likert-type scale of 1 to 5 (for items 1 to 10, 1=not at all and 5=very much; for items 11 and 12, 1=lowest 20% and 5=highest 20%). Item 8 was optional, and it was omitted from the analysis due to a large amount of missing data. Spearman correlations were used to evaluate the relationship between item 4 (I learned a lot in this course) and the 10 other items: (1) I value the material/ topics covered in this course (r=0.59), (2) This course stimulated my interest in the subject (r=0.72), (3) This course encouraged me to think (r=0.73), (5) Individual class meetings or lectures were well planned and effective (r=0.57), (6) This course was well organized and provided a coherent understanding of the subject (r=0.59), (7) Useful supplementary materials were available (r=0.36), (9) The instructor was approachable and seemed to enjoy teaching (r=0.51), (10) The grading system was appropriate, clearly explained, and fairly applied (r=0.43), (11) Overall, I rank this instructor (r=0.55), and (12) Overall, I rank this class (r=0.65). The above correlations were significant at the level of $P < 0.001$. The correlations were not affected by course type (required vs. elective), but varied based on intended class level. Student-centered evaluation items (1, 2 and 3) had the lowest relationship with self-reported amount of learning in Freshman classes relative to Junior and Senior classes. Typically, instructor or course-centered items (5, 6, 7, 9, 10, and 11) had a weaker correlation than student-centered items with students' self-reported amount of learning. Students' overall class ranking appeared to be heavily based on self-reported amount of learning.

Key Words: Learning, Evaluation, Student-centered

W255 Leadership development through leadership action plans. D. R. Brink*, L. D. Moody, and M. M. Peterson, *University of Nebraska, Lincoln*.

Business and industry desire entry level employees who possess strong leadership and interpersonal skills. A partnership of the University of Nebraska-Lincoln departments of Animal Science and Agricultural Leadership Education and Communication was established in 2001 to incorporate leadership development in the Animal Science curriculum. Animal Science students who elect to join the Animal Science Leadership Academy (ALA) participate in four leadership development seminars. ALA students develop leadership action plans (LAP) during the second semester of their four semester ALA program. Students enroll in a 1-credit seminar. In the seminar, faculty and students discuss: dimensions of professional development, leadership identity development models, sources of motivation and rewards, and effective coaching. Each student develops an action plan to achieve at least three development goals in three areas: personal qualities, leadership skills and communication skills. Task timelines, witnesses, support team, rewards and potential sources of resistance are identified. Written and oral progress reports are presented during the semester. Student evaluations indicate the most valuable parts of developing LAP are the

understanding of leadership development as a process and sources of motivation. Eighty-eight percent of the students reporting either agreed or strongly agreed that they will continue their leadership development by using the concepts learned in completing the LAP.

Key Words: Leadership, Plan, Teaching

W256 Promoting student engagement in the animal sciences: Incorporation of an academic pedigree project into an undergraduate animal breeding and genetics course. C. J. Kojima*, *University of Tennessee, Knoxville*.

Undergraduates majoring in Animal Science often progress through their program without learning much about the history of the discipline or the faculty who make up the department. In an effort to increase student-faculty interaction, stimulate interest in research in Animal Science, and increase general engagement of students in a genetics course, an "Academic Pedigree" project was incorporated into the UT Animal Science core Animal Breeding and Genetics class. Groups of 3-4 students were each assigned a faculty member; the project was to trace the faculty member's "lineage" as far as possible through personal interviews, email, telephone, and internet searches. The faculty member provided the students with two "parents" (most often thesis advisors and dissertation mentors), institution where the member studied under that parent, the years that the student studied with that parent, and any other pertinent information the member wished to volunteer. One set of students were responsible for the general summation of results for the department as a whole. The students were required to present a poster of their findings, including a brief summary or abstract, calculation of inbreeding coefficients (if any), and a pedigree-styled depiction of their faculty member's lineage. A seminar was arranged so that all posters were presented and faculty and graduate students of the department could view the posters and discuss the findings with the presenters. Each faculty member graded the posters on accuracy, style, and participation of the presenters. The project grade was determined by averaging the faculty evaluations. The project was very well received by faculty and students alike; many students greatly enjoyed their telephone and online conversations with "parents" and "grandparents" of their faculty member. The exercise served not only to increase the interest level of the students but also to teach basic breeding principles. Further modifications of this teaching tool may be to single out sub-disciplines each semester the course is taught; this semester the theme is "geneticists".

Key Words: Teaching, Genetics, Undergraduate

W257 Teaching animal behavior research to animal science students. D. B. Imwalle*, S. E. Becker, and L. S. Katz, *Rutgers University, New Brunswick, NJ*.

In our section of Research in Animal Science, students enroll for varying numbers of credits, for which they participate in different research activities throughout the semester. Undergraduates are expected to work three hours per week per credit. They must keep a journal that describes their efforts. An aim of this course is to teach students large animal behavioral endocrinology research. Behavioral endocrinology experiments often require days of animal preparation (such as hormone treatments) before the behavior tests. Graduate

students assign undergraduates specific research tasks (e.g. working goats, observing behaviors, recording behavioral data, etc.). For each experiment, the graduate student explains the rationale and hypothesis being tested, and trains the students to collect behavioral data in a standardized fashion. In one project, the behavior tests are videotaped for student viewing. Thus, students can observe these tests in addition to having performed tasks they were assigned at the farm. In the classroom students are grouped to record the behavior of specified animals. The data from each group is averaged and the variability of those data is used to teach the students the concept of inter-observer reliability. In a second project, the class is gaining experience in estrus detection of a dairy heifer herd. The students were taught three behaviors (mounting, standing to be mounted, and escaping from a mount attempt) using a video tape. Students access a web-based sign-up calendar and observe cattle at any time any day of the week, having been told that most estrus behavior in cattle occurs at night. To assess the effectiveness of this estrus detection program based upon the random observation schedule of a large number of students (n=30), these data are compared to estrus detection based upon an electronic activity monitoring system. Including students in research affords opportunities for them to work with animals and to learn animal behavior. Also, graduate students learn to be mentors to enthusiastic, trained students.

Key Words: Teaching, Animal behavior, Research methods

W258 Development of a course in embryo transfer and related technologies for undergraduate students in agriculture. C. R. Youngs*, *Iowa State University, Ames.*

Embryo transfer is an animal biotechnology that is experiencing a rapidly increasing rate of adoption in production agriculture. Embryo transfer is a comprehensive set of procedures involving the production and collection of preimplantation embryos from genetically superior females (donor females) and subsequent transfer of the harvested embryos into the uteri of recipient females whose estrous cycles have been synchronized with that of the donor. Initial use of embryo transfer in the commercial livestock industry involved the surgical collection and transfer of embryos, and, hence, it was considered a veterinary procedure. However, with the advent of non-surgical embryo collection and transfer techniques, some states have now revised their state veterinary practice acts to allow non-veterinarians to perform embryo transfer for a fee. A course in embryo transfer and related technologies (e.g., embryo cryopreservation and in vitro fertilization) was developed to provide undergraduate students in agriculture with sufficient background information so that they could either pursue further training in the field or alternatively engage in meaningful dialogue with embryo transfer technicians whom they employ. The objective of this presentation is to provide readers with an overview of the development, implementation, and 10-year experience in teaching this

course at Iowa State University. Prerequisites for the course include a course in reproductive physiology, and students who enrolled in the course without the necessary prerequisite achieved lower mean course grades than students who had completed the prerequisites. Student enrollment for the initial course offering was 9, but enrollment grew to as many as 38. Student evaluations of the course indicated that a hands-on laboratory course would be helpful, and such a course was developed and implemented. Three students who have taken these courses are now actively engaged in commercial embryo transfer, while other students are actively using embryo transfer in their livestock breeding operations.

Key Words: Curriculum development, Embryo transfer

W259 Introduction of a laboratory component to a therapeutic horseback riding course. M. Nicodemus* and K. Slater, *Mississippi State University, Mississippi State.*

In the fall of 2001 a 3 credit lecture course in the introduction of therapeutic horseback riding (TR), ADS 3233, was offered for the first time at Mississippi State University. A survey given before and after the course indicated the majority of the students recommended a hands-on component. In the fall of 2005 ADS 3233 was offered for the first time with a weekly laboratory component. For both the 2001 lecture only TR course (01) and the 2005 lecture/laboratory TR course (05) a 22 question survey was completed on the first (S1) and the last (S2) days of lecture with answers given as strongly agree (SA), agree (A), disagree (D), or not applicable (NA). 83% of the 01 students had experience in TR, while only 20% of the 05 students had TR experience. For 01 S1, D was given by the majority of students (67%) for 7 of the questions, while the same questions in S2 the majority of the students (67%) either answered SA or A. These questions concerned the setting up of TR programs, working with the medical and educational communities, and finding TR resources. For 05 S1, D was given for the same questions (5 of the 7 questions) concerning similar topic areas as those reported in 01 for 40% of the students, while the same questions in S2 100% of the students either answered SA or A. For S2 05, the majority of answers (60%) in the survey were SA or A. The largest shift in answers for 01 concerned TR horse selection in which 40% answered D in S1 and 40% answered SA in S2. The greatest answer shift for 05 concerned TR career possibilities in which 70% answered D in S1 and 50% answered SA in S2. 33% of 01 students intended to make a career in this field, while 40% of 05 students had the same intentions. 100% of the 05 students answered SA or A concerning the helpfulness of the laboratory to understanding TR. Therefore, survey results supported the conclusions that the addition of a laboratory to ADS 3233 was beneficial for the students further understanding of TR.

Key Words: Horse, Therapeutic riding, Teaching

Wednesday, July 12, 2006

SYMPOSIA AND ORAL SESSIONS

ADSA Production Division, Dairy Reproductive Terminology Workshop

426 Reproductive terminology workshop. E. R. Jordan^{*1}, J. S. Stevenson², P. M. Fricke³, and M. W. Overton⁴, ¹Texas A & M University, Dallas, ²Kansas State University, Manhattan, ³University of Wisconsin, Madison, ⁴University of Georgia, Athens.

Reproductive physiologists have developed a number of different synchronization programs and measures for reproductive analyses. Terminology, however, is not being applied consistently and uniformly in the scientific literature, textbooks, and popular press. Advances in reproductive biology of domestic species and adoption of the latest technical developments often are hindered by confusion and inconsistency regarding terminology, nomenclature, and specific definitions used to describe the protocols, treatments, or clinical conditions. During this workshop, a standardized set of terminology will be presented and discussed with the objective of developing a consensus, standardized reference to serve as a guideline for nomenclature use in manuscripts, textbooks, and popular press articles.

Examples of the nomenclature to be discussed include: Ovsynch, Select Synch, Select Synch plus CIDR, Presynch, Presynch + Ovsynch, Co-Synch, CIDR Synch, CIDR + Co-Synch, Resynch with CIDR, Resynch at pregnancy diagnosis, % compliance, compliance rate, pregnancy rate, palpation pregnancy rate, AI-submission rate, conception %, conception rate, rate vs. risk, embryonic mortality, fetal mortality, abortion, retained fetal membranes, melengesterol acetate (MGA) + prostaglandins, MGA Select, MGA with natural service, 7-11 Synch, metritis, endometritis, pyometra, and daughter pregnancy rate (DPR). Standardizing reproductive physiology nomenclature, definitions, and descriptive terminology should facilitate comparisons across studies, and most importantly, provide dairy producers, veterinary practitioners, and scientists more precise measures of the utility of the observations when new reproductive technologies are reported and then applied in the field.

Key Words: Reproduction, Terminology, Nomenclature

ARPAS Symposium: Assessment and Management of Feedstuff Variation in Dairy Nutrition

427 How can dairy nutrition models deal with uncertainty? R. A. Kohn^{*}, University of Maryland, College Park.

Diet formulation models for dairy cattle require estimates of feed composition provided as table values or from feed analysis. In addition to feed composition, models use predicted milk production and body weight for when the ration will be offered, and internal constants like digestibility coefficients for specific nutrients. Current models do not account for uncertainty of feed analysis, animal performance, or internal constants; they simply overestimate requirements by applying "safety" factors, or adjustments above estimated requirements to compensate for the risk of underfeeding. Optimal safety factors can be calculated by balancing the increased ration cost against the potential loss in milk income from the risk of underfeeding due to uncertainty. For the previous 5-yr average milk and feed prices, the optimal safety factor for diet CP was 35% of the SD in predicted requirements and supply. At half the cost of feed protein relative to milk, the optimal safety factor is 86% of the SD in feed CP supply. Multiple safety factors can be added as squared terms to account for uncertainty in feed

analysis, animal production, intrinsic model uncertainty, and variation among animals. For example, if cows are fed 50% corn silage (9% CP; SD = 0.9%) and 50% grain mix (25% CP; SD = 1.0), the final ration is 17% CP with $SD = 0.67 \sqrt{(0.5^2 \times 0.9^2 + 0.5^2 \times 1.0^2)}$. Only considering variation from CP analysis would optimally target 17.2% CP in the diet $\{17 + 0.35 \times 0.67\}$. If uncertainty from other sources sums to an additional unit of CP as a fraction of feed DM, the total safety factor would be $0.42 \{0.35 \times \sqrt{(1.0^2 + 0.67^2)}\}$ and the diet should target 17.4% CP. Common pitfalls in use of safety factors are 1) failure to understand that variance of ration composition is less than the variance for individual feeds, 2) failure to square safety factors before adding, and 3) using safety factors that are greater than optimal. These mistakes result in overfeeding of nutrients beyond the economic optimum. Explicitly understanding the sources of uncertainty in diet formulation and feeding would enable more accurate compensation for uncertainty.

Key Words: Ration formulation, Forage analysis

428 Quantifying assay variation in nutrient analysis of feedstuffs.

D. R. Mertens*, *USDA-ARS, US Dairy Forage Research Center, Madison, WI.*

Analytical results from different laboratories have greater variation than those from a single laboratory, and this variation differs by nutrient. Objectives of this presentation are to describe methods for quantifying the analytical reproducibility among and repeatability within laboratories, estimate the expected variation for nutrient assays, and discuss sources of assay variation. Only carefully designed and replicated collaborative studies or proficiency testing programs can measure variation in nutrient assays. The National Forage Testing Association (NFTA) has developed a proficiency testing program that partitions variation in nutrient analysis into two components: accuracy and precision. This program and its statistical methodology will be described. Although they are often used interchangeably, accuracy and precision measure two independent sources of variation. Accuracy is related to the closeness of the result to the known or consensus reference value. The NFTA determines consensus values as the censored averages of only laboratories using the reference method. Precision is related to the consistency of results among repeated assays. Precision is related mostly to random variation and accuracy is related primarily to systematic error or bias. Much of the random variation associated with precision is related to differences in test samples from heterogeneous materials. Most systematic bias is related to differences in methodology among laboratories and technicians, although some systematic true error is associated with mistakes in calculation or corrections using inaccurate DM determination. Although consistency in analyses (precision) is desired by feed producers, accuracy is required by feed users because the animal provides an independent and ultimate evaluation of nutrient content and utilization. Variation in nutrient analysis is real and controllable, but not completely avoidable. For accurate determination of mean values for tables of feed composition, assays should be replicated across both test samples and analytical laboratories to verify consensus among results.

Key Words: Nutrient analysis, Feed composition

429 Impact of variation in diet nutrient inputs on model output predictions. J. G. Fadel, H. A. Johnson, and P. H. Robinson*, *University of California, Davis.*

Objectives were to assess impacts of variation in diet nutrient inputs on model output predictions and determine if nutrient variation is important to predicted outputs of dairy cows. Models used were Molly and CPM, and their default diets were used for evaluation with each model. Diet nutrient inputs varied were sugars, starch, soluble protein (SP), neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, ether extract (EE), lysine (Lys) and methionine (Met). Nutrients were varied individually, both plus and minus 10% from model default values. Default diets were then switched between the models and the nutrient inputs varied as before. Outputs used to assess impacts of variation in diet nutrient inputs on model predictions were fecal nitrogen (N), urinary N, plasma urea N, metabolizable energy (ME) balance, ME requirement, body weight change, microbial dry matter, milk, milk fat and milk protein creating a total of 90 combinations of nutrient inputs and model predicted outputs. An ANOVA was

completed on the percent differences from model default predicted outputs with both +10% and -10% changes in nutrient inputs. The statistical model included diet and model as main effects, as well as the interaction. In 23 of 90 input/output combinations there were no statistical significances. In 66 of 67 significant ($P < 0.01$) combinations, model or the interaction was significant indicating the impact of nutrient variation on predicted outputs was largely model dependent. In only one combination was diet alone significant, indicating that models were affected by nutrient variation differently and predicted outputs differently. Effects are substantial, as starch and ADF affected 10 of 10 predicted outputs, sugars affected 9, SP and Met affected 8 and NDF and Lys affected 7. In contrast, lignin and EE only affected 4. All outputs were sensitive to 5 or more of the 9 inputs, except milk protein (only sensitive to 3). Results may differ with other diets. Overall, models were least sensitive to changes in lignin and EE, and milk protein was the least sensitive output to changes in nutrient inputs.

Key Words: Diet nutrient variation, Predicted output, Cow models

430 Managing feedstuff variation in nutritional practice. N. R. St-Pierre*¹ and W. P. Weiss², ¹*The Ohio State University, Columbus,* ²*Ohio State University, Wooster.*

Variation in feedstuff composition can lead to reduced performance by animals. Our objective is to review practical ways to reduce the variation in nutritional characteristics of diets. There are two types of variations: 1) abrupt changes in composition as when receiving a new batch of a commodity, and 2) random variation because feed particles are not nutritionally uniform. The control of variation in diet composition must be initiated before diet formulation. This requires periodical chemical analyses of feedstuffs. What should be analysed, at what frequency, and when the diet should be modified has been studied as a renewal reward process. Results showed that the optimal sampling pattern varies across feeds, nutrients, and herd size. Important practices include 1) maintaining separate inventories of feeds with different nutritional characteristics, 2) sourcing commodities from a single source, and 3) purchasing commercial feeds from a manufacturer with an effective quality control program. Variation in diet composition can be greatly affected by formulation. With simple nutrients, i.e., those that can be expressed as a proportion of DM and that do not interact with other nutrients (e.g., CP), the contribution of an ingredient to diet variance changes with the square of its inclusion rate. For complex or composite nutrients (e.g., RUP), diet variance is a complex function of multiple variances and covariances. Approximation formulas exist but are generally very inaccurate. Monte Carlo simulation methods have been used successfully in these instances. Unresolved issues exist related to the identification of response functions to nutrient variation as well as obtaining reasonable estimates of variances and covariances for each feedstuff. In general, increasing the number of ingredients in the diet, and increasing the use of ingredients with low variability lead to less variable diets. Post-formulation, one must ensure that the amounts actually fed (mixed) are close to the theoretical ones. Sorting of diet components must also be minimized.

Key Words: Feedstuff variation, Nutrient variance, Diet formulation

Bioethics: Ethical and Social Issues in Animal Biotechnology

431 Ethics and animal biotechnology: A re-evaluation in light of the Bush Administration Science Policy. P. Thompson*, *Michigan State University, East Lansing.*

In previous studies, this author has advocated a procedural approach not unlike the one that is used in IACUCs to address ethical issues for animal biotechnology. Although there is no evidence that the Bush administration is contemplating action with respect to animal biotechnology, the accumulation of indicators in how key individuals within the administration approach science policy suggest that earlier recommendations emphasizing production goals and animal welfare needs to be re-evaluated. Three key indicators are reviewed in this process: policies on stem cell research, the published position of Leon Kass, Chair of the Bioethics Advisory Committee, and published statements by Mathew Scully, an occasional speechwriter for the President. These three indicators in combination provide the basis for thinking that it will be important to take a range of perspectives formerly associated exclusively with European attitudes into account in conceptualizing the ethical issues associated with animal biotechnology. This will, in turn, lead to a considerably expanded universe of issues that need to be addressed in any procedural approach to the ethics of animal biotechnology.

Key Words: Animal welfare, Cloning, Gene transfer

432 Animal biotechnology: Interfacing ethics with scientific advancement. R. Anthony*, *University of Alaska, Anchorage.*

One of the important tools and processes by which scientists determine the ethical merits of a particular research effort has been Russell and Burch's (1959) Principles of the Three R's, namely Replacement, Reduction and Refinement. Animal ethics review committees, i.e., Institutional Animal Care and Use Committees (often made up of mostly scientists), employ these principles to guide policies and scientific behavior as one way to assuage tensions between the social benefits of the research and the interests of the animal research subjects. Thus, committees wrestle with ways to replace the use of live-animal experiments with viable alternatives, reduce the number of animals used and the degree of their exposure to aversive experimental conditions, and refine techniques that may cause animals to suffer. The principles of the three R's have governed much of how laboratory

science that employs animals is conducted in the United States. They reflect a utilitarian reformist attitude that supports piecemeal changes to increase animal well-being, finding the most favorable balance of benefits and harms for all the sentient beings affected by human action. This presentation explores the extent to which recent advances in contemporary animal biotechnology challenges the ethical guiding prowess of the Three Rs. Recent cultural views regarding the dignity or integrity of individuals animals and concern for natural living will be discussed as a way to highlight opportunities to expand how we should consider animal research in this particular case but also more broadly. I consider other ethical notions like need, reciprocity, and care responsibilities with an eye to expanding discussions on governance issues related to research involving animals in North America.

Key Words: Animal biotechnology, Animal ethics, Institutional Animal Care and Use Committees

433 Genetically engineered animals and the ethics of food labeling. R. Streiffer* and A. Rubel, *University of Wisconsin, Madison.*

The current debate about labeling genetically engineered (GE) food focuses on food derived from GE crops, neglecting food derived from GE animals. This is not surprising, as GE animal products have not yet reached the market. Participants in the debate may also be assuming that conclusions about GE crops automatically extend to GE animals. But (i) there is already an interest in selling surplus GE farm animals used in research for use in the food supply, (ii) there are two GE animals, the Enviropig and the AquAdvantage Bred salmon, that are approaching the market, (iii) animals raise more ethical issues than plants, and (iv) U.S. regulations treat animal products differently from crops. Whether there are legally mandated labels may well impact the commercial viability of GE animal products: if labels enable consumers to make a choice at the point of sale as to whether to purchase GE animal products, consumers might well choose not to. This is therefore an important gap to fill in the existing literature. This presentation examines the specific question of whether there should be mandatory labeling on all food products derived from GE animals, including an examination of the likely regulatory pathways, salient differences between GE animals and GE crops, and relevant social science research on consumers' attitudes.

Key Words: Ethics, Labeling, Genetically engineered animals

Dairy Foods: Products and Processing

434 Aggregation of casein micelles and κ -carrageenan in reconstituted skim milk. S. Ji, H. D. Goff*, and M. Corredig, *University of Guelph, Guelph, Ontario, Canada.*

It is well known that 0.025% κ -carrageenan can gel skim milk. However, when the system is sheared while cooling from 60°C to 25°C, aggregates of 10-100 μm can be formed and the system shows fluid like behavior. Effects of shear (200, 400, 800 s^{-1}) and concentrations of κ -carrageenan (0.025%, 0.05%, 0.075%) on the formation of micellar casein/ κ -carrageenan aggregates were studied with a controlled stress rheometer. Particle size of casein/ κ -carrageenan aggregates decreased with increasing shear rate (200, 400 and 800 s^{-1}) but increased with carrageenan concentration (0.025%, 0.05% and 0.075%). The

microstructure of casein/ κ -carrageenan aggregates was studied with Cryo-SEM, field emission-SEM and TEM. Interaction between casein micelles and κ -carrageenan was significantly affected by the total solid content of solution. It was shown that the aggregation of casein micelles and κ -carrageenan decreased with increasing total solid content of solution and was completely inhibited at 21% of total solid content. Effects of casein/ κ -carrageenan ratio on casein/ κ -carrageenan interaction at different total solid contents (13%, 16%, 18% and 21%) were studied. It was shown that although the concentration of κ -carrageenan had great effects on particle size distribution of aggregates, at higher level of total solid content, increasing κ -carrageenan concentration did not significantly enhance casein/carrageenan interaction. Effects of K^+ and Ca^{2+} on the formation of casein/ κ -

carrageenan aggregates at different total solid contents (13%, 16%, 18% and 21%) were studied. It was shown that addition of K^+ did not affect the formation of aggregates but addition of Ca^{2+} did. However, casein aggregation rather than casein/ κ -carrageenan interactions may be involved in Ca^{2+} supplemented systems. By removing ions from skim milk powder solution, the interactions between casein micelles and κ -carrageenan were enhanced and less κ -carrageenan was needed to form aggregates with casein micelles.

Key Words: Protein-polysaccharide interaction, Casein micelles, κ -carrageenan

435 Comparison of the fatty acid distributions among different vegetable oil blends toward infant milk formulation. C. O. Maduko*¹, C. Akoh¹, and Y. W. Park², ¹*University of Georgia, Athens*, ²*Fort Valley State University, Fort Valley, GA*.

The absorption efficiency of human milk fat is reportedly higher than caprine or bovine milks due to the differences in fatty acid arrangements of the milk fats. Unlike milk of ruminants and most other mammals, human milk contains predominantly saturated, monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA) ranging from C10 to C22. Caprine milk has been recommended as a substitute for those who suffer from allergies to cow milk. Cow milk allergy is a frequent disease in infants, but its etiologic mechanisms are not clear. There is need to develop milk products more homologous as well as less allergenic to human milk fat by using vegetable oil blends rich in saturated long chain acids, MUFA and PUFA. The purpose of this study was to determine the best ratio combination of different vegetable oils to simulate the fatty acid composition of human milk for infant feeding. Five different vegetable fat blends using coconut, safflower and soybean oils were incorporated into skim goat milk at several different formulation ratios to make 4.4g fat/100 ml milk. Fat content of each vegetable oil was determined before blending, and the blended milks were lyophilized. Fatty acid profiles of skim goat milk, whole goat milk and reconstituted formulated lyophilisates were determined by a gas chromatography. Fatty acid profiles of the blended samples were compared to those of human milk for compositions of long chain saturated acids, MUFA and PUFA. The formulated caprine milk containing 2.5, 1.1 and 0.8g blend of coconut, safflower and soybean oils, respectively, had the best simulation to the fatty acid composition of human milk. This product contained 12.5%, 9.2%, 11.8%, 9.2%, and 1% of C14:0, C16:0, C18:1, C18:2 and C18:3, respectively, and concluded that it is closer to human milk for infant feeding than those of whole goat milk and other preparations.

Key Words: Fatty acids, Distribution, Infant milk formulation

436 Milk quality improvement in Iran. R. Noorbakhsh*¹ and A. Heravi Moussavi², ¹*Institute of Standards and Industrial Research, Mashhad, Iran*, ²*Center of Excellence and Department of Animal Science, Ferdowsi University, Mashhad, Iran*.

The dairy industry in Iran has changed dramatically in the last decade. Milk production has increased from 620,000 tons a year after the revolution, to 6.7 million tons in 2003. The government will aim at increasing total annual milk production to 12.5 million tons. Raw milk is mainly processed into sterilised or pasteurised milk, cheese, butter, yoghurt, and ice cream. Along with increase in milk production, the quality also has been improved. Many factors have caused this improvement. Defined regulatory requirements for sanitation, machine milking, pipeline systems, better cleaning and sanitation materials,

more rapid cooling of milk, improved milk quality testing methods, better farm management to prevent mastitis, and reporting of milk quality test results to producers are some of them. However, a very important and encouraging factor in improving milk quality was the initiation of premium payments to producers with higher milk quality. According to the raw milk standard provided by Iranian Institute of Standards and Industrial Research (ISIRI) producer must meet following criteria to qualify: bacteria count: less than 100,000/mL, antibiotic: negative, freezing point: between -0.507 and -0.545°C, somatic cells: less than 500,000/mL. As the most quality problems originate at the farm cannot be erased by further processing, some dairy farms are complying with a HACCP-compatible program for quality control. On the other hand, the processing plants especially the milk powder factories pay more for their products. The trend towards improvement in the milk quality in Iran has resulted in a huge decrease in somatic cell counts from over millions to less than 500,000 in modern farms during the recent years. Results from this study demonstrate that establishing the mandatory national standard by ISIRI containing the new criteria for somatic cell counts along with using better technology and methods in dairy farms and the premium payments support the improvement in raw milk quality.

Key Words: Milk quality, Iran dairy, Somatic cell counts

437 Functional behavior of liquid virgin whey protein concentrate. P. Marcelo* and S. S. H. Rizvi, *Institute of Food Science, Cornell University, Ithaca, NY*.

The compositional variability and fractional protein denaturation in commercial whey proteins (WP) products give rise to varied levels of aggregation during heat and shear applications. In food products, this often results in uncontrolled structure development and impedes attainment of the desired texture. The liquid virgin whey protein concentrate (LVWPC) is a novel ingredient rich in native WP. Harvested before cheesemaking and concentrated by membrane technology alone, LVWPC offers unique physicochemical properties not shown by commercial products. The objective of this study was to elucidate LVWPC's behavior, microstructure formation and texture development under heat and shear applications and compare them with those of commercial products. Thermal properties of LVWPC and commercial whey protein products were determined by differential scanning calorimetry. Textural changes during shear applications at 70 °C were quantified by rheological measurements. Structure development was elucidated using scanning electron microscopy (SEM) and confocal laser scanning microscopy (CLSM). While the denaturation temperature was similar to those of commercial products, LVWPC's onset and enthalpy of denaturation were higher, indicating higher thermal stability. The apparent viscosity at pH 6.1 of 8 wt.% LVWPC at 70 °C and 245 s⁻¹ shear rate was constant for a period of time before increasing at a steady rate of 0.18 mPa-s per minute to 27 mPa-s. On the other hand, those of commercial products increased rapidly at 0.25 mPa-s per minute shortly after the start of the test. SEM images showed that the sheared and heat-treated LVWPC formed a continuous structure, giving smooth texture, while the commercial products gave either fractured or flaky texture due to extensive aggregation that led to phase separation. CLSM results indicated well-controlled structure development of LVWPC upon heating. WP products continue to be important food ingredients due to incessant demand for products of specific texture and nutritive value. Our results suggest that LVWPC is ideal for imparting fine-tuned texture in foods compared with existing commercial WP products.

Key Words: Virgin whey, Functional behavior, Texture

438 Pressure-induced interactions of milk proteins: Are they different from heat-induced interactions? H. A. Patel^{*1,2}, H. Singh³, and L. K. Creamer², ¹*Institute of Food, Nutrition and Human Health, Massey University, Palmerston North, New Zealand*, ²*Fonterra Research Centre, Palmerston North, New Zealand*, ³*Riddet Centre, Massey University, Palmerston North, New Zealand*.

Almost all dairy products are subjected to some form of heating, either directly or by virtue of being made from heated milk. Heating has direct effects on the structure and functionality of milk proteins. Therefore, heat-induced interactions of the milk proteins have considerable importance in the manufacture of dairy products (e.g. yogurt, heat-stable milk powder, evaporated milk, etc.). As a result, this subject has been investigated extensively and ample literature is available. During the past few years, growing consumer demand for minimally processed, high quality, and safe foods has led to increasing interest in non-thermal processes for food preservation; among them, high hydrostatic pressure processing (HPP) is currently a major focus of investigation. As HPP is being considered for the processing of dairy products, an understanding of the modification of the protein structure and the functional properties as a result of HPP is particularly important for its application to dairy products. The changes in the heat and pressure treated samples were studied using various analytical techniques (viz. polyacrylamide gel electrophoresis, size exclusion chromatography, transmission electron microscopy and rheology). A comparison of the HPP-induced and heat-induced interactions of milk proteins using selected commercial pressure treatments and heat treatments showed that HPP has many useful effects on milk proteins. Each of the major whey proteins responded differently to pressure and heat treatments, showing quite different denaturation and aggregation patterns in the pressure- and heat-treated samples. The cysteine-containing caseins (α_s - and κ -casein) and whey proteins (notably β -lactoglobulin, α -lactalbumin, and bovine serum albumin) interacted differently under pressure, compared with under heat. The implications of such effects on the functionality of pressure-treated products may be profound.

Key Words: Milk proteins, Heat treatment, Protein interactions

439 Microbial and somatic cells removal from raw skim milk by cold microfiltration: Quality and shelf life effects. J. A. Fritsch^{*} and C. I. Moraru, *Cornell University, Ithaca, NY*.

The removal of microorganisms from milk using microfiltration (MF) has the potential to significantly improve the safety, quality and shelf life of dairy products. Maximum benefits can be achieved if the process takes place in the early stages of milk processing, preferably in the raw milk stage. Technical challenges of applying MF to raw milk arise from the fact that for regulatory reasons such a process must occur at temperatures < 45F (7C), which are conducive of low permeate fluxes. The objective of this work was to investigate the factors that influence the separation efficiency in cold milk MF and to develop technical solutions for maximizing both the flux, as well as the shelf life and quality benefits of such a process. An experimental setup including a ceramic MF membrane of 1.4 μ m pore size was used to MF raw skim milk at $t < 7C$. The microbiological quality of the milk was evaluated by standard plating and counting, protein composition by the Kjeldhal method and particle size distribution by laser light scattering. Membrane fouling was assessed by scanning electron microscopy. High cross-flow velocities (v), which lead to turbulence

and destabilization of the fouling layer, and low transmembrane pressures (TMP) were conducive of high permeate fluxes. An average permeate flux of about 52 L/(m²h) was obtained after 45min of microfiltration skim milk at $v=7$ m/s and TMP=10psi, as compared to 17.5 L/(m²h) after 45min at 7m/s and 19psi. The protein composition of the MF milk obtained under optimal process conditions was nearly identical to that of the raw skim milk. Significant flux enhancement and reduced flux decay were achieved by employing a CO₂ surging technique. The cold MF process led to about 5 log reduction in bacteria and near complete removal of spores and somatic cells, which resulted in a significantly longer shelf life of the MF milk as compared to the unfiltered milk. Additional shelf life extension for the MF milk stored under CO₂ pressures >0.68bar was found. Optimum process parameters coupled with the developed CO₂ technique have the potential to make raw milk MF an economically attractive process.

Key Words: Microfiltration, Shelf life, CO₂

440 Process analysis for liquid virgin whey protein concentrate production using membrane technology. P. Marcelo^{*} and S. S. H. Rizvi, *Institute of Food Science, Cornell University, Ithaca, NY*.

Native whey proteins (WP) possess high conformational potentials that give rise to superior functional properties compared with denatured WP. In harvesting and concentrating these valuable proteins, care must be taken to minimize denaturation. The objective of this study was to analyze relevant process parameters in the production of the native WP-rich liquid virgin whey protein concentrate (LVWPC) using membrane technology. Virgin whey, containing 0.5 wt.% WP and 5.3 wt.% total solids (%TS) harvested from slightly acidified skim milk (pH 6.0) prior to cheesemaking, was concentrated by two-stage ultrafiltration (UF) with diafiltration (DF) at 45 °C. First-stage UF was done in a 10,000-molecular weight cut-off (MWCO) polysulphone spiral wound membrane (SWM) with filtration area of 5.9 m². It was operated at $-\Delta P$ of 275 kPa until the concentration factor (CF) was 13 and DF ensued using four diavolumes of phosphate buffer in the SWM. The second-stage UF was done using 10,000-MWCO polysulphone hollow fiber membrane (HFM) with 2.9 m² filtration area, operated at $-\Delta P$ of 130 kPa until CF reached 5. In the SWM, 42.9 kg/hr-m² average permeate flux was initially observed before declining exponentially with time to 34.6 kg/hr-m² as CF reached 1.12. The flux then became approximately constant at 30 kg/hr-m² as the retentate %TS went up to 8.94 and the viscosity increased by 34% as CF reached 13. The relatively low cross-flow velocity of 0.5 m/s generated a moderate shear stress of 90 Pa at the membrane wall and may have been sufficient to balance particle erosion and deposition rates on the membrane to give quasi steady-state permeation. There was an exponential flux decay with time in the second-stage UF as %TS increased to 26% (91% WP) and viscosity increased six times to 11.7 mPa-s. The results suggest that because of the high purity and the native state of the WP, instead of protein-protein interactions, changes in bulk transport properties due to increasing protein concentration contributed significantly to flux decline in the UF.

Key Words: Whey proteins, Ultrafiltration, Virgin whey

Forages and Pastures: Forage Finishing

441 Effects of forage species on fatty acid composition of beef longissimus muscle from forage-finished beef. S. K. Duckett^{*1}, E. Pavan², R. N. Sonon², J. Neel³, J. P. Fontenot⁴, and W. Clapham³, ¹Clemson University, Clemson, SC, ²University of Georgia, Athens, ³USDA-ARS, Beaver, WV, ⁴Virginia Tech, Blacksburg.

Forty-seven Angus-crossbred steers were used to evaluate the effects of forage species grazed in the last 41 d of the finishing period on rib composition, color, and palatability in forage-finished beef and compared to traditional high concentrate finished. Steers grazed naturalized pastures (bluegrass/white clover) for 93 d and then grazed alfalfa (AL; n = 12), pearl millet (PM; n = 12), or naturalized pastures (NP; n = 12) pastures for the final 41 d of finishing. Steers (n = 11) were also finished on a high concentrate diet (C) for 134 d. Data were analyzed with finishing treatment in the model. Total lipid content of longissimus muscle was 57% lower (P < 0.01) for forage-finished than C with no differences among forage species. Saturated fatty acid percentage was higher (P < 0.05) for AL than PM and C due to greater (P < 0.05) concentrations of stearic acid. Monounsaturated fatty acid percentage was higher (P < 0.05) for C than all forage-finished treatments indicating greater activity of delta-9 desaturase enzyme. Omega-6 fatty acid concentration did not differ among treatments. Omega-3 fatty acid concentration was higher (P < 0.05) for AL, PM and NA than C. Linolenic acid percentage was greater (P < 0.05) for AL than PM and NA, which were greater (P < 0.05) than C. The ratio of omega-6 to omega-3 fatty acids was lower (P < 0.05), hence more desirable from a human health standpoint, for forage-finished than C (1.32 vs. 6.37, respectively). Trans-11 vaccenic acid concentration was greater (P < 0.05) for forage-finished than C; whereas, trans-10 octadecenoic acid concentration was greater (P < 0.05) for C than forage-finished. The cis-9 trans-11 isomer of conjugated linoleic acid concentration was 150% greater (P < 0.05) for forage-finished than C. Overall, forage-finished beef was leaner and contained greater concentrations of desirable fatty acids compared to concentrate finished. However, only minor changes in fatty acid composition as related to finishing on different forage species were observed.

Key Words: Beef, Forage, Fatty acids

442 Effects of forage species on rib composition, color, and palatability in forage-finished beef. S. K. Duckett^{*1}, R. N. Sonon², E. Pavan², J. Neel³, J. P. Fontenot⁴, G. Scaglia⁴, and W. Clapham³, ¹Clemson University, Clemson, SC, ²University of Georgia, Athens, ³USDA-ARS, Beaver, WV, ⁴Virginia Tech, Blacksburg, VA.

Forty-seven Angus-crossbred steers were used to evaluate the effects of forage species grazed in the last 41 d of the finishing period on rib composition, color, and palatability in forage-finished beef and compared to traditional high concentrate finished. Steers grazed naturalized pastures (bluegrass/white clover) for 93 d and then grazed alfalfa (AL; n = 12), pearl millet (PM; n = 12), or naturalized pastures (NP; n = 12), pasture for the final 41 d of finishing. Steers (n = 11) were also finished on traditional high concentrate diets (C) for 134 d. Data were analyzed with finishing treatment in the model. Hot carcass weight (HCW) was 99 kg heavier (P < 0.01) for C finished than NP, AL, and PM with no differences among forage types. Ultimate longissimus muscle pH was lower for C than PM or NP with AL being intermediate. Percentage total fat was 43% lower (P < 0.05) and percent fat-free lean was 17% greater for forage-finished than C in

the 9-10-11th rib section. No differences were detected in lean, fat and bone composition among forage species. Longissimus muscle color was darker (P < 0.05; lower L* value) for forage-finished than C. Muscle color was also darker (P < 0.05) for PM than AL with NA being intermediate. Yellowness (b*) of LMA was higher (P < 0.01) for C than NA or PM with AL being intermediate. Yellowness of s.c. fat was higher (P < 0.01) for forage-finished than C. Steak juiciness as rated by trained sensory panelist was highest (P < 0.01) for AL and lowest (P < 0.05) for C. Initial and overall tenderness scores were highest (P < 0.01) for AL. Panelists rated initial and overall tenderness lower (P < 0.01) for NP than PM with C being intermediate. Beef flavor intensity was greater (P < 0.01) and off-flavor intensity lower (P < 0.01) for C than F. Beef flavor intensity ranked higher (P < 0.01) and off-flavor intensity ranked lower (P < 0.05) for C than forage-finished treatments. Beef flavor intensity was higher (P < 0.05) for AL than NP with PM intermediate. No differences in off-flavor intensity among forage types were detected.

Key Words: Beef, Forage, Carcass

443 Corn oil or corn grain supplementation to forage-finished steers. I. Effects on animal performance and carcass quality. E. Pavan^{*1,2} and S. Duckett³, ¹University of Georgia, Athens, ²INTA, Balcarce, Bs. As., Argentina, ³Clemson University, Clemson, SC.

Twenty eight Angus (289 ± 3.8 kg) steers were used in a completely randomized design to evaluate the effect of isoenergetic supplementation of two different energy sources to steers rotationally grazing tall fescue pastures for 197 d. Steers were supplemented with either corn grain (0.52% BW; PC) or soybean hulls plus corn oil (0.45% BW + 0.10% corn oil; PO) using Calan gates for individual intake measurement. Negative (pasture only; P) and positive (85% concentrate/15% roughage; C) control diets were also included in the study to compare with the performance of the supplemented steers. Steers on PC, PO and P treatments were managed together under a rotational grazing system; whereas, C steers were maintained on an adjacent tall fescue pasture for the initial 105 d and then fed a high concentrate diet also using Calan gates. Data were analyzed using Mixed procedure of SAS; LS-means were separated using pdiff option. The ADG for PC and PO was higher (P < 0.01) than in P and lower (P < 0.01) than C. ADG tended (P = 0.09) to be greater for PC than PO during the first 105 d period but ADG did not differ among supplement sources during final 92 d or overall. Hot carcass weights for PO and PC were 36 kg greater (P < 0.01) than P and 67 kg lighter (P < 0.01) than C. However, efficiency of concentrate utilization (overall kg of gain above P/kg supplement or overall kg of gain/kg high concentrate intake) did not differ among energy supplement sources or compared to concentrate finished. Dressing percentage, s.c. fat thickness, KPH percentage and yield grade were lower (P < 0.01) for PO and PC than C and higher (P < 0.01) for PO than P. Only dressing percentage was higher for PC than P, for the other variables PC was similar (P > 0.05) to either P or PO. Marbling score, quality grade, and LMA were also lower (P < 0.01) in PO and PC than in C, but did not differ (P > 0.05) from P. Energy supplementation, regardless of energy source, to grazing steers increased performance and carcass weight but did not alter carcass quality.

Key Words: Beef, Pasture, Supplementation

444 Corn oil or corn grain supplementation to forage-finished steers. II. Effects on s.c. and i.m. fatty acid composition. E. Pavan*^{1,2} and S. Duckett³, ¹University of Georgia, Athens, ²INTA, Balcarce, Bs. As., Argentina, ³Clemson University, Clemson, SC.

Samples of s.c. and i.m. fat were obtained from 28 Angus steers after slaughter to determine the effect of energy supplementation of steers grazing tall fescue pastures. Steers (289 ± 3.8 kg) were supplemented with either corn grain (0.52% BW; PC) or soybean hulls plus corn oil (0.45% BW + 0.10% corn oil; PO). Negative (pasture only; P) and positive (85% concentrate/15% roughage; C) controls were also included in the study. Steers were slaughtered at similar time-on-feed endpoint. Fatty acid (FA) composition from the s.c. and i.m. were determined by GLC and analyzed with dietary treatment in the model by fat depot. Total fatty acid content of longissimus muscle was 55% greater ($P < 0.01$) for C than PC, PO, or P. In i.m. fat, forage-finished beef contained lower ($P < 0.01$) percentages of myristic and palmitic acids. Stearic acid concentration was greater ($P < 0.01$) for PO than PC or P, which were greater ($P < 0.01$) than C. Concentrations of trans-11 vaccenic acid (TVA) were increased ($P < 0.01$) by 90% and 467% with PO compared to P and C, respectively. Conjugated linoleic acid (CLA; cis-9 trans-11) concentration was 24% and 217% greater ($P < 0.01$) for PO than P and C, respectively. Omega-6 fatty acid concentration was greater ($P < 0.01$) for PO than PC or P, which were greater ($P < 0.01$) than C. Supplementation reduced ($P < 0.01$) omega-3 fatty acid concentration compared to P but levels were greater ($P < 0.01$) than C. In s.c. fat, PO reduced ($P < 0.01$) palmitic acid percentages compared to PC and P; however, all forage-finished beef were lower ($P < 0.01$) in palmitic acid than C. Oil supplementation increased ($P < 0.01$) concentration of TVA and CLA by 71% and 27%, respectively, compared to P and by 629% and 443%, respectively, compared to C. PO had the highest ($P < 0.01$) omega-6 fatty acid concentration and P the lowest ($P < 0.01$). Oil supplementation lowered ($P < 0.01$) omega-3 fatty acid concentration compared to P to levels of C. Oil supplementation to grazing steers reduced the level of atherogenic fatty acids and increased anticarcinogenic fatty acids in forage finished beef.

Key Words: Forage-finished beef, Supplementation, Fatty acid

445 Corn oil or corn grain supplementation to forage-finished steers. III. Effects on longissimus pH, tenderness, and flavor. E. Pavan*^{1,2} and S. Duckett³, ¹University of Georgia, Athens, ²INTA, Balcarce, Bs. As., Argentina, ³Clemson University, Clemson, SC.

Twenty eight Angus (289 ± 3.8 kg) steers were used in a completely randomized design to evaluate the effect of isoenergetic supplementation of two different energy sources to steers rotationally grazing tall fescue pastures for 197 d on meat quality. Steers were supplemented with either corn grain (0.52% BW; PC) or soybean hulls plus corn oil (0.45% BW + 0.10% corn oil; PO). Negative (pasture only; P) and positive (85% concentrate/15% roughage; C) control treatments were also included in the study to compare with the supplemented steers (S). Steers on C were maintained on an adjacent tall fescue pasture for the initial 105 d and then fed a high concentrate diet. At the end of the feeding period steers were slaughtered and carcass temperature and pH were determined during the first 24 h post-mortem. LM color was determined, samples obtained, and aged for a total of 1, 3, 7, 14 and 28 d for subsequent Warner-Bratzler shear force and trained sensory panel evaluation. Carcass temperature decline was slowest ($P \leq 0.05$) in C than in PC, PO or P. LM pH at 3 h and 24 h postmortem was lower ($P \leq 0.01$) for C than PC or P with PO being intermediate. LM lightness

was higher ($P \leq 0.05$) for C than PO, PC, or P and was also higher ($P \leq 0.01$) for PC and PO than P. Yellowness of s.c. fat was higher ($P \leq 0.01$) for PO and PC than C or P, which did not differ. WBSF was lower ($P \leq 0.05$) for C than for PC and P, with PO being intermediate. Trained sensory panel ratings for tenderness and beef-flavor intensity were higher ($P \leq 0.05$) for C than for PC, PO, or P. Off-flavor scores were lower ($P \leq 0.01$) for C than P with PC and PO being intermediate. Oil supplementation to forage-finished steers alters muscle pH, tenderness, color and off-flavors scores; the latter two variables are also affected by corn grain supplementation

Key Words: Beef, Tenderness, Pasture

446 Dried distillers grains substitute for forage and nitrogen on pasture. M. A. Greenquist*, K. J. Vander Pol, L. Baleseng, T. J. Klopfenstein, W. H. Schacht, and G. E. Erickson, *University of Nebraska, Lincoln.*

Forty five yearling steers (349 ± 10 kg) were used in a randomized complete block to evaluate performance, nitrogen use, and economic impact of supplementation and management strategies on smooth bromegrass pastures. Yearling steers were stocked at 9.9 AUM/ha for smooth bromegrass pastures fertilized with 88 kg N/ha (CONT), non-fertilized smooth bromegrass pastures stocked 69% of the CONT (NOFERT), or non-fertilized smooth bromegrass pastures stocked at the same rate as the CONT with 2.3 kg (DM) of dried distillers grains with solubles (DDGS) supplemented daily (SUPP). Pastures were grazed from April 22 to September 19, 2005 and blocked by location. Pasture represented the experimental unit and was replicated three times. Pastures were strip-grazed at the assigned stocking rate for 4 d/strip (6 strips/cycle) in cycles 1 and 5 and for 6 d/strip in cycles 2, 3, and 4. Nitrogen accretion was estimated from weight gains using NRC (1996) equations. Steers on CONT gained the same as NOFERT ($P=1.0$, 0.62 kg/d and 0.62 kg/d for CONT and NOFERT, respectively) but had greater costs of gain (\$0.81/kg gain vs. \$0.65/kg gain) due to additional costs of N being greater than the additional cost of land use. Steers supplemented with DDGS gained more ($P<0.01$) than CONT or NOFERT (0.89 kg/d vs. 0.62 kg/d). The cost of gain for SUPP steers was \$0.68/kg gain (DDGS was \$0.121/kg, delivered). Nitrogen accretion per ha for SUPP steers was 38.5% greater than CONT ($P<0.01$, 9.30 kg/ha vs. 6.72 kg/ha) and 99.6% ($P<0.01$, 9.30 kg/ha vs. 4.66 kg/ha) greater than NOFERT. Nitrogen use efficiency based on the amount of N applied as either fertilizer or in DDGS was 3.2 times greater for SUPP steers than CONT steers (26.38 % vs. 8.23%). Nitrogen accretion costs were \$0.23/kg N gain, \$0.30/kg N gain, and \$0.26/kg N gain for the NOFERT, CONT, and SUPP steers, respectively. Dried distillers grains can be used as a substitute for forage and N fertilizer by improving performance, reducing cost of gains, and reducing costs associated with N accretion in yearling steers.

Key Words: Dried distillers grains, Fertilizer, Forage

447 Use of cuticular wax alkanes to estimate digestibility and intake of cows at pasture with a view to estimating efficiency. S. W. Coleman*, C. C. Chase, Jr., and D. G. Riley, *USDA ARS Subtropical Agricultural Research Station, Brooksville, FL.*

Determination of feed efficiency requires estimates of intake and digestibility of the diet, but they are difficult to measure on pasture. The objective of this research was to determine if plant cuticular alkanes were suitable as markers to estimate intake and diet digestibility of grazing cows with sufficient precision to determine differences among

breeds. Purebred Angus (A), Brahman (B) and Romosinuano (R) cows grazing Bahiagrass pastures, all nursing 2 to 3 mo old calves were used. External markers were administered to four cows of each breed using an intraruminal device that continuously delivered 320 mg of C32 and C36 daily. After 7 d for equilibration, forage and feces (10 samples/cow) were collected over the next 2 wk. All samples were lyophilized and ground to pass a 1 mm screen. Alkanes were extracted and analyzed by gas chromatography. Digestibility was calculated from the ratio of C31, C33, or C35 in the forage and feces. Ratios of C31/C32, C32/C33, and C35/C36 in feces were to quantify fecal output and intake as a proportion of body weight (BW). Digestibility and intake values were analyzed using a repeated measures model where animals were repeated measures over days using a compound symmetry covariance structure. Coefficients of variation (CV) in digestibility among animals were 2.44, 3.49, and 5.98 % for C31, C33, and C35, respectively, quite low and similar to pen fed measurements. Digestibility was different ($P < 0.05$) among breeds when estimated with C31 (73, 75 and 73 %) or C35 (64, 63, and 59 %, for A, B and R cows, respectively). Estimates made with C33 approached significance ($P = 0.055$) with estimates of 71, 71, and 68 % for A, B and R cows. Intake CVs were 27, 20, and 28 % for ratios of C31/C32, C32/C33, and C35/C36, respectively. Mean intakes were 53, 39, and 46 g/kg BW daily for the three alkanes, and were not different among breeds. Mean intake values appeared to be biased upward, possibly due to rather large adjustments for the amount of C32 (13.5 ppm) and C36 (24.6 ppm) in forage samples. Use of other forage species with lower amounts of C32 and C36 should improve estimates of intake. Estimates of intake and digestibility differed with different alkane pairs.

Key Words: Forage intake, Alkanes, Grazing

448 Effect of grazing management on cattle distribution patterns.

M. Haan*, J. Russell, J. Davis, D. Strohbehn, D. Morrical, and W. Powers, *Iowa State University, Ames.*

Because of concern that grazing cattle may elevate nutrient and sediment loads in surface waters, a study was conducted to measure spatial and temporal distribution, defecation, and urination patterns of cattle managed by different stocking systems. Six 12.1-ha cool-season grass pastures were divided into 2 blocks and assigned one of three treatments; continuous stocking - unrestricted stream access (CSU), continuous stocking - restricted stream access (CSR), and rotational stocking (RS). Pastures were stocked with 15 fall-calving Angus cows (650 kg) from May to October 2005. Cow location and activity were recorded at 10 min intervals from 0600 to 1800 h on two consecutive days during 7 observation periods during the grazing season. Location was defined as within stream and 0 to 33.5 m, 33.5 to 67 m, and more than 67 m from the stream. Activities included the number of cattle present, urination, and defecation. The use of RS and CSR decreased ($P < 0.05$) time cows spent in the stream and within 33.5 m of the stream and increased ($P < 0.05$) time spent greater than 67 m from the stream compared to CSU. There was no effect of observation period or observation period \times treatment interaction on time cattle spent in the stream. Significant treatment by observation period interactions existed ($P < 0.05$) for time cows spent 0 to 33.5 m from the stream. Cows managed by RS spent 46% of their time in the stream during the September 17 observation period while during other observation periods, cows in the RS pastures spent approximately 1% of their time in the stream. Cows in the CSU pastures spent more than 20% of their time from 0 to 33.5 m from the stream during the May 23 and September 17 observation periods and less ($P < 0.05$) time during other observation periods. In CSR pastures cows spent approximately 1% of their time 0 to 33.5 m from the stream for all observation periods. Patterns of defecation and urination distribution followed that of cow distribution. Compared to CSU, RS and CSR are potential management strategies for decreasing negative impacts of cattle behavior on water quality.

Key Words: Grazing, Animal behavior

Goat Species: Improving Meat, Milk and Parasite Control in Goats

449 Indicators of fitness in Boer, Kiko, and Spanish does managed on pasture in Tennessee (Year 2). R. Browning, Jr.*, B. Donnelly, T. Payton, M. L. Leite-Browning, P. Pandya, W. Hendrixson, and M. Byars, *Tennessee State University - IAgER, Nashville.*

Boer (BR; $n = 55$), Kiko (KK; $n = 51$), and Spanish (SP; $n = 50$) straightbred does representing a broad base of within-breed genetic lines were managed together on pasture from September 2004 to August 2005. Three-quarters of each breed were mated in October and the remainder bred in December. Herd health records were analyzed by GLM for the 2004-2005 production year to assess animal fitness under the prevailing production environment. Does were treated for hoof scald and hoof rot upon observed lameness. Breeds differed ($P < 0.01$) for lameness cases treated during the year. Boer does required more ($P < 0.01$) treatments for lameness (2.15 ± 0.19 cases/doe) than SP (0.80 ± 0.2 cases/doe) or KK (0.57 ± 0.2 cases/doe). A higher ($P < 0.01$) frequency of BR required hoof treatments per year compared with SP or KK (86.9 vs. 37.7 and 36.9 \pm 6.2%, respectively). Does due to kid in March were dewormed with ivermectin as a group in February. All does were dewormed with moxidectin individually at parturition.

Individual does presenting clinical signs of internal parasitism during the year received extra anthelmintic treatments. Breeds differed ($P < 0.01$) for extra anthelmintic treatments. Extra dewormings were more numerous for BR than for SP or KK (0.56 vs. 0.23 and 0.13 ± 0.08 cases/doe, respectively). A higher ($P < 0.01$) frequency of BR received extra dewormings during the year ($43.1 \pm 5.5\%$) compared to SP ($17.3 \pm 5.8\%$) or KK ($13.1 \pm 5.7\%$). Fecal egg counts (FEC) were determined on a random subset of does (31 BR, 28 KK, 25 SP) across kidding groups near the weaning of kids at 3 mo of age (June and August). Breed affected ($P < 0.01$) log-transformed FEC with values higher ($P < 0.04$) for BR than for SP. Geometric mean FEC for BR, KK and SP were 419, 274, and 137 eggs/g, respectively. The proportion of does weaning kids and doe survival rate through the production year were lower ($P < 0.01$) for BR does ($67 \pm 5\%$, $84 \pm 4\%$) than for KK ($88 \pm 6\%$, $98 \pm 4\%$), SP does were intermediate ($82 \pm 6\%$, $90 \pm 4\%$). Results mirror Year 1 and suggest differences among meat goat breeds for doe fitness under southeastern US conditions.

Key Words: Breed, Fitness, Meat goats

450 Concentrate protein level for finishing intact or castrated Boer-cross meat goats. M. Poore*, A. Shaeffer, S. Freeman, H. Glennon, and J.-M. Luginbuhl, *North Carolina State University, Raleigh.*

Producers often add value to meat goats by feeding after weaning, but information on post-weaning nutrient requirements are limited. Some producers castrate male kids destined for post-weaning feeding programs, whereas others leave kids intact. Data to evaluate the practice of castration are also limited. This trial was conducted to evaluate protein level in a pelleted concentrate fed post-weaning to kids that were either intact or castrated at birth. Kids were at least ¾ Boer. As kids were born, litters within doe age and litter size were randomly designated to be castrated or left intact until there were 21 intact and 19 castrated males generated. After weaning, the heaviest 18 of each castration status were selected, and they were individually housed for the 84-d finishing trial. The kids were blocked by weight within castration status and assigned to one of three concentrates fed at 2% of BW (1.7% on a dry basis). The commercial pelleted concentrates were composed primarily of corn, wheat middlings, and soybean hulls, and contained trace minerals, vitamins, decoquinat (25 mg/kg), and ammonium chloride (0.75%). Soybean meal was substituted for soybean hulls to give protein levels of 13, 15, or 17% as fed (analyzed 14.2, 16.7, or 18.7% dry basis). Mixed grass hay was fed ad libitum and contained 9.9% CP and 40.2% ADF. Following 84 d on the finishing diets, ruminal and blood samples were taken 4 h after feeding. On the following day kids were harvested, and carcass weight and other carcass measures were determined. Carcass weight and the average carcass yield was used to adjust final live BW. Few diet by castration status interactions were observed. As indicated in the following table, intact kids had higher DMI, gained faster, and had higher final BW, carcass weight and other carcass measurements than castrated kids. Increased protein level in the concentrate had no impact on DMI, but resulted in linear increases in gain, carcass weight, gain/feed and improved carcass grade.

Table 1. Main effects of castration and concentrate protein level on finishing meat goats

Item	Bucks Wethers		P	13%	15%	17%	P ¹
Start wt, kg	19.7	18.4	0.01	19.3	18.9	19.0	0.47
Final wt, kg	29.2	25.3	0.01	26.3	27.3	28.1	0.02
ADG, g/d	106	84	0.01	82	94	106	0.01
Gain/Feed	0.138	0.127	0.12	0.113	0.141	0.145	0.01
DMI, g/d	768	655	0.01	711	693	730	0.53
Carcass grade ²	2.16	2.33	0.22	2.42	2.20	2.11	0.07
Carcass wt, kg	14.6	13.0	0.01	13.3	13.8	14.3	0.02
Ruminal ammonia, mg/dL	41.7	39.9	0.56	39.0	42.4	41.0	0.58
BUN, mg/dL	19.1	20.7	0.10	17.9	19.2	22.5	0.01

¹P value for linear effect of protein level; ²1 to 1.9 = prime, 2 to 2.9 = choice

Key Words: Castration, Meat goats, Protein

451 Generation and annotation of expressed sequence tags (ESTs) for the goat. B. L. Sayre*¹, G. Harris¹, J. Dzakuma², S. Samake³, N. Whitley⁴, and Z. Wang⁵, ¹Virginia State University, Petersburg, ²Prairie View A&M University, Prairie View, TX, ³Fort Valley State University, Fort Valley, GA, ⁴University of Maryland-Eastern Shore, Princess Anne, ⁵Langston University, Langston, OK.

Goat and sheep producers across the southeastern U.S. have identified control of internal parasites as their primary production issue. The best long-term solution for producers is the development of an effective method for determining genetically resistant animals and selecting for resistance to parasites. Our basic approach is to use a combination of quantitative trait loci (QTL) mapping and microarray analysis to identify genes associated with parasite resistance. However, we need greater genome research in goats to effectively compare species and search for the genes related to traits important for productivity, such as parasite resistance genes. The objective of this project was to increase the genomic information related to gene expression in the goat. Total RNA was collected from mixed tissues from goats (n=10) using the RNeasy extraction kit. A cDNA library was developed as a unidirectional library in the pAGEN vector, with an average insert size of 1.7 kb. We had approximately 92% of the clones that were recombinants. The library was plated and redundancy checked by BLAST after the initial sequencing (500 – 700 clones). Redundancy was normal, so sequencing was continued. Randomly chosen clones were sequenced generating 12,821 sequences from the library. The sequences were assembled and clustered with the Paracel Transcript Assembler. Of the 12,821 sequences, 8,373 were members of 1,921 primary clusters with 4,433 sequences remaining as singletons. A functional annotation was assigned to each consensus and singleton. This cDNA library and EST data will be a useful resource for goat research for comparative analyses with other species, development of a physical map for the goat, microarray development, and identification of potential genes involved in resistance to parasites.

Key Words: EST, Genomics, Goat

452 Effects of preparturient intramuscular injection of vitamin E and selenium on milk somatic cell counts in dairy goats. I. Lin*^{1,2}, Y. Fan¹, and H. Chang^{1,3}, ¹National Chung Hsing University, Taichung, Taiwan, ROC, ²National Taiwan University, Taipei, Taiwan, ROC, ³Uni-President Enterprises Corp., Tainan, Taiwan, ROC.

This experiment investigated the effects of high dose D-α-tocopherol (vit E) and selenium (Se) injection intramuscularly on the blood concentrations of vit E, Se and GSHpx activity, and milk somatic cell counts (SCC) at wk 2 and 4 postpartum in dairy goats. Twelve multiparity dairy goats (4 Toggenburg, 2 Nubian, 2 Alpine, 1 Lamancha, 2 Alpine × Toggenburg hybrids, 1 Lamancha × Saanen hybrid; averaging body weight 63.6 kg; 3.73 year-old; 2.92 parities) were randomly allotted into four treatments, e.g., intramuscular injection with 4.4 g Tween 80 (Tw), 3,000 IU vit E plus 5 mg Na₂SeO₃ dissolved in 4.4 g Tw (E3Se), or 1,000 IU vit E plus 5 mg Na₂SeO₃ dissolved in 2.2 g Tw (E1Se) as well as controls (CON) without injection. Goats were injected twice, two and one week prepartum. The goats in E3Se or E1Se had higher level of vit E in their blood plasma (2.08 fold, *P* < 0.05) and milk (1.55 fold, *P* < 0.05). Elevated plasma and milk levels of vit E were sustained longer (*P* < 0.05) for treatment E3Se than for E1Se. Blood plasma level of vit E in E3Se dropped not so abruptly as those in other treatments (*P* < 0.05). No correlation (*P* > 0.05) existed between vit E concentration in milk and that in blood plasma. The goats in E3Se and E1Se had increased Se concentrations in blood

serum (1.21 fold, $P < 0.05$) and in milk (1.35 fold, $P < 0.05$). Whole blood GSHpx activities in E3Se and E1Se were 143% higher ($P < 0.05$) than those in TW and CON. SCC at wk 2 postpartum in E1Se and TW were 8.48 % lower ($P < 0.05$) than those in E3Se and CON. Clinically, no mastitis or retained placenta occurred in these goats. The correlation of iron concentrations between milk and blood serum, or the correlations among lactoferrin, transferrin, and SCC were not significant ($P > 0.05$). In conclusion, intramuscular injection of high dose vit E and Se to preparturient goats does prevent abruptly drop of vit E level in their blood plasma at parturition. Preparturient injections of vitamin E and Se did not markedly effect somatic cell counts in postparturient dairy goats.

Key Words: Selenium, Somatic cell count, Vitamin E

453 Genetic parameters for milk yield in dairy goats across lactations in Germany. B. Zumbach^{1,2}, S. Tsuruta^{*1}, I. Misztal¹, and K. J. Peters², ¹University of Georgia, Athens, ²Humboldt University, Berlin, Germany.

Breeding value estimation for dairy goats in Germany is still based on herd mate comparison within breeding society. The objective of this study is to estimate genetic parameters for milk yield based on a test day model as basis for a new national evaluation. For the analysis 35,463, 29,871, and 23,103, test day records from lactations 1, 2 and

3 from 5,217, 4,125, and 3,133 animals, respectively, were used. The data between 1987 and 2003 were obtained from 6 German breeding societies. The multiple trait (lactation 1-3) repeatability model included the fixed effects of herd-year (1239 levels), litter size (1, 2 \geq 3), kidding season (1, 2, ..., 11), and days in milk of 3rd order (1-270) nested within herd-year, and the random effects of animal additive and permanent environment. The 3-trait random regression model included also the random regressions based on 2nd order Legendre polynomials for animal additive and permanent environmental effects. Heritability estimates in the repeatability model were 0.27 ± 0.02 , 0.20 ± 0.02 , and 0.37 ± 0.02 for the 1st, 2nd and 3rd lactation, respectively. Genetic correlations between lactations were 0.69 (1-2), 0.77 (2-3), and 0.43 (1-3), respectively. Heritability estimates from the random regression model decreased continuously in the 1st and 2nd lactation from the beginning to the end of the lactation, and increased at the extreme, with average values of 0.28 and 0.26. Estimates in the 3rd lactation showed a maximum in the middle of lactation, averaging 0.36. Genetic correlations between lactations averaged 0.60 (1-2), 0.65 (2-3), and 0.44 (1-3), respectively. Despite the small data set and restricted relationship structure - use of selected males in natural service within herds - the estimates are reasonable with the exception of estimates from the 3rd lactation, which seem inflated. Genetic evaluation can be based on estimates from lactations 1 and 2.

Key Words: Dairy goats, Genetic parameters, Test day model

Horse Species: Equine Nutrition

454 Endocrine changes in peri-parturient mares and their newborn. E. L. Berg*, D. L. Meyer, and D. H. Keisler, University of Missouri, Columbia.

The metabolic events that the female endures as she transitions from the pregnant to non-pregnant condition are decisive, dramatic, and challenging. Our objective was to characterize a portion of this process via endocrine changes in peri-parturient mares and their offspring. Nine pregnant Quarter Horse mares, aged 4-21 y, and their newborn were used. Once weekly, 2 wk prior to their predicted parturition date, pregnant mares were weighed, body condition scored (BCS), and blood sampled via jugular venipuncture. Within 2 h of parturition and before foals nursed (d 0), blood samples were taken from mares and foals, and a milk sample collected from the mares. Blood from foals, and blood and milk from mares were also collected at 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 12, 19, 26, 33 and 61 d post-partum. Blood and milk serum were assayed for concentrations of leptin, IGF-1, and TSH. On d 0, 5, 12, 19, 26, 33 and 61 mares and foals were weighed and BCS. Ultrasound images of fat depth and muscle area of the longissimus dorsi immediately cranial to and parallel with the last rib on the left side of foals were measured to characterize changes in fat depth and muscle area over time. Time series analysis revealed no change in mare blood serum concentrations of IGF-1 or TSH over time ($P > 0.07$), nor were there any changes in foal blood serum concentrations of leptin or TSH over time ($P > 0.10$). Mare blood serum leptin changed dramatically over time ($P < 0.01$), decreasing from d 0 to d 5. Foal blood serum IGF-1 increased ($P < 0.01$) to d 19 where it remained for the duration of study. Milk serum leptin and TSH were highest on d 0, decreasing to nadir levels on d 61 ($P < 0.01$). Milk serum IGF-1 was also highest on d 0 ($P = 0.02$) and decreased to undetectable levels by d 12. Mare BCS was not detectably different between pre- and post-partum ($P = 0.61$), while BW differed dramatically ($P < 0.01$) due to parturition. During the 61 d interval that mares were studied post-partum neither BW nor BCS differed over time ($P > 0.75$). As foals

aged, ultrasonic fat depth and longissimus dorsi muscle area increased ($P < 0.04$) as did BCS and BW ($P < 0.01$).

Key Words: Horse, Leptin, IGF-1

455 Effect of parity and day on foal nursing behavior during the first month of lactation. T. N. Stamper^{*2}, B. D. Nielsen¹, J. Liesman¹, and N. L. Trottier¹, ¹Michigan State University, East Lansing, ²Grand-Valley State University, Grand-Rapids, MI.

Arabian mares, three primiparous and three multiparous, were used to examine nursing behavior of foals. All nursing bouts and their duration were recorded for 24 h on d 9, 19 and 29 of lactation. A nursing bout was defined as any uninterrupted nursing interval lasting 27 sec or longer. Nursing frequency (number of nursing bouts per h), duration of a nursing bout, and total duration of nursing per h were averaged over the daytime (0830 to 1600) and nighttime (1600 to 0830) periods. Across parities, nursing frequency (bouts/h) was higher ($P \leq 0.01$) during the day time compared to that of night time (4.0, 3.2 and 3.1 vs 1.1, 1.0, and 0.9 on d 9, 19, and 29, respectively), and was lower ($P = 0.097$) in primiparous during day time on d 9 and 19 compared to multiparous mares (3.73 vs 4.36 and 2.67 vs 3.69 on d 9 and 19, respectively). Nursing frequency decreased with d of lactation in both primiparous and multiparous mares ($P \leq 0.05$ and $P = 0.08$, respectively) during day time only. Total duration of nursing per h (min/h) was higher during daytime compared to nighttime ($P \leq 0.001$) and decreased (linear, $P \leq 0.05$) with d of lactation in both primiparous and multiparous mares (3.74, 2.9, and 2.98 vs 4.12, 3.43, 2.81 for d 9, 19, and 29, respectively). Duration of a single nursing bout (min/bout) did not differ between day and nighttime, parities or d of lactation, and varied between 1.34 and 1.61 min. In conclusion, nursing frequency and total nursing duration per h declined with d of lactation during the daytime, and nursing frequency and total nursing duration per h were greater during the daytime compared to nighttime. The duration of a

single nursing bout was similar across time of day, d of lactation, and parity of mare. In conclusion, d of lactation, time of d and parity affect total nursing duration per h via changes in nursing frequency (bouts/h) rather than via changes in nursing duration per single bout. Thus, nursing frequency rather than duration of nursing per single bout appears to be the determinant of nutrient intake by foals.

Key Words: Foal, Nursing, Behavior

456 Effect of parity and day on nutrient intake by foals and nutrient demand on mares during the first month of lactation. T. N. Stamper², B. D. Nielsen¹, and N. L. Trotter¹, ¹Michigan State University, East Lansing, ²Grand-Valley State University, Grand Rapids, MI.

Arabian mares, three primiparous (P) and three multiparous (M), were used to estimate milk and nutrient intake by foals and nutrient demand on mares. Milk intake was estimated on d 10, 20 and 30 of lactation by weigh-suckle-weigh. Milk was collected on d 11, 21 and 31. Digestible energy (DE) requirements (Mcal/d) were estimated based on milk E content derived from milk lactose, protein and fat concentrations and a conversion coefficient (CC) of 0.72. Digestible protein (DP) requirements (g/d) were estimated based on daily true milk protein (TP) and a CC of 0.65. Data were analyzed as repeated measures over d of lactation and relationships between d of lactation and response variables determined by linear and quadratic orthogonal contrasts. Milk yield (kg) did not change with d of lactation in P mares but tended to increase in M mares (linear, $P = 0.12$) (12.98, 12.86, and 12.85 vs 12.66, 14.62, and 14.31 \pm 1.43, respectively). As a percentage of BW, milk yield over d of lactation was 3.05 and 3.40 for P and M mares, respectively. Concentrations of TP decreased (linear, $P = 0.05$) and lactose and total solids increased (linear, $P = 0.05$ and $P \leq 0.001$, respectively) in P mares, but did not change in M mares. Milk fat of M mares decreased (linear, $P \leq 0.05$) with d of lactation (3.2 to 1.7 %) but did not change in P mares (2.05 to 2.39 %). Fat and TP yield did not differ between parities, but lactose yield was higher ($P \leq 0.05$ on d 30) in M compared to P mares. Day of lactation increased (linear, $P \leq 0.01$) lactose yield in M mares. Estimates of DP (g/d) requirements in P mares decreased (linear, $P \leq 0.05$) with d of lactation (625, 579 and 503 for d 10, 20 and 30, respectively), but did not change in M mares (564, 527 and 633 for d 10, 20, and 30, respectively). Estimates of DE (Mcal/d) did not differ between P and M mares or between d of lactation (26.8, 26.3 and 27.2 vs 29.5, 30.0, and 31.8 \pm 3.3, respectively). Results suggest that decreasing milk TP yield with d of lactation and lower milk lactose yield in P mares may limit foal protein and carbohydrate intake compared to that of M mares.

Key Words: Mare, Milk composition, Milk yield

457 Duration of nursing and resting bouts of foals ten and twenty days after birth. B. D. Nielsen¹, T. N. Stamper¹, N. L. Trotter¹, J. S. Liesman¹, I. Gyorkos², L. Tecszy², A. Harcsa², and A. Tecszy², ¹Michigan State University, East Lansing, ²College of Nyiregyhaza, Nyiregyhaza, Hungary.

The objective of this study was to determine the frequency and duration of nursing bouts in foals. This information is essential in order to estimate nutrient intake of foals and nutrient demands on nursing mares. Seven foals out of Hungarian sport half-breed (primarily Thoroughbred breeding) mares (5 to 15 yr of age) and by Holstein, French and Dutch stallions were used in this study that was conducted at the Demonstration Farm of the College of Nyiregyhaza, Napkor,

Hungary. Horses were housed in box stalls ranging in size from 10.5 to 15 m². Horses were fed approximately 8 kg of a mixture of grass and alfalfa hay, and 4 to 6 kg of corn and crimped oats. Mares and foals were observed for a 24-h period on d 10 and 20 after foaling. Length of time spent nursing and the number of times a foal nursed, as defined as any suckling attempt lasting longer than 27 seconds, were recorded. Additionally, the length of time foals spent lying on the ground resting was recorded. Data were analyzed as repeated measures with hour of day within foal and day of lactation being the repeated variable. Nursing bouts per hour decreased from 3.85 \pm 0.21 on d 10 to 2.85 \pm 0.21 on d 20 ($P < 0.02$). The average duration of the nursing bouts was 1.22 \pm 0.05 min on d 10 and 1.11 \pm 0.05 min on d 20 ($P = 0.15$) resulting in a decrease ($P < 0.03$) in average time spent nursing per h from 4.67 \pm 0.34 min/h on d 10 to 3.18 \pm 0.34 min/h on d 20. In contrast, time resting remained unchanged with an average of 28.7 \pm 1.1 min/h spent resting on d 10 as compared to 27.8 \pm 1.1 min/h on d 20. The greatest number of nursing bouts/h and the longest time nursing within an hour were observed from 0600 to 0659 while the lowest were from 0300 to 0359. The second greatest number of nursing bouts and time nursing within an hour was from 1600 to 1659. The duration of resting periods was reduced when nursing activity was greatest and corresponded to the time when mares were being fed. This study demonstrates there are changes in duration and frequency of nursing bouts of young foals during a 24-h period and across days of lactation that must be considered when estimating milk production and consumption.

Key Words: Foal, Nursing, Rest

458 Effect of dietary n-3 fatty acid supplementation on plasma and milk composition and immune status of mares and foals. E. L. Stelzleni^{*}, L. K. Warren, and J. Kivipelto, University of Florida, Gainesville.

To determine the effects of dietary n-3 fatty acid (FA) supplementation on plasma and milk FA composition and immune function, 36 Thoroughbred and Quarter Horse mares were randomly assigned to one of three treatments from 28 d pre-partum to 84 d post-partum: encapsulated fish oil (FISH, n=12); milled flaxseed (FLAX, n=12); or no supplementation (CON, n=12). FISH contained 15 g eicosapentaenoic acid (EPA) and 12.5 g docosahexaenoic acid (DHA) per 100 g fat. FLAX contained 61 g α -linolenic acid (ALA) per 100 g fat. Mares had free access to coastal bermudagrass hay and bahiagrass pasture and were individually fed a grain mix concentrate (4% crude fat) at 1.5% of BW/d. FISH and FLAX were mixed into the concentrate in amounts to provide 6 g total n-3/100 kg BW. Blood samples were obtained from mares at 28 d pre-partum and milk and blood samples were obtained from mares and foals at foaling, 36 h and 14, 28, 56 and 84 d post-partum and analyzed for FA and IgG content. On d 84, mares and foals received intradermal injections of phytohemagglutinin (PHA) and skin thickness was determined over 48 h as a measure of cell-mediated immune response. Body weight of mares and foals was not affected by treatment. Mares fed FLAX had higher plasma ALA ($P=0.06$). Mares fed FISH had higher plasma EPA, DHA and total n-3 ($P=0.03$). Across treatments, total n-3 increased ($P=0.005$) and total n-6 decreased ($P=0.001$) in milk from foaling to d 84. Milk from FLAX mares had higher ALA ($P=0.01$) and a lower n-6:n-3 ratio ($P=0.007$). Milk from FISH mares had higher EPA and DHA ($P=0.001$). Foals suckling FLAX mares had higher plasma ALA ($P=0.04$). Foals suckling FISH mares had higher plasma EPA, DHA and total n-3 ($P=0.03$) and a lower plasma n-6:n-3 ratio ($P=0.002$). Colostrum from mares fed FISH had lower IgG ($P=0.02$), but milk

and foal serum IgG were not affected by treatment. Response to PHA injection was greater ($P=0.0001$) in mares compared to foals, but similar between treatments. Although the addition of n-3 FA to the mare's diet altered the FA content of milk and mare and foal plasma, changes in immune response were not detected.

Key Words: Omega-3 fatty acids, Immune response, Horse

459 Effects of dietary fish oil and flaxseed on plasma fatty acid composition and immune response in yearling horses. K. R. Vineyard^{*1}, L. K. Warren¹, K. A. Skjolaas², J. E. Minton², and J. Kivipelto¹, ¹University of Florida, Gainesville, ²Kansas State University, Manhattan.

To determine the effects of different sources of dietary n-3 fatty acids on plasma FA composition and immune response in yearling horses, 18 Quarter Horse yearlings were randomly assigned to one of three treatments: encapsulated fish oil (FISH, n=6), milled flaxseed (FLAX, n=6), or no supplementation (CON, n=6). FISH contained 15 g eicosapentaenoic acid (EPA) and 12.5 g docosahexaenoic acid (DHA) and FLAX contained 61 g ω -linolenic acid (ALA) per 100 g fat. Horses had free access to bahiagrass pasture and were individually fed a grain mix concentrate at 1.5% BW/d. FISH and FLAX were mixed into the concentrate in amounts to provide 6 g total n-3/100 kg BW. Horses were fed their respective treatments for 70 d. Blood samples were obtained at 0, 35 and 70 d for determination of plasma FA and isolation of peripheral blood mononuclear cells (PBMC). PBMC were stimulated with Concanavalin A and phytohemagglutinin (PHA) for determination of lymphocyte proliferation (LP). PBMC collected on d 70 were also challenged with lipopolysaccharide (LPS) to determine PGE₂ production. On d 70, horses were injected intradermally with PHA, and skin thickness and area of swelling were evaluated over a 48 h period to assess *in vivo* inflammatory response. Treatment did not affect body weight gain (mean \pm SE, 41.8 \pm 1.9 kg). Horses fed FISH had higher ($P<0.05$) plasma EPA, DHA and total n-3 and lower ($P<0.05$) plasma linoleic acid, ALA and n-6:n-3 FA ratio than FLAX and CON. PBMC positively responded to mitogen stimulation and PGE₂ increased in response to LPS, but treatment did not affect LP or PGE₂ production. Across treatments, peak increase in skin thickness was observed between 4 h and 6 h after PHA injection. At 4 h post injection, FISH and FLAX had a greater increase in skin thickness than CON ($P<0.05$) and FISH had a larger area of swelling than CON at 4 h and 12 h ($P<0.05$). Although fed to supply a similar level of n-3 FA,

FISH had a greater impact on plasma n-3 FA and n-6:n-3 ratio than FLAX. However, both FISH and FLAX demonstrated a more pronounced early inflammatory response to PHA injection than unsupplemented horses.

Key Words: Omega-3 fatty acids, Immune response, Equine

460 Effects of fatty acid supplementation on plasma fatty acid concentrations and characteristics of the first postpartum estrous in mares. T. A. Poland^{*1}, J. M. Kouba¹, C. M. Hill¹, C. Armendariz¹, J. E. Minton¹, and S. K. Weibel², ¹Kansas State University, Manhattan, ²JBS United, Inc., Sheridan, IN.

Fat supplementation of horse diets has traditionally utilized sources rich in n-6 fatty acids. The objective of this study was to evaluate the effects of supplementing mares with protected marine-derived n-3 fatty acids (JBS United) during late gestation and early lactation. Twenty Quarter-type mares were randomly assigned to one of three treatment groups. Beginning 60 d prior to the expected foaling date, mares were fed either a control diet (CON, concentrate base with added corn oil, n=6), a docosahexaenoic acid (DHA) supplemented diet (D, n=7), or a eicosapentaenoic acid (EPA) / DHA supplemented diet (ED, n=7). Diets continued after parturition through the first postpartum estrous cycle. Mare plasma was collected at the start of treatment, at parturition, and at wk 3 postpartum. Gas chromatography was used to analyze mare plasma for linoleic acid (LA), arachidonic acid (AA), alpha-linolenic acid (ALA), EPA, and DHA. Gestation length did not differ between treatment groups. The time from foaling to the first postpartum ovulation was increased ($P<0.01$) in the ED group (22.5 \pm 2.1 d) compared to both the CON (12.5 \pm 2.3 d) and D (13.3 \pm 2.3 d) groups. The length of time that mares in the ED group held a large (≥ 35 mm) follicle during the first postpartum estrous period was increased ($P<0.05$, 12.7 \pm 1.9 d) compared to the CON (6.3 \pm 2.0 d) or D (6.0 \pm 2.0 d) groups. Mare plasma LA and ALA concentrations were not affected by treatment. AA was elevated ($P<0.05$) in D mares at parturition and 3 wk postpartum compared to the CON mares. DHA was increased ($P<0.01$) in both the ED and D mares at parturition and 3 wk postpartum compared to the CON group. EPA was increased ($P<0.01$) in ED mares at parturition and 3 wk postpartum compared to both the D and CON mares. Feeding mares diets high in EPA may result in increased follicle retention and affect timing of ovulation in the early postpartum period.

Key Words: Mare, n-3 fatty acids, Follicle

Nonruminant Nutrition: Sow Nutrition and Gilt Development

461 Determining the threonine requirement of the lactating sow. J. D. Schneider^{*}, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. L. Nelssen, and J. M. DeRouchey, Kansas State University, Manhattan.

A total of 182 lactating sows were used to determine the optimal threonine:lysine ratio, and the relative difference in performance of diets with high levels of crystalline amino acids compared to a corn-soybean meal diet. All experimental diets were corn-soybean meal-based and formulated to contain 0.88% true ileal digestible (TID) lysine (1.00 and 0.97% total lysine for the control and crystalline amino acid diets, respectively). Diets were formulated to be below the expected lysine requirement of the sows based on modeled performance

of previous farrowing groups. The control diet contained no added crystalline amino acids, whereas the five other diets contained 0.37% L-lysine HCl with other amino acids added to ensure threonine was first limiting. The TID threonine levels in these diets were formulated to 0.44, 0.50, 0.57, 0.64, and 0.70%. Sows were randomly allotted to the dietary treatments based on parity. Over the entire lactation period, sows fed the diets containing crystalline amino acids consumed more ($P < 0.04$) feed than the sows fed the control corn-soybean meal diet (5.5 vs 5.1 kg, respectively). Sows fed the control diet lost numerically ($P > 0.10$) more weight (15.1 vs 12.9 kg) over the lactation period and had higher ($P < 0.01$) PUN on d 18 of lactation than sows fed diets

with added crystalline amino acids. Increasing threonine had no effect ($P > 0.10$) on litter weaning weight (average 65.8 kg). Based on litter weaning weights the expected dietary lysine requirement of these sows would have been 55 g/d compared to the 48 g/d of actual lysine intake, confirming we were below the sow's requirement for lysine. Numeric changes in PUN, litter weight gain, and feed intake suggest the TID threonine requirement was approximately 0.50%, suggesting a TID threonine to lysine ratio of 57%. The greatest implication of this study, however, was that the use of crystalline amino acids as a replacement for soybean meal in lactation diets resulted in increased feed intake and tended to decrease sow weight loss.

Key Words: Lactation, Sows, Threonine

462 Progenos in sows increases number of piglets born. P. Ramaekers^{*1}, B. Kemp², and T. van der Lende², ¹Nutreco Netherlands BV, Boxmeer, The Netherlands, ²Department of Animal Sciences, Wageningen, The Netherlands.

In two experiments the effect of Progenos in pregnant sows was examined on litter traits and farrowing rate. Progenos contains 25% L-Arginine. Two hundred ten multiparous Hypor sows were used in Exp. 1. One hundred thirty six primiparous and two hundred ten multiparous PIC sows were used in Exp. 2. In both experiments, one hundred g Progenos was fed to pregnant sows from day 14 throughout day 28 of gestation. Control groups received a placebo without L-Arginine. In Exp. 1, Progenos increased ($P < 0.05$) litter size (+0.8 piglet/litter) and farrowing rate (+11.6%). Progenos did not affect the fraction of still born piglets and birth weight, but increased ($P < 0.05$) the within-litter standard deviation for birth weight (+31g). In Exp 2, Progenos increased in primiparous and multiparous ($P < 0.05$) total born piglets (+1.25/litter and +1.18/litter) and piglets born alive (+1.08/litter and +0.93/litter), respectively. Farrowing rate was not affected ($P > 0.1$) by treatment. A potential explanation for the effect of Progenos might be that L-Arginine stimulates angiogenesis and might thereby influence placental efficiency. This leads to extra survival of those fetuses that normally do not survive. It is concluded that Progenos has a positive effect on litter size in primiparous and multiparous sows.

Key Words: L-Arginine, Pig, Litter size

463 Dietary protein concentration alter amino acid extraction rate across the porcine mammary gland during lactation. J. Perez Laspiur and N. L. Trottier*, Michigan State University, East Lansing.

Six multiparous sows were used to determine if amino acid (AA) extraction rate by the porcine mammary gland is affected by the availability of dietary AA. Sows were fed graded concentrations of crude protein (CP) consisting of 12, 18, and 24% CP to limit, meet, or exceed, respectively, protein and AA requirements. Sows were fitted with mammary vein and carotid artery catheters between d 3 and 5 of lactation. Arterial and venous blood samples were collected on d 10, 14, and 18 of lactation. For each blood sampling day, blood samples were collected every 30 min for a total of 3 h, and samples pooled per sow. Repeated measures analysis was used for repeated measures over days of lactation and relationships between dietary CP intake and response variables (AA extraction rate, piglet ADG, sow feed intake) were determined by linear and quadratic orthogonal contrasts. Differences were considered significant at $P < 0.10$ while tendency for differences were considered at $P < 0.2$. Dietary protein intake (g/d) did not differ with increasing dietary CP concentration (732, 787

and 871 \pm 144 g/d for 12, 18 and 24% CP diet, respectively). Piglet ADG tended to decrease linearly ($P = 0.12$) with increasing dietary CP concentration. Mammary extraction rates of arginine and lysine decreased linearly ($P = 0.06$) while threonine and valine tended to decrease linearly ($P = 0.13$ and 0.18, respectively) with increasing dietary CP concentration. Leucine and phenylalanine extraction rates increased with increasing CP concentration from 12 to 18% and decreased with increasing CP concentration from 18 to 24% (quadratic, $P = 0.09$ and 0.07, respectively). In conclusion, mammary AA extraction rates decreased with increasing dietary CP concentration from deficient to excess, with little change in dietary AA availability. Conversely, the decrease in dry matter and(or) energy intake with increasing dietary CP concentration may have limited mammary AA extraction.

Key Words: Amino acid transporter, Mammary gland, Porcine

464 Dietary protein intake and stage of lactation differentially alter amino acid transporter gene expression in porcine mammary gland. J. Perez Laspiur*, J. L. Burton, P. S. D. Weber, and N. L. Trottier, Michigan State University, East Lansing.

The objective of this study was to determine if dietary AA and stage of lactation regulate AA transporter gene expression in porcine mammary tissue (MT). Eighteen sows were used in a 2 x 3 randomized block design consisting of two stages of lactation and three dietary treatments. Diets limited (12% CP; Deficient), met (18% CP; Adequate) or exceeded (24% CP; Excess) protein and AA requirements for lactation. Biopsies of MT were collected between d 3 and 6 (early) and d 17 and 19 (peak) of lactation. Increasing CP concentration did not affect sow feed intake but increased CP intake (linear, $P \leq 0.001$) (565, 911, and 1315 \leq 47 g/d for 12, 18, and 24% CP, respectively). Dietary protein intake did not affect milk yield. Milk CP and casein yield, and piglet ADG increased as CP intake increased from Deficient to Adequate and decreased as CP intake increased further to Excess (quadratic, $P \leq 0.05$). Plasma glucose (mg/dL) did not change with dietary CP concentration while plasma concentration for the majority of AA increased linearly ($P \leq 0.01$). Transporters CAT-1, CAT-2B, ASCT1 and B⁰⁺ mRNA in MT was quantified by real-time PCR. Increasing CP from Deficient to Excess decreased the expression of CAT-2B (linear, $P \leq 0.05$). Dietary CP intake had no effect on expression of CAT-1, ASCT1 and B⁰⁺. Expression of ASCT1 and B⁰⁺ was higher at peak compared to that of early stage of lactation ($P \leq 0.01$), while expression of CAT-1 and CAT-2B remained unchanged. In conclusion, milk protein and casein yield, and neonatal pig growth were impacted by dietary CP intake and plasma AA availability. Only CAT-2B responded to changes in AA availability at the transcription level, suggesting that CAT-2B may be involved in regulating cationic AA transport into MT for protein synthesis. Increasing lactation demand increased ASCT1 and B⁰⁺ mRNA abundance, while the CATs remained unchanged, suggesting a different regulatory pathway for non-cationic AA transport across the mammary gland in vivo.

Key Words: Amino acid transporter, Mammary gland, Porcine

465 An omega-3 enriched diet mitigates inflammatory mediators derived from ex vivo porcine cartilage explants. M. W. Orth^{*1}, J. D. Spencer², C. I. O'Connor¹, P. M. Wolfe¹, and J. B. Wheeler¹, ¹Michigan State University, East Lansing, ²JBS United, Inc., Sheridan, IN.

Omega-3 fatty acids, specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), may reduce the inflammation associated

with joint pain. The objective of this study was to determine if long-term supplementation of long chain protected polyunsaturated fatty acids (PUFAs) in sow rations alter the metabolism of cartilage *ex vivo*. Sows (6 sows/trt) were fed either control corn/soybean meal based diets, or the control diets supplemented with 0.5 to 1.0% protected PUFA from Fertiliium (JBS United, Sheridan, IN). Sows were fed their respective treatments continuously for at least three parities prior to slaughter and harvesting of both forelimbs approximately 2 inches above the humeral-ulnar joint. Cartilage explants (6 mm disks) were isolated and placed, 2 per well, in a 24-well culture plate, with twelve wells per animal. Explants were cultured in DMEM: Ham's F-12 modified serum free medium with no exogenously added fatty acids or cultured in the same media and challenged daily with porcine Interleukin-1 (pIL-1; 10 ng/ml) to stimulate inflammatory pathways. Media were collected every 24 h for 3 d and analyzed for the production of nitric oxide (NO), PGE₂, and Interleukin-6 (IL-6). Proteoglycans in the media were measured as an indicator of cartilage catabolism. Statistics were analyzed using proc mixed of SAS 8.2 with sow, day, pIL-1 addition, and diet as class variables. Explants from sows fed PUFAs had reduced proteoglycan and IL-6 release regardless of pIL-1 challenge (Diet $P < 0.05$). The pIL-1 challenge increased NO production (pIL-1 x Day $P < 0.01$) and sows fed PUFAs had a 31% reduction in NO production, but the impact of PUFA feeding was not significant (Diet $P = 0.30$). Media PGE₂ concentrations were not different among treatments. Thus, 2 out of the 4 indicators of inflammation were significantly mitigated in cartilage explants following long-term supplementation with protected PUFAs. These results suggest that protected PUFAs containing high levels of EPA and DHA can alter chondrocyte metabolism *in vivo*.

Key Words: Arthritis, Health, Swine

466 Varying dietary cation-anion difference in late gestation and in lactation on sow productivity. M. L. Roux^{*1}, P. W. Jardon², S. L. Johnston¹, T. D. Bidner¹, and L. L. Southern¹, ¹LSU Agricultural Center, Baton Rouge, ²West Central, Ralston, IA.

Primiparous or multiparous sows and their pigs were used to evaluate the effects of changing dietary cation-anion difference (DCAD; Na + K - Cl - S) in late gestation and in lactation on sow productivity. In a preliminary experiment (20 sows), urinary pH was linearly decreased ($P < 0.001$) as DCAD decreased in the diet (DCAD; 140, 99, 75, and 45 mEq/kg). Reducing DCAD tended to linearly increase ($P = 0.15$) plasma Ca concentrations. Thus, in Exp. 2, 66 sows (33 per treatment) were used and the dietary treatments consisted of corn-soybean meal diets with DCAD of 140 or 45 mEq/kg. These DCAD's were achieved by 0 or 3.5% added SoyChlor 16-7. The diets were fed from d 111 of gestation to weaning. Sows were allotted based on parity and the date of d 111 of gestation. Reducing DCAD reduced ADFI from d 111 of gestation to d 1 postfarrowing ($P < 0.02$), but ADFI was not affected by DCAD during lactation or overall ($P > 0.10$). Sow weight change was not affected by DCAD ($P > 0.10$). Reducing DCAD did not affect total number pigs born, pigs born alive, stillbirths, mummies, number nursed, number weaned, percent survivability, live and total birth weights, initial litter weight adjusted for mortality and cross-fostering, final litter weight, or litter weight gain ($P > 0.10$). Decreasing DCAD in the diet decreased urinary pH ($P < 0.001$) but had no effect on plasma Ca concentration. Twenty-seven sows fed the control diet and 21 sows fed the reduced DCAD diet were evaluated during their subsequent farrowing. Sows that had been fed the reduced DCAD diet had increased total number of pigs born ($P < 0.08$) and pigs born alive ($P < 0.02$) in the subsequent farrowing. Stillbirths, mummies, and live and total birth weights were not affected in the subsequent farrowing by DCAD. Changing DCAD had little effect on sow and litter response variables, but it decreased urine pH ($P < 0.001$) and increased total number of pigs born and pigs born alive in the subsequent farrowing.

Key Words: Electrolyte balance, Sows, Urinary pH

Production, Management and the Environment III

467 Carry-over effect of extended photoperiod during pubescence on first lactation in beef heifers. J. A. Small^{*1} and A. D. Kennedy², ¹Agriculture & Agri-Food Canada, Brandon, MB, Canada, ²University of Manitoba, Winnipeg, MB, Canada.

A 2*2 factorial arrangement of photoperiod treatments in autumn (A) and winter (W) was applied to spring-born crossbred beef heifers (N=540 over 6 yrs) assigned at weaning (Sep; 0 wk), by body weight and age, to one of four pens in one of two similar open shed/drylot facilities. Supplemental light (350 lux, 1 m above ground) was used to extend photoperiod (natural + supplemental light) to 16 h for 12 wk starting in Sep (A), or Dec (W), or for both periods (AW), while the control group was exposed to natural photoperiod (NP) only. Heifers were fed diets formulated to achieve 60% mature body weight at 32 wk through one of three feeding strategies: low gain during the prepubescent (0.6 kg d-1; 4 to 16 wk), high gain during the pubescent (1.2 kg d-1; 16 to 24 wk) and moderate gain during the post-pubescent (0.7 kg d-1; 24 to 32 wk) period, or low, low, high and constant (0.9

kg d-1) gain throughout these periods, respectively. In May each year heifers were synchronized for fixed-time AI (0 d) followed by exposure to bulls (2-42 d) and turn-out. In the fall bred heifers continued in one management group. At 8 wks postpartum heifers were milked, separated from their calves and milk collected 8 h later used to determine yield and composition. Data were analyzed as a 2*2*3 factorial using Proc Mixed and included the random effect of year. Mean pre- and post- calving body weights and condition scores, and calf birth weight of milked heifers were similar ($P > 0.05$) among treatments. Yield of milk (8.3±0.3, 8.3±0.2, 7.9±0.3 and 7.6±0.2 kg d-1), protein and solids not fat were greater for A- or W- than AW- and NP treatments, respectively ($P = 0.05$). Feeding strategy had no significant effect ($P > 0.05$) on milk, body weight or condition. Extended photoperiod treatment during pubescence increased first lactation milk yield by 9.2%.

Key Words: Beef heifer, Photoperiod, Lactation

468 Influence of breed type and temperament on feedlot growth and carcass characteristics of beef steers. R. C. Vann^{*1}, R. D. Randel², T. H. Welsh, Jr.², S. T. Willard⁴, J. A. Carroll⁵, M. S. Brown³, and T. E. Lawrence³, ¹MAFES-Brown Loam Exp. Station, Raymond, MS, ²TAES, College Station and Overton, TX, ³West Texas A&M University, Canyon, ⁴Mississippi State University, Starkville, ⁵Livestock Issues Research Unit, Agricultural Research Service-USDA, Lubbock, TX.

Forty steers (Angus, n = 20; Brahman, n = 20) were used to examine the effects of breed type and temperament classification on feedlot growth performance and carcass traits. Steers were weaned, assigned a temperament classification (TEMP; calm or excited), commingled and grazed on rye-ryegrass pastures for 130 d and then shipped from Overton to Canyon, TX (500 miles). At weaning, steers were assigned a pen temperament score (PS; 1 = non-aggressive, to 5 = aggressive), weighed and assigned a chute score [CS; 1 = calm, to 5 = highly agitated), restrained in a squeeze chute and then released; time to travel 1.83 m was recorded (exit velocity (EV), m/s). TEMP was calculated as [(PS + EV)/2]. Steers were assigned to pens at the feedlot based on mean TEMP: calm pen means for Angus were 2.3 and 2.3 (n = 2), and for Brahman were 1.4 and 1.4 (n = 2; SEM 0.4); excited pen means for Angus were 3.5 and 3.4 (n = 2) and for Brahman were 3.8 and 2.5 (n = 2; SEM 0.4). Steer BW, ultrasound measurements for Longissimus area, rib fat, and percent intramuscular fat (%IMF), and PS and EV were collected on arrival at the feedlot and after 113 d on feed. A positive correlation (P < 0.001) between weaning PS (r=0.64) and EV (r=0.72) and PS and EV at feedlot arrival demonstrates the utility of the predictive value of weaning TEMP scores to future TEMP scores. Steers were harvested after reaching a similar rib fat thickness as per breed type. Angus steers ate 1.68 kg/d more DM (P = 0.004), and had greater ADG (P = 0.05), adjusted feed efficiency (P = 0.05), HCW (P = 0.001), carcass marbling score (P = 0.05), ultrasound and carcass fat thickness (P = 0.003), yield grade (P = 0.05) and lower shear force (P = 0.04). TEMP influenced carcass fat thickness (P = 0.03); excited steers had lower fat thickness compared to calm steers. Breed type x temperament interaction influenced carcass marbling score (P = 0.08); Angus calm steers had greater marbling scores than Brahman calm or excited steers. Temperament and breed type influenced carcass quality as indicated by marbling; however, breed type had the greatest effect on growth and carcass characteristics.

Key Words: Steers, Feedlot, Temperament

469 The effect of supplemented light on certain production parameters of young beef bulls fed intensively. P. J. Fourie*, D. J. Maasz, and D. O. Umesiobi, *Central University of Technology, Free State, South Africa.*

The objective of the study was to quantify the differences in average daily gain (ADG), back fat thickness (BFT), longissimus dorsi (LD), P8 (fat layer on the rump), feed conversion ratio (FCR) and body dimensions (by means of body measurements) of animals exposed to different levels of light supplementation. Thirty young Bonsmara bulls from the same farm (203 ± 14 days old) weighing (257 ± 15.1kg) were randomly divided into three homogeneous groups (n = 10 per group) and were subjected to three different levels of light supplementation (16h, 24h and normal photoperiod). The additional lights provided an average light intensity of 155 lux measured at eye level. The animals were housed in open pens and fed intensively ad libitum on a diet containing 11 MJ ME/kg DM and 14% CP for 84 days. An accredited operator did the ultrasound scanning, using a PIE Medical Falco 100

scanner to measure subcutaneous fat depth between the 12th and 13th rib (BFT), LD and P8 on days 1, 22, 51, 62 and 84 (end of the trial). Other data collected included body weight (BW) (taken every seven days starting on day one of the trial), shoulder height, body length and heart girth. The ADG, FCR and feed intake (FI) were calculated at the end of the trial. Data was statistically analysed using a one-way ANOVA in Proc GLM to determine the effect of supplemented light on the different parameters. Results of this study demonstrate that light supplementation was significantly effective in improving the ADG and FCR, mostly at 24 h photoperiod. No differences between the groups were evident for body measurements and ultrasound parameters. The final results of the study concluded that extended photoperiod (EP) (24h) improved ADG and FCR of young beef bulls fed under intensive conditions.

Key Words: Extended photo period, Beef bulls, Intensively

470 A nutritional supplement for beef cattle grazing endophyte-infected tall fescue. I. Response of herd-managed cows and calves. D. G. Ely*, D. K. Aaron, J. Wyles, R. A. Zinner, A. K. Lunsford, and M. L. Mallory, *University of Kentucky, Lexington.*

Eighty-four Angus x Beefmaster cow/calf pairs were used in a 3-yr study to determine response to gradient levels (0, 10, 20, and 40 g/cow) of a nutritional supplement produced from brewer's dried yeast (FEB-200™, Alltech, Inc., Nicholasville, KY). The supplement, carried in 0.45 kg ground shelled corn, was provided 1x/d during the grazing period. Cows and calves were managed in eight, 10.5-ha endophyte-infected (> 90%) KY 31 tall fescue pastures (two pastures/supplement level, re-randomized each year) from May 4 to July 11 (Period 1) and from July 11 to weaning on October 24 (Period 2). Cows averaged 5.1 yr, 490 kg, and 5.3 BCS on May 4. Initially, calves averaged 106 kg at 72 d of age. In Period 1, cows in the 0, 10, and 20 g treatments lost 9, 8, and 9 kg, respectively, as cows in the 40 g treatment gained 1 kg/hd (Linear; P = 0.03). No treatment effects on cow gain were found in Period 2. Gains for the total grazing season (May 4 to October 24) were 26, 26, 23, and 31 kg/cow for 0, 10, 20, and 40 g treatments, respectively. The greatest treatment effect was found in cows older than 5 yr (Linear; P = 0.01). Cow BCS increased linearly (P = 0.07) with increasing supplementation level during Period 1. No treatment effect was found in Period 2; however, overall BCS changes from May 4 to October 24 were positive and increased linearly (P = 0.07). Although supplementation had no effect on condition of 2-yr-old cows, BCS of 3 to 5 and > 5-yr-old cows increased linearly (P = 0.04 and 0.07) as level of FEB-200™ consumption increased. Calves in the 0, 10, 20, and 40 g treatments gained 61, 60, 58, and 65 kg/hd, respectively (Linear; P = 0.01), in Period 1. Gains during Period 2 were not affected by supplement level. Overall gains from May 4 to October 24 were 154, 153, 150, and 159 kg/hd (Quadratic; P = 0.02). These results show daily supplementation with 40 g FEB-200™ can increase weight gains of cows and calves grazing endophyte-infected tall fescue.

Key Words: Fescue, Cows, Calves

471 A nutritional supplement for beef cattle grazing endophyte-infected tall fescue. II. Response of individually-pastured cow/calf pairs. D. K. Aaron*, D. G. Ely, J. Wyles, R. A. Zinner, A. K. Lunsford, and M. L. Mallory, *University of Kentucky, Lexington.*

Sixty, 3 to 5 yr-old, Angus x Beefmaster cows and their calves were used in a 3-yr study to assess response to gradient levels (0, 10, 20, and

40 g/cow) of a nutritional supplement produced from brewer's dried yeast (FEB-200™, Alltech, Inc., Nicholasville, KY). The supplement, carried in 0.45 kg ground shelled corn, was provided to cows on a daily basis during the grazing period, which began on May 4 each year. From this date until July 11 (Period 1), cows and calves were managed in eight, endophyte-infected (> 90%) KY 31 tall fescue pastures (two pastures/supplement level, re-randomized each year) stocked with 10 to 16 cow/calf pairs each. On July 11 each year, 20 pre-designated cow/calf pairs were allotted to individual 1.6-ha plots of equivalent pasture (five plots/supplement level, re-randomized each year). Cows continued their respective supplement regimes from this date until calves were weaned on October 24 (Period 2). Cow weight changes in Period 1 were -15, -9, -8, and -1 kg/hd (Linear; $P = 0.01$) for 0, 10, 20 and 40 g supplement levels. Although corresponding weight changes in Period 2 showed no significant trend, total cow gains from May 4 to October 24 increased linearly (24, 28, 30, and 34 kg/hd; $P = .10$) as level of supplementation increased. Likewise, cow BCS increased linearly in Period 1 (-0.03, 0.22, 0.30, and 0.58; $P = 0.001$) and overall (0.68, 0.64, 0.90, and 1.13; $P = 0.02$). In Period 1, calves gained 57, 58, 56, and 64 kg/hd (Linear; $P = 0.10$) as supplement level increased. No significant differences were found in Period 2; however, overall calf gains (146, 149, 148, and 158 kg/hd) were linear ($P = 0.11$). In Period 2, performance of individually-supplemented cow/calf pairs mimicked that of group-supplemented cows and calves remaining in the larger pastures until weaning. These results show that daily supplementation with 40 g/cow of FEB-200™ can increase production of cows and calves grazing endophyte-infected tall fescue.

Key Words: Fescue, Production, Cows

472 A general model for predicting the retention of electronic boluses in the forestomachs of cattle and sheep. G. Caja^{*1}, J. Ghirardi¹, J. Casellas¹, S. Carné¹, M. Hernández-Jover¹, and D. Garin², ¹Grup de Recerca en Remugants, Universitat Autònoma de Barcelona, Bellaterra, Spain, ²Facultad de Veterinaria, Universidad de la República, Montevideo, Uruguay.

Permanent identification is a key point for animal traceability and farm management. Electronic boluses are an efficient method for ruminant identification. Data from 1,203 beef calves and 1,662 sheep identified with electronic ruminal boluses, were used to build up a model for predicting bolus long-term retention in their forestomachs. All animals wore official ear tags as a control. Boluses consisted of 23 types of cylindrical capsules varying in dimensions and made of different materials (ceramic, concrete or plastic). Dimension ranges were: o.d. (9- to 21-mm), length (37- to 78-mm), weight (11 to 75 g), volume (2.5 to 22.4 ml) and specific gravity (0.63 to 3.91). Each bolus contained one half-duplex standardized glass encapsulated transponder (length × o.d., 32- × 3.8-mm). Boluses were administered orally at different ages (1 wk to adult) by using the appropriate balling guns. Bolus retention rate ($RR = \text{read/applied} \times 100$) was calculated from data obtained by reading periodically the transponders with standardized handheld and stationary transceivers (working frequency, 134.2 kHz), under intensive conditions in cattle (for at least 1 yr) or under semi-intensive conditions in sheep (for at least 2 yr). Unreadable boluses were checked at slaughter or at necropsy of the dead animals by using a handheld transceiver. The RR varied between 0 and 100% according to bolus features in cattle and sheep. Inadequately dimensioned boluses were regurgitated or passed through the gastrointestinal tract and were rejected with the feces. Ear tag losses during the trial averaged 3.5 and 7.5% in cattle and sheep, respectively. Despite the differences between species, bolus retention rate was predicted by a unique logistic

regression model ($R^2 = 0.989$; $P < 0.001$) from bolus volume (V, ml), weight (W, g) and animal specie (SP: sheep = 0; and, cattle = 5.80). The model was: $RR (\%) = 1/(1 + 1.849 e^{0.400 V - 0.429 W + SP})$ The minimum bolus dimensions estimated to reach a $RR > 99\%$ are: 19 g and 5.5 ml in sheep, and 55 g and 16 ml in cattle, when the bolus are made of a material with an specific gravity >3.4.

Key Words: Electronic Identification, Bolus, Ruminant

473 Estimation of demand function for different types of meat in Iran: Application of cointegration. J. Azizi^{*}, Islamic Azad University, Rasht Branch, Rasht, Iran.

In this study by using the Almost Ideal Demand System (A.I.D.S), the demand function for different types of meat in urban and rural societies have been estimated and price as well as non-price elasticities of Marshall and Hicks demand function were investigated, Application of cointegration theory for determining the appropriate demand function was also investigated: Results obtained from this study indicated that during the period under study, household budget allocated to red meat have been decreased both in urban and rural societies, whereas during the same period household budget allocated to the purchase of chicken and fish have been increased. Furthermore, the share of budget allocated to the purchase of fish in the rural societies increased first but later decreased. Price elasticities of different types of meat in urban as well as rural areas showed that during the period of study the use of price variable for the modification of consumption pattern have not been effective. This indicates that for the modification of consumption pattern, price variable has not been an effective factor. Therefore other variable such as population growth rate is of great significance that should be taken into account. Moreover, because of using time series data in this study, first the unit root in the model's variables was examined and then long-term relation of data was investigated. The results of study has revealed the existence of cointegration in this regard.

Key Words: Meat, Almost Ideal Demand System, Cointegration

474 Optimising lactation length based on subsequent sow reproductive performance. M. Aparicio^{*}, L. M. Ramirez, J. Morales, and C. Pineiro, PigCHAMP Pro Europa, S.A., Segovia, Spain.

Legislation of EU is requiring 28 d minimum of lactation, based on welfare recommendations. In others countries (US or Canada), lactation length (LL) has been progressively reduced, affecting productive results and economical benefits. The objective of this study was to determine the optimal LL based on productive results. For the study, 72,160 reproductive data from a total of 15 farms and 11,275 sows were used, obtained from the PigCHAMP[®] database in the interval 2001-2005. Data were distributed in 5 groups depending on LL: 0-7 (L1), 8-15 (L2), 16-23 (L3), 24-32 (L4) and more than 33 days (L5). Weaning-to-first mating interval (WFMI), weaning-to conception interval (WCI), farrowing rate (FR), total number of piglets born (TB) and born alive (BA) in the subsequent farrowing were evaluated. Data were analyzed using the GLM procedure of SAS. The shortest LL groups (L1 and L2) took more time ($P=0.0001$) to show oestrus (18.9, 8.0 and 6.4 d WFMI in L1, L2 and the rest of groups, respectively). The same tendency was observed for WCI, which was optimal for 16-32 days LL (groups L3 and L4). WCI increased again with longer lactations (11.3 vs 9.9 d WCI in L5 and L3/L4, respectively; $P<0.001$). The resulting equation is an exponential curve, and the calculated optimal LL to minimize WCI was 25.1 days. FR was also influenced

by LL, and longer lactations (>16 days) showed higher FR ($P<0.001$), and was seriously affected by lactations shortest than 7 days (60.3 vs 72.5% in L1 and L2; $P<0.001$). Based on the FR equation described, the optimal LL was 25.4 d. On the other hand, TB and BA in the subsequent farrowing increased linearly with LL ($P<0.001$). However, prolonging lactation decreases number of weaned piglets/sow/year. In this case, from the LL and WCI data, the calculated number of

litters/sow/year decreased from 2.39 in L4 to 2.26 in L5 group. We conclude that increasing LL improves productive and reproductive parameters. From these results we conclude that the best interval of LL is 24-32 d with an optimum of 25 d, offering an optimum balance among the main performance indicators.

Key Words: Lactation length, Performance, Sow

Production, Management and the Environment IV

475 Potential demand for dairy farm revenue insurance. C. A. Wolf*, J. C. Hadrich, and J. R. Black, *Michigan State University, East Lansing.*

Lowering the dairy price support throughout the 1980's led to a market milk price that has been largely determined by market forces since the early 1990's. Consequently the base farm market milk price has varied much more than it had in the decades where the price support intervened. In 2000 the Federal Crop Insurance Corporation authorized the Agricultural Risk Protection Act of 2000 to facilitate the provision of insurance on livestock, expanding insurance possibilities on farms to livestock enterprises. Adjusted Gross Revenue insurance is an insurance contract using expected accrual gross revenue as basis for determining the insurance guarantee. This paper examines the magnitude and causes revenue risk on dairy farms with the resulting implications for dairy farm revenue insurance demand. The empirical component of the analysis is based upon Michigan dairy farm panel data from 1990 through 2004. The average coefficient of variation for annual milk price across farms and over years was 11 percent with a standard deviation of 2 percent. This indicates that, while market price varied substantially, the institutions and policies in place to market milk heavily insulated farms from price variation on an annual basis. The crops for which current crop revenue insurance contracts are facilitated have coefficients of variation in the 18 to 22 percent range, much greater than for dairy. Milk yield per cow is also much less variable than yield in field crops, ranging from 5 to 9 percent; that compares to 25 to 40 percent for dryland crops. Kernel densities of de-trended milk per cow (milk yield) indicate that 92% of all farms were within 3,000 pounds/cow of trend yield (and 84% were within 2,000 pounds). With an average yield of 20,040 pounds/cow, the vast majority of farms were within 10 percent of trend yield. The resultant variability in milk revenue per cow is much less than that of crops, even irrigated crops. Dairy farm revenue shortfalls would seldom trigger an indemnity under the insurance policies evaluated. Potential sources of increasing risk and alternative risk management tools are considered.

Key Words: Insurance, Risk management

476 Effect of mastitis and postpartum metabolic diseases on milk yield persistency in Holstein and Jersey cows. J. A. D. R. N Appuhamy*¹, B. G. Cassell¹, and J. B Cole², ¹*Virginia Polytechnic Institute and State University, Blacksburg*, ²*Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

The objective of this study was to investigate the effects of mastitis (MST) and postpartum metabolic diseases (PPMD) on persistency

of milk yield (P) in Holstein (H) and Jersey (J) cows. Data consisted of daily milk yields and health events for 59 H and 27 J cows calved between July, 2004 and March, 2005 in the Virginia Tech herd (Blacksburg, VA). Persistency was calculated as a function of a standard lactation curve and the linear regression of a cow's test day deviations on days in milk (DIM) and standardized. Values of $P > 0$ indicate greater persistency. Standard curves were calculated from the data and did not account for breed differences. 10 test day yields before 128 DIM and 10 after were used to compute P for each cow; test day DIM were the same for all cows. Milk fever and ketosis were pooled into PPMD, and two MST classes were defined: occurrences before (MST1) and after (MST2) 128 DIM. Each disease was defined as a binary trait distinguishing between cows with at least one reported case (1) and cows with no cases (0). The statistical model included fixed effects of breed and parity with two binary variables indicating the presence (1) or absence (0) of the disease of primary interest or any other disease. Frequencies of cows with MST1, MST2 and PPMD were 24.5%, 25.6% and 10.5% respectively. The effect of MST1 on P was significant and had a phenotypic correlation of -0.20 with P. Thus, cows with mastitis in the first 128 d of lactation tended to be less persistent than cows with no mastitis. The correlations of MST2 and PPMD with P were -0.04 and 0.14, respectively and were not significant. Breed effects were highly significant, suggesting that H and J have differently-shaped lactation curves. Parity effects were not significant, as expected, because different standard curves were used for first and later parities.

Key Words: Mastitis, Metabolic diseases, Milk yield persistency

477 Effect of preparturient intramuscular injection of vitamin E and selenium on milk somatic cell counts in Holstein cows. Y. K. Fan*¹, I. T. Lin^{1,2}, and H. I. Chang^{1,3}, ¹*National Chung Hsing University, Taichung, Taiwan, ROC*, ²*National Taiwan University, Taipei, Taiwan, ROC*, ³*Uni-President Enterprises Corp., Tainan, Taiwan, ROC.*

Blood concentrations of D- α -tocopherol (vitE), selenium (Se), and glutathione peroxidase (GSHpx) activity decrease along with immune ability declines and incidence of mastitis increases during periparturient stage in dairy cows. It is supposed that application of vitE and Se on dairy cows is capable to prevent the animals from mastitis through promoting their antioxidation ability. This experiment investigated the effects of a high dose vitE and Se injection intramuscularly on the blood concentrations of vitE, Se and GSHpx activity, and milk somatic cell counts (SCC) at wk 2 and 4 postpartum in Holstein cows. Ten of 13 multiparity cows (535 \pm 50.6 kg) were randomly allotted into two treatments, e.g., intramuscular injection with 4.4 g Tween 80 (Tw) or with 3,000 IU vitE plus 50 mg Na₂SeO₃ dissolved in 4.4 g Tw (ESe)

once per head at both 2 weeks and 1 week prior to calving leaving 3 cows without injection regarded as controls (CNTRL). Blood plasma concentrations of vitE in ESe were 86% higher at one day after injection and declined in less extent at parturition ($P < 0.05$). The correlation coefficient was 0.79 ($P < 0.01$) between milk and plasma concentrations of vitE. There were no significant differences among the treatments in Se concentrations of blood serum and milk, GSHpx activity in whole blood, and SCC at week 2 postpartum. The incidences of clinical mastitis among the treatments were not significantly different. The incidence of retained placenta was 60% in ESe, which might be attributable to the consequence of the lowest Mg level in the blood serum. The correlation between milk and blood serum Fe concentrations, or the correlations among lactoferrin, transferrin, and SCC were not significant. In conclusion, intramuscular injection of vitE and Se to preparturient cows does prevent abruptly drop of blood plasma vitE level at parturition. However, the efficacies of lowering SCC and enhancing mammary gland health status by preparturient intramuscular injection with vitE and Se stay unclear in Holstein cows.

Key Words: Vitamin E, Selenium, Somatic cell count

478 Management risk factors associated with clinical lameness in free stall housed Holstein cows. L. A. Espejo and M. I. Endres*, *University of Minnesota, St. Paul.*

The objective of this study was to investigate the association of some management factors with the prevalence of clinical lameness in 53 high production groups of Holstein cows housed in 50 commercial dairy farms with free stall barns in Minnesota. Cows in the high production group (total of 5626 cows) were scored for locomotion (LS; scale of 1 to 5, where 1 = normal and 5 = severely lame) in order to estimate the prevalence of clinical lameness in the group. A cow was considered clinically lame if her LS ≥ 3 . Prevalence of lameness averaged 24.6% across dairy farms. Management variables were used to explain the variation in the prevalence between groups. Among the variables tested, number of cows in the herd, pen square footage per cow, parlor type, parlor size, TMR crude protein content, TMR NDF content, feeding frequency and use of footbath did not show an association with the prevalence of lameness ($P > 0.3$) in the univariate analysis screening test and they were not included in the multivariate model. Pen stocking rate (cows per stall), total daily distance between pen and parlor, number of cows per full time employee equivalent, rumination index and barn type (2-row or 3-row) were eliminated from the multivariate model with a stepwise procedure ($P > 0.05$). The final model used to explain the variation in the prevalence of lameness between groups included time away from the pen during milking, cow comfort quotient, frequency of hoof trimming, brisket board height, area behind brisket board filled with concrete, and interaction between brisket board height and area behind brisket board filled with concrete. Time away from pen was positively associated with the prevalence of lameness ($P < 0.01$), whereas cow comfort index was negatively associated with the prevalence of lameness ($P < 0.01$). The prevalence of lameness was higher when farms performed hoof trimming only when was needed and not on a scheduled basis ($P < 0.05$). Height of brisket board had a positive association with the prevalence of lameness ($P < 0.01$) and there was an additive association when the area behind the brisket board was filled with concrete ($P < 0.05$).

Key Words: Lameness, Free stall, Risk factor

479 Using heat stress audits to evaluate the level of heat stress on commercial dairies. J. Smith*¹, M. VanBaale², R. Rodriguez³, C. Jamison³, M. Brouk¹, and J. Harner III¹, ¹*Kansas State University, Manhattan*, ²*University of Arizona, Tucson*, ³*Monsanto, St. Louis, MO.*

A project to evaluate the level of heat stress on individual dairies was conducted during the summer of 2005. The object of this project was to develop a method to evaluate or audit how effective an individual dairy is managing heat stress. Approximately 45 herds in 24 different states were audited to determine the level of heat stress cows experienced during a 72 h period. Dairies were selected based on geography, climate and facility design. Lactating cows 40 to 100 DIM and dry cows within 30 days of calving were evaluated. Vaginal temperatures of 8 cows located in the same group were collected every 5 min using data loggers (HOBO U12)[®] attached to a blank CIDR[®]. Ambient climatic data was collected throughout the project on dairies from utilizing logging devices which collected temperature and relative humidity at 5 minute intervals. Census data was collected at each dairy and included pen sizes, milking frequency, milking times, average milk production, DIM, parity, holding pen design, and timing of cow movements. Data were imported into Excel[®] as individual cow files aligned by time. The individual cow was then averaged with all other cows in the pen in hourly increments over a 24 hour period. Each 24 hour period was a summary of that hour on 3 consecutive days, with eight devices contributing 12 points per hour per day to the summary. So each hour is a summary of 12 data points x 8 cows x 3 days or 288 data points/hour. Information was summarized graphically in PowerPoint[®] and presented to the individual producers along with recommendations on how to improve their heat stress abatement practices. The project was not designed as a controlled trial; therefore caution is advised in over-interpreting the data. However, the project does demonstrate the feasibility and usefulness of using intra-vaginal temperature recording to monitor how well an individual dairy is managing heat stress.

Key Words: Heat stress, Cow comfort, Dairy facilities

480 Evaluation of Advanced Dairy Systems shade tracker fans and Korral Kool coolers on lactating dairy cattle. R Burgos*, L. J. Odens, R. J. Collier, L. H. Baumgard, and M. J. VanBaale, *University of Arizona, Tucson.*

Two independent trials were conducted during the summer months of June 3rd to September 30th of 2004 and 2005. In each trial 400, multiparous and 100 primiparous Holstein cows balanced for parity, stage of lactation, and milk yield were randomly assigned to 1 of 2 cooling treatments (trts). Individual milk yields and pen DMI were collected daily, respiration rates (RR) and body surface temperatures (ST) were recorded weekly, and milk components, BCS and body weights (BW) were obtained monthly. In 2004, average daily milk production did not differ for multiparous cows housed in ADS-ST or KK (41.8 kg/d) pens. However, daily milk yield for primiparous cows housed under KK conditions tended ($P = 0.10$) to be higher than cows housed under ADS-ST conditions (37.8 vs. 36.7 kg/d). Multiparous cows cooled with ADS-ST had a higher RR (60.5 vs. 58.3 BPM); however, RR in primiparous cows did not differ between treatments (59.2 \pm 0.8 BPM). In 2005, daily milk production for multiparous (42.2 vs. 38.3 kg/d) and primiparous (35.2 vs. 32.7 kg/d) cows housed in KK were higher ($P < 0.05$) compared to cows housed under ADS-ST pens. Body weight change was similar in 2004 between multiparous cows housed in KK or ADS-ST trts (-0.49 vs. 13.3 kg/d), however

primiparous cows housed under KK conditions gained more BW (60.5 vs. 19.9 kg) than heifers housed under ADS-ST. Multiparous (70.9 vs. 59.3 BPM) and primiparous (72.2 vs. 61.3 BPM) cows cooled with ADS-ST had a higher RR. During times of moderate to severe heat stress cows housed under KK cooler out performed those cows housed under ADS-ST fans. During both trials, ADS-ST cooling system used less electricity (526 vs. 723; 2004 and 517 vs. 840; 2005 kwh/d) and water (291 vs. 305 and 290 vs. 460 L/d) than the KK coolers. The daily costs for the ADS-ST and KK system was \$27.30 and the KK system was \$36.36/d in 2004 and 25.95 vs. \$42.06 during the 2005 trial.

Key Words: Dairy cattle, Evaporative cooling, Heat stress

481 Comparison of a 2-stage and linear controls for feedline soaking systems utilized in 2-row freestall barns. M. J. Brouk*, B. Cvetkovic, J. F. Smith, and J. P. Harner, *Kansas State University, Manhattan.*

Sixteen lactating Holstein cows were housed in four identical, 108 cow, 2-row freestall barns (four per barn) and utilized in a replicated double-switchback design to evaluate a 2-stage and linearly increasing feedline soaking system controller (C-440S, Edstrom Industries). Gradually increasing soaking frequency as temperature increases, could reduce heat stress as compared to a 2-stage control system. Initial barn minimal operation temperature for both treatments was set at 23.9 °C, with a soaking cycle every 15 min. The 2-stage treatment increased soaking frequency to once every 5 min when the barn temperature exceeded 29.4°C. The linear setting did not reach this frequency until the temperature exceeded 35°. All barns were equipped with supplemental cooling fans that operated when the barn temperature exceeded 21.1 °C. The study was completed during a period of summer heat stress and each experimental period contained 24 hr. Cattle were fitted with vaginal temperature probes that recorded vaginal temperature every minute. Visual respiration rates were recorded in the afternoon and early morning. Prior to statistical analysis, individual cow data were averaged by barn and day. Vaginal temperature data was summarized in 5-min segments of time for each hour of the day. Both controller treatments were equally (P=0.7) effective as indicated by similar average body temperatures (38.9°). Body temperatures differed at various times of the day but were unaffected by treatment (P=0.9). Afternoon, morning and average respiration rates were also similar (P=0.36). Based on these data, both controller settings provided effective heat abatement for the barns tested. The linear increase program utilized 8% less water than the 2-stage setting. Utilizing this type of controller may reduce freshwater consumption on dairy farms. Results may be different with differing barn designs, environment and feedline soaker systems.

Key Words: Heat abatement, Cow cooling, Facilities

482 Impact of feedline soaker minimum operation temperature upon respiration rate and body temperature of lactating dairy cows. M. J. Brouk*, B. Cvetkovic, J. F. Smith, and J. P. Harner, *Kansas State University, Manhattan.*

Feedline soaking systems are generally operated when barn temperature reaches a predetermined threshold temperature. While it is generally recognized that heat stress in dairy cattle is associated with a THI of 72, other reports indicate that heat stress may occur prior to reaching this level. A common recommendation has been to operate fans when barn temperature exceeds 21.1°C and feedline soakers are generally set

to operate when temperature exceeds 23.9°C. This study investigated four different threshold temperatures for a feedline soaking system in four 2-row freestall barns located in northeast KS. Each barn was identical in construction and housed 108 Holstein cows. Four animals were selected from each barn (16 total) and fitted with temperature probe that recorded vaginal temperature every minute. Respiration rates were visually observed and recorded in the afternoon and early morning. A Latin square design was utilized to evaluate four different minimum operation temperatures (18.3, 21.1, 23.9 and 26.7°C). Each feedline soaking system was controlled by an electronic controller (C-440S, Edstrom Industries) which linearly increased soaking frequency as temperature increased to 35°C. All controllers increased soaking frequency as barn temperature increased. Periods were 24-hr in length during summer heat stress and all treatments appeared in all pens. Data were averaged by treatment within period prior to statistical analysis. Body temperature as indicated by vaginal temperature did not vary (P>0.35) with minimal operation temperature (38.7, 38.8, 38.8 and 38.8 °C, respectively for each treatment). Respiration rates tended to be greater (P<0.10) for the 26.7°C treatment as compared to the 18.3°C treatment. These data indicate that when feedline soaking systems are controlled electronically and increase soaking frequency as barn temperature increases, threshold temperature may range from 18.3. to 26.7°C in 2-row freestall buildings. Results may differ with other barn design and control systems lacking linear functions with increasing barn temperature.

Key Words: Heat abatement, Cow cooling, Facilities

483 Rearing system effects on growth, puberty and serum prolactin concentrations in dairy heifers derived from beef cattle recipients of in-vivo developed or in-vitro produced embryos. J. A. Small*¹, B. Sawatzky², A. D. Kennedy², H. Engelhardt³, J. D. Ambrose⁴, and K. M. Wittenberg², ¹*Agriculture and Agri-Food Canada, Research Centre, Brandon, MB, Canada*, ²*University of Manitoba, Winnipeg, MB, Canada*, ³*Brandon University, Brandon, MB, Canada*, ⁴*Alberta Agriculture, Food and Rural Development, Edmonton, AB, Canada.*

Our objective was to determine the effects of different rearing systems on the development of dairy heifers (n=26) derived from either in-vivo developed (IVD; n=12) or in-vitro produced (IVP; n=14) embryos in beef cattle recipients. At birth (Mar 13-29, 2004), gestation length was 5 d longer (P<0.05), and body weight (BW) 4 kg greater (P=0.06) for IVP than IVD heifers. At age 2 mo. BW was similar (P>0.05) between IVP and IVD heifers and at this time 10 heifers (4 IVD and 6 IVP) were weaned and transferred to a dairy farm for conventional rearing (CR). The remaining cow/calf pairs were turned-out to pasture until Sep-weaning, and at this time, heifers were assigned to one of two outdoor beef rearing facilities with (EP) or without (NP) supplemental lighting to extend winter photoperiod to 16 hr/day. After age 6 mo., all heifers were fed a mixed ration formulated for 2.46 Mcal ME and 161 g protein/kg DM. Mean BW and wither height at age 6, 12 and 15 mo. (467, 462 and 463 ±13 kg and 133, 131 and 132 cm) did not differ (P>0.05) among groups; but were greater for CR than EP or NP at age 9 mo., respectively (P<0.05). Mean serum prolactin concentration at ages 8, 9, 10, 11 and 12 mo. tended (P=0.09) to be higher for CR and EP than NP (10.9, 7.0 and 2.9 ±2.3 ng/mL, respectively). Fixed-time first service was at age 15 mo. and return services were based on standing estrus. Mean BW and condition score at age 19 mo., were greater for CR than EP and similar to NP (541, 500, and 499±5 kg and, 2.9, 2.3 and 2.3 ±0.1, respectively), and age at predicted calving, based on service date and pregnancy diagnosis, tended (P<0.09) to be greater for CR than EP or NP, and greater for IVD than IVP (24.5, 23.3 and

24.3 ±0.4 mo., and 24.3 and 23.6±0.3 mo., respectively). Compared to CR, dairy heifer growth in a beef system was set-back slightly after weaning and turnout, but this was overcome with time, and

EP treatment increased serum prolactin and advanced predicted calving date.

Key Words: Puberty, Photoperiod, Dairy Heifers

Ruminant Nutrition: Nitrogen Metabolism – Dairy

484 Effects of duodenal infusion of graded amounts of threonine on lactational performances of dairy cows. H. Rulquin*¹ and P. M. Pisulewski², ¹University and Research Unit on Milk Production, Saint Gilles, France, ²Agricultural University, Cracow, Poland.

Threonine is one of the proposed limiting amino acids for dairy cow. However, its requirement is poorly documented. A 4x4 Latin square was realized to study effects of duodenal infusion of graded amounts of Thr (0, 7, 28, and 49 g/d) during 4 days in 4 duodenally cannulated Holstein cows. DM of the diet consisted of 69 % corn silage, 4.9 % grass hay, 14% pea, 1.1 % molasses, 1.0 % urea, 7.3 % maize starch, 0.2 % fat, and 2.9 % of minerals and vitamins supplement. Diet covered 100 and 75% of energy and protein requirements. Requirements of the remaining 9 essential amino acids were met by infusing into the duodenum 666 g/d of a mixture including, Lys, His, Arg, Val, Met, Ile, Leu, Phe, Tyr, Trp and Glu (72, 33, 7, 41, 32, 27, 63, 19, 40, 4, 295 g/d respectively). Supply of Thr provided 75, 100, 125, and 150% of the expected requirements for the 4 treatments respectively. Concentration of Thr digestible in the small intestine were 3.65, 4.02, 5.0, 6.0 % of PDIE (equivalent to MP) for the 4 treatments respectively. Milk yield, fat yield and true protein content were not significantly affected by infusions. True protein yield tended to decrease linearly up to - 8 percent. It is concluded that Thr is not a limiting amino acid for dairy cows but excess of Thr decrease feed intake.

Table 1. Effects of Thr duodenal infusion on lactational performances

	Thr, g/d					
DMI, kg/d	20.1	19.4	19.6	18.1	0.34	L(P<0.01)
Milk, kg/d	30.0	28.8	27.5	28.9	0.58	NS
Fat yield, g/d	1442	1510	1389	1492	94	NS
True protein yield, g/d	886	851	853	812	22	L(P<0.1)
Fat content, %	4.78	5.17	5.09	5.17	0.34	NS
True protein content, %	2.96	2.96	3.12	2.82	0.06	NS
True protein content, %	2.96	2.96	3.12	2.82	0.06	NS

L = Linear effect; NS= non significant

Key Words: Thr requirements, Dairy cows, Milk protein

485 Effect of different forms of methionine on lactational performance of dairy cows. H. Rulquin*¹, B. Graulet², L. Delaby¹, and J. C. Robert², ¹University and Research Unit on Milk Production, Saint Gilles, France, ²Centre of Studies and Research on Nutrition, Commentry, France.

The use of rumen-protected Met to correct diets of dairy cows is limited by the lack of an efficient product that could be incorporated into the concentrate. The main objective of this trial was to test at practical doses (around 10 g absorbable Met) the efficiency of two forms of pelletable Met hydroxy analogs, D,L-2-hydroxy-4-(methylthio)-butanoic acid (HMB) and the isopropyl ester of HMB

(HMBi) to provide Met to cows, especially for milk protein synthesis compared to a control and to SmartamineMTM. These treatments were tested according to a 4 x 4 Latin square in 16 Holstein cows. The mean DM composition of the diet was 71.6 % corn silage, 14.6 % energy concentrate, 3.1% soyabean meal, 7% formaldehyde-treated soyabean meal, 1 % urea, 1.3 % mineral and vitamin supplements, and 0.13 % of HMB or HMBi. Smartamine was supplied top dressed (17g/hd/day) Dry matter of the energy concentrate contained 21.8% ground barley, 21.1% ground wheat, 15% fine wheat bran, 37.5% dehydrated beet pulp, 1.7% beet molasses, 0.6% limestone, 1.1% sodium bicarbonate, and 1.1% salt. DMI, milk and fat yields were not affected by the treatments (20.5, 20.3, 20.7, 20.9 kg/d; 31.4, 31.8, 31.5, 32.0 kg/d, and 1291, 1337, 1300, 1312 g/d for control, HMB, HMBi, and Smartamine respectively). Milk true protein yield increased by 32 and 41 g/d and true protein content increased by 0.1 and 0.07 % (P < 0.05) for HMBi and Smartamine respectively (962, 980, 994, 1003 g/d and 3.09, 3.10, 3.19, 3.16 % for control, HMB, HMBi and Smartamine respectively). Plasma Met concentrations were increased by 110 and 65 % that of the control value (P < 0.05) after HMBi and Smartamine treatments, respectively (16.49, 14.81, 34.65, 27.18 µM for control, HMB, HMBi and Smartamine respectively). Conversely to HMB, the isopropyl ester of HMB (HMBi) appeared to be an efficient source of methionine for dairy cows. As Smartamine, it significantly increases the milk protein yield and circulating Met level while HMB has no effect. HMBi is a new rumen-protected form of Met that can be supplied to cows integrated into pellets and this is important for feed manufacturer industry.

Key Words: Rumen-protected Met, Dairy cows, Milk protein

486 Effect of the isopropylester of the hydroxylated analogue of methionin (HMBi) on feed intake and performance of dairy cows in early lactation. V. A. Hindle¹, C. A. Kan¹, J. C. Robert², and A. M. van Vuuren*¹, ¹Animal Sciences Group of Wageningen UR, Lelystad, The Netherlands, ²Adisseo France SAS, Commentry, France.

A performance trial involving 68 multiparous Holstein-Friesian dairy cows was carried out from parturition till 15 weeks post partum, to evaluate the efficacy of isopropylester of the hydroxylated analogue of methionin (HMBi). The cows were fed a TMR comprising grass silage, corn silage, grass straw and soybean meal and were randomly assigned to one of the two dietary treatments: concentrates containing HMBi (daily dose 29 g of HMBi per cow) or concentrates without HMBi; the latter designed to provide approximately 90% of methionin requirements. Cows entered the trial according to calving date. Feed intake, bodyweight and milk yield were recorded daily. Milk was sampled during three evening and three morning milkings weekly and analyzed for protein, fat and lactose. Statistical analyses were performed on the calculated weekly averages of week 3 to 15. In lactation weeks 3, 7, 11 and 15, extra milk samples were taken to determine MUN and true protein concentration, and blood samples were taken to determine urea. Data were obtained from 31 cows receiving HMBi and 34 cows receiving the control diet. Average

daily DMI was 25 kg without significant between-treatment variation. Average daily milk yield was 42 kg. No significant differences were observed between-treatment groups for yields of milk fat, milk protein and lactose. Milk fat concentration did not differ significantly between treatment groups. HMBi significantly increased milk protein concentration (3.28 % versus 3.17 % for Control; $P = 0.002$) and decreased lactose concentration (4.59 % versus 4.64 % for Control; $P = 0.012$). Milk true protein concentration was significantly higher in the HMBi group (2.98 % versus 2.89 % in the Control group; $P = 0.03$). Concentrations of MUN were always slightly lower for the HMBi group (11.2 mmol/L versus 11.9 mmol/L for the Control group; $P = 0.04$) which was in agreement with the difference in blood urea concentration. From these results, we conclude that HMBi increases true protein concentration in milk and improves nitrogen utilization in dairy cows fed diets with a limited methionin supply.

Key Words: Dairy cattle, Methionin, Milk protein

487 Effect of dietary crude protein, rumen-undegraded protein and rumen-protected methionine on milk production of lactating dairy cows. G. A. Broderick¹, M. J. Stevenson², and R. A. Patton³, ¹U.S. Dairy Forage Research Center, Madison, WI, ²Degussa Corp., Kennesaw, GA, ³Nittany Dairy Nutrition, Inc., Mifflinburg, PA.

When crude protein (CP) is fed above that needed to meet requirements for metabolizable AA, excess urinary N contributes to environmental pollution. Rumen-undegraded protein (RUP) or rumen-protected Met (RPMet) may permit reduction of dietary CP without loss of production. A lactation trial was conducted using diets formulated to contain 28% NDF and 16.8 or 15.5% CP [dry matter (DM) basis], with or without RUP added as expeller soybean meal (ESBM). Diets were fed as TMR and contained (DM basis) 20% alfalfa silage, 35% corn silage, 4% soyhulls, 2% ground shelled corn, 2% rumen-inert fat, 0.5% sodium bicarbonate and 0.5% vitamins and minerals. Diets with 16.8% CP contained about 23% high moisture corn and 13% soybean meal; diets with 15.5% CP contained about 26% high moisture corn and 10% soybean meal. The RPMet was fed as Mepron®. Forty-eight Holstein cows were blocked by DIM into 6 groups of 8, randomly assigned to incomplete 8x8 Latin squares and fed the TMR for three 4-wk periods. Data were summarized from the last 2-wk of each period. The statistical model included square, period, cow(square), diet, and diet*period. Probability was set at 0.05; LS means are reported below. Contrasts indicated that higher dietary CP increased intake and yield of milk, FCM, fat and protein but RUP reduced fat and protein yield. Feeding RPMet increased intake and yield of FCM, fat and protein. Feeding RUP increased milk/DM intake. Milk urea was increased by both CP and RUP. While supplementing RPMet at 15.5% CP gave production comparable to 16.8% CP without RPMet, RPMet gave similar responses at both CP levels.

Table 1.

CP, %	15.5	16.8	P > F		0.0		5.0		P > F	
ESBM, %										
Mepron, g/d										
Variable	0	15	P > F							
DM intake, kg/d	24.3	25.4	<0.01	25.1	24.7	0.13	24.6	25.2	0.04	
BW gain, kg/d	0.37	0.38	0.96	0.42	0.33	0.50	0.35	0.40	0.67	
Milk, kg/d	40.0	41.6	0.01	40.8	40.9	0.88	40.5	41.2	0.26	
Milk/DMI	1.65	1.64	0.62	1.63	1.67	0.03	1.65	1.64	0.60	
3.5% FCM, kg/d	44.9	47.2	0.01	45.4	46.6	0.16	45.1	46.9	0.04	
Fat, kg/d	1.43	1.52	0.01	1.44	1.51	0.07	1.44	1.51	0.02	
Protein, kg/d	1.28	1.32	0.04	1.31	1.29	0.24	1.28	1.32	0.05	
Lactose, kg/d	1.93	1.99	0.10	1.96	1.96	0.98	1.94	1.98	0.25	
SNF, kg/d	3.58	3.68	0.07	3.64	3.62	0.72	3.59	3.67	0.17	
MUN, mg/dl	9.8	11.5	<0.01	10.4	11.0	<0.01	10.6	10.8	0.36	

Key Words: Dietary crude protein, Rumen-undegraded protein, Rumen-protected methionine

488 Milk production response of dairy cows to silage mixtures fed with concentrates of varying ruminal degradation rate. A. Konyali^{1,2}, K.-H. Südekum^{1,3}, W. Junge¹, and E. Kalm¹, ¹University of Kiel, Kiel, Germany, ²Çanakkale Onsekiz Mart University, Çanakkale, Turkey, ³University of Bonn, Bonn, Germany.

The objectives of this study were to evaluate effects on lactational performance and efficiency of nitrogen utilization of dairy cows fed with isocaloric and isonitrogenous concentrates that also had similar ruminal degradabilities of crude protein (CP) and organic matter (OM) but differed in the rate CP and OM were degraded ruminally. Both concentrates were supplemented to mixtures (80:20 and 20:80, dry matter basis; CORN and GRASS, respectively) of corn and grass silage so that ruminal degradation rate was synchronous either to the GRASS (SYNGRASS) or the CORN (SYNCORN) silage mixture and asynchronous to the other. During two complete winter feeding periods, 252 dairy cows, 120 (62 Red Pied and 58 German Friesian) in year 1, and 132 (65 Red Pied and 67 German Friesian) in year 2, were fed on diets consisting of combinations of one of the concentrates that were allocated according to milk yield and one of the silage mixtures fed for ad libitum intake. Neither forage nor concentrate type affected ($P > 0.05$) milk (26.5 kg/d) or milk component yields (fat, 1.18 kg/d; total protein, 0.92 kg/d), though milk protein concentration was higher ($P < 0.05$) for cows on the CORN treatments. Feeding the GRASS mixture resulted in elevated ($P < 0.001$) milk urea levels, which were also higher for cows on the SYNCORN than on the SYNGRASS treatments (interaction effect; $P < 0.001$). Efficiency of N utilization was higher ($P < 0.001$) for cows on the CORN (27%) than on the GRASS (24%) treatments but was not affected ($P > 0.05$) by concentrate type.

Key Words: Protein, Carbohydrate, Rumen synchrony

489 Reduced rumen degradable protein (RDP) and abomasal inulin reduce diet digestibility and urinary nitrogen in lactating dairy cows. T. F. Gressley* and L. E. Armentano, *University of Wisconsin, Madison.*

Increasing intestinal carbohydrate fermentation in dairy cows may increase conversion of blood urea N (BUN) into fecal microbial protein. This should reduce urinary N and consequently reduce manure ammonia volatilization. However, if BUN recycling to the intestine competes with BUN recycling to the rumen, hindgut fermentation may reduce ammonia available for rumen microbial metabolism. Eight lactating Holstein cows were used in a replicated 4x4 Latin square design with 14-day periods. Treatments were arranged as a 2x2 factorial. Cows were fed diets predicted (NRC, 2001) to contain adequate RDP (HP) or RDP 28% below requirements (LP). Cows also received abomasal infusions via a rumen fistula of 10 L/d saline alone (S) or 10 L/d saline plus 1 kg/d inulin (I). Reducing RDP did not reduce urinary purine derivative excretion or milk production but reduced rumen *in situ* neutral detergent fiber (NDF) digestion. Abomasal inulin did not reduce ruminal ammonia or *in situ* NDF digestibility, suggesting that hindgut fermentation of inulin did not compete for ruminal ammonia. Inulin shifted 23 g/d N from urine to feces, however we estimated that only 8 g/d of the increase in fecal N was due to increased fecal microbial output. Although increasing hindgut fermentation in practical diets may reduce manure ammonia volatilization, it may also interfere with intestinal digestibility. Alternatively, reduced digestibility may have been an artifact of the model.

Table 1.

	Treatment				<i>P</i> value		
	LPS	LPI	HPS	HPI	RDP	I	RDP x I
Milk, kg/d	29.7	31.3	30.4	29.3	0.25	0.63	0.02
Oral DMI, kg/d	20.0	20.3	20.2	19.8	0.53	0.88	0.25
OM digestibility							
including inulin, %	64.1	62.8	67.5	64.6	0.05	0.10	0.50
Starch digestibility, %	94.3	92.0	95.8	94.3	0.008	0.01	0.53
<i>In situ</i> NDF							
digestibility, %	24.6	25.3	27.6	27.3	0.02	0.85	0.57
Urine N, g/d	140.5	124.2	245.8	213.4	0.001	0.02	0.36
Feces N, g/d	149.3	166.9	143.1	172.4	0.95	0.001	0.30
BUN, mg/dl	6.6	5.7	13.1	12.2	0.001	0.05	0.98
Rumen NH ₃ ,							
mM geometric mean	1.68	1.27	3.42	3.95	0.001	0.43	0.03
Urine allantoin+uric							
acid, mmol/d	450	487	501	481	0.11	0.56	0.05
Fecal purines, g/d	10.28	10.69	9.07	11.41	0.40	0.001	0.005

Key Words: Fructans, Fecal nitrogen, Urinary nitrogen

490 Evaluation of dried distillers grains versus soybean protein as a source of rumen-undegraded protein for lactating dairy cows. B. W. Pamp*, K. F. Kalscheur, A. R. Hippen, and D. J. Schingoethe, *South Dakota State University, Brookings.*

Ten primiparous and ten multiparous Holstein dairy cows (127 ± 29 DIM) were used in a 5 × 5 Latin square design with 28 d periods to evaluate the effect of increasing rumen-undegraded protein (RUP) by comparing dried corn distillers grains with solubles (DDGS) vs. soybean protein (SBM 44%, extruded beans, soy hulls, and Soyplus®) as a protein source in lactation diets. Diets were formulated to provide 3 concentrations of dietary RUP (% of DM) from 2 different sources: 1) 5.3% RUP (control), 2) 6.8% RUP from soybean protein, 3) 6.8% RUP from DDGS, 4) 8.3% RUP from soybean protein, and 5) 8.3% RUP from DDGS. All diets were formulated to contain 10% RDP. Diets consisted of 38.5% corn silage, 16.5% alfalfa hay, and 45% concentrate (DM basis). Dry matter intake tended to increase with the addition of RUP (*P* < 0.09). Milk production (31.1, 32.3, 34.2, 33.7, and 34.8 kg/d for diets 1 through 5, respectively) increased (*P* < 0.05) with the addition of RUP, and was greater for cows fed diets containing DDGS vs. soybean protein. Percentage of milk fat was not affected by treatment, however, milk fat yield (1.11, 1.12, 1.22, 1.16, and 1.22 kg/d) was greater for diets containing DDGS compared to soybeans (*P* < 0.05). Milk protein concentration (2.82, 2.80, 2.84, 2.81, and 2.86%) was greatest for diets containing DDGS (*P* < 0.01). Milk protein yield (0.87, 0.90, 0.97, 0.94, and 0.99 kg/d) was greater for diets containing DDGS (*P* < 0.01) and increased with the addition of RUP (*P* < 0.01). The greatest increase in lactose yield (1.50, 1.58, 1.65, 1.63, and 1.68 kg/d) occurred with DDGS supplementation (*P* < 0.05). Increasing dietary RUP increased MUN (12.8, 15.0, 15.3, 18.1, and 17.7 mg/dl; *P* < 0.01). The greatest increase in energy-corrected milk occurred with the addition of DDGS (*P* < 0.05). Multiparous cows fed diet 5 improved in feed efficiency compared to primiparous cows resulting in a treatment × parity interaction (*P* < 0.03). Increasing RUP in the form of DDGS increased milk production and milk component yields to a greater extent than RUP supplied by soybean protein.

Key Words: Dried distillers grains, Soybean protein, Rumen-undegraded protein

Ruminant Nutrition: Ruminal Fermentation

491 A meta-analysis of the effects of fumarate on ruminal methanogenesis. E. M. Ungerfeld* and R. A. Kohn, *University of Maryland, College Park*.

The objective of this analysis was to understand the effects of fumarate addition on ruminal fermentation. Because the chemical reduction of fumarate to succinate can draw electrons away from ruminal methanogenesis, fumarate has been studied as a potential feed additive to decrease methane (CH₄) production in ruminants. A meta-analysis of the effects of added fumarate on CH₄ production by ruminal batch cultures was carried out using 74 treatment means from 9 experiments in 8 different studies. Treatment means were weighted by the reciprocal of their variance. All regressions included the random effect of experiment. Interactions between the random effect of experiment and independent variables were not significant and were removed from models. The average decrease in CH₄ was of 0.037 μmol/μmol of added fumarate, which is considerably lower than 0.25, the theoretical decrease calculated from stoichiometries of the pathways involved. One reason fumarate was not very effective at decreasing CH₄ was because only an average of 48% of added fumarate appeared to be converted to propionate. Secondly, the uptake of reducing equivalents by the conversion of fumarate to propionate was almost entirely offset by the release of reducing equivalents from 20% of added fumarate that was converted to acetate. Therefore, fumarate addition must have directly or indirectly stimulated other electron sinks to result in the small net decrease in CH₄. Succinate accumulation, which was generally not measured, may account for some of the decrease in CH₄ observed. Fumarate addition does not seem to stimulate another potential electron sink, microbial biomass. Thermodynamic calculations indicate that the conversion of added fumarate to both propionate and acetate initially was feasible. Thus, along with electron incorporation, the addition of electron-accepting intermediates may also result in the release of electrons through alternate pathways. Thermodynamic considerations should be taken into account when designing these strategies for CH₄ abatement through external electron acceptors.

Key Words: Rumen, Methane, Fumarate

492 Implications of a carbon balance study: Organic acid and protein supplies change with fermentable carbohydrate:protein ratio. M. B. Hall* and P. J. Weimer, *USDFRC, USDA-ARS, Madison, WI*.

Three concentrations of sucrose (Suc, trt) with one of isolated neutral detergent fiber (isoNDF) from bermudagrass were fermented together in vitro with rumen inoculum to evaluate the effects of Suc concentration on partition of carbon (C) in Suc into fermentation products. Nitrogen sources were inoculum, isoNDF and casein hydrolysate and NH₄HCO₃ in the medium. Yield of C in fermentation products [organic acids (OA:acetate, propionate, butyrate, lactate), microbial crude protein (MCP), CO₂, CH₄, glycogen] from C from fermented Suc was evaluated at peak MCP production from Suc (detected at 4 to 8 h of fermentation; Suc almost entirely fermented at this point). Yield of total products, MCP and OA decreased or tended to decrease linearly with increasing Suc. This may be a function of decreased catabolic efficiency of the microbes with increasing Suc as evidenced by increasing yields of lactate, but increased energy spilling is also a possibility. Values > 1.0 indicate incorporation of C from the medium, likely from the inoculum and casein hydrolysate. When corrected for estimates of microbial cell C not in MCP, product C from

Suc for the greatest Suc trt was 0.96. Even with C from MCP excluded, yield of C in other products per unit of Suc utilized still differed among trt (1.03, 0.77, and 0.61 from lowest to greatest Suc inclusion; linear effect of Suc, P = 0.017; SED = 0.054). In this study, the ratio of available protein to fermentable Suc decreased with increasing Suc. Published studies report increased yield of MCP in vitro and increased ruminal acid concentrations in vivo as the ratio of degradable protein:fermented carbohydrate was increased. Results of this C balance support the premise that the ratio of available N to Suc and direct effects of Suc concentration altered partitioning of C into products. This has implications for prediction of ruminal pH and supply of nutrients from ruminal fermentation.

Table 1. Yield of C in products from fermented Sucrose C (mg/mg)

Trt	Suc C, mg	Total product C, mg	Product yield	MCP yield	OA yield	Glycogen yield	Gas yield
Suc65	27.4	32.8	1.28	0.257	0.822	-0.025	0.230
Suc130	54.7	51.6	0.98	0.215	0.602	-0.029	0.193
Suc195	82.1	63.5	0.81	0.204	0.493	-0.029	0.147
SED	---	3.80	0.047	0.020	0.068	0.047	0.038
p-values	---	0.015	0.010	0.121	0.040	0.934	0.158

Number in Trt = Suc mg fermented with 130 mg isoNDF; Gas as CO₂ + CH₄ predicted from theoretical stoichiometries based on OA production; p-values describe linear effect of Suc determined with orthogonal contrasts. PROC MIXED model = fermentation run, suc, run*suc.

Key Words: Rumen fermentation, Carbohydrate, Degradable protein

493 Effects of grain induced subacute ruminal acidosis on ruminal lipopolysaccharide and inflammation in Holstein cows. G. N. Gozho, J. C. Plaizier*, and D. O. Krause, *University of Manitoba, Winnipeg, MB, Canada*.

The effects of grain induced subacute ruminal acidosis (SARA) on free ruminal lipopolysaccharide (LPS) and the acute phase proteins serum amyloid A (SAA) and haptoglobin (Hp) in peripheral blood serum were determined in four mid lactation Holstein dairy cows using a repeated switchover design with four 7 day experimental periods. During each period, SARA was induced in two animals for 5 subsequent days by replacing 25% of their total mixed ration on a dry matter basis with grain pellets consisting of 50% ground wheat and 50% ground barley, and two other cows acted as controls. The control cows received a total mixed ration containing 50% of dry matter as concentrate. Rumen pH was monitored continuously using indwelling probes. During one day in each period blood was collected at 9 am and at 3 pm, and rumen fluid was collected at six hour intervals. Data was evaluated by SAS Mixed procedure for repeated measures with treatment (SARA or control), sampling time and their interaction as fixed effects, and cow and experimental period as random effects. On average, inducing SARA reduced average daily rumen pH from 6.24 to 6.01, increased the duration of time below rumen pH 5.6 from 187 to 309 min/d, increased LPS from 22,908 to 147,910 EU/mL, increased SAA in blood serum from 286.8 to 498.8 μg/mL, but did not affect the Hp, milk yield and dry matter intake. Rumen pH data and the milk fat contents suggest that, although inducing SARA reduced

rumen pH, control cows also experienced a mild form of this disease. Concentrations of LPS in blood serum of control and SARA cows was lower than the detection limit of <0.01 EU /mL. Results suggest that inducing SARA in mid lactation dairy Holstein cows increases the lysis of gram-negative bacteria. The increase in SAA suggests that SARA also activated an inflammatory response.

Table 1.

	Diet Control	SARA	SE	P value
DMI (TMR + grain), kg/d	18.0	18.3	1.64	0.74
Milk yield, kg/d	27.5	28.6	1.83	0.27
Milk fat, kg/d	0.68	0.63	0.04	0.43
Milk protein, kg/d	1.01	0.98	0.08	0.77
Avg. rumen pH	6.24 ^a	6.01 ^b	0.07	<0.01
Time < pH 5.6, hr/d	187 ^b	308 ^a	32.1	<0.01
LPS, Log 10 EU/mL	4.39 ^b	5.11 ^a	0.15	<0.01
SAA, ug/mL	286.8 ^b	498.8 ^a	85.6	0.03
Hp, mg/mL	0.244	0.265	0.03	0.59

a, b Means differ ($P < 0.05$)

Key Words: Subacute ruminal acidosis, Lipopolysaccharide endotoxin, Acute phase proteins

494 The effects of rumen-degradable protein level on fermentation of corn-based diets in continuous culture. C. J. Fu*, J. A. Pugh, J. H. Porter, and M. S. Kerley, *University of Missouri, Columbia.*

A single-phase continuous culture system, operated at a 0.04/h dilution rate, was used to determine the effects of rumen-degradable protein (RDP) level on ruminal fermentation when cultures were fed all-concentrate diets. The microbial efficiency (MOEFF), VFA (including lactic acid: LA), pH, and digestibility were measured. The study included seven treatments with four RDP levels. The CORN diet served as the 0.5X RDP treatment, and SBM was used to adjust RDP level to 6.0 (0.75X), 8.0 (1.0X), and 16.0% (2.0X). The other three diets were UREA (urea as RDP source and equal to 1.0X), CORNPH, and UREAPH (CORN and UREA diets with pH controlled at 5.7). Data were analyzed using GLM procedure of SAS with linear and quadratic responses tested by CONTRAST statement. The results indicated that total VFA production increased and LA production decreased linearly ($P < 0.01$) as RDP level increased from 0.5X to 2.0X. The 0.5X and 0.75X diets showed higher ($P < 0.01$) LA production than that of 1.0X and 2.0X diets, resulting in lower pH ($P < 0.01$). As RDP level increased, the MOEFF and the acetic to propionic ratio (AC:PRO) increased and decreased linearly ($P < 0.01$). The ammonia level was higher ($P < 0.01$) for 2.0X treatment compared to other three treatments. When the fermentor pH was controlled, the UREAPH showed lower LA production compared to UREA ($P < 0.01$), however there were no differences observed for the total VFA production or AC:PRO. The MOEFF increased by controlling the pH ($P < 0.05$). In contrast, the CORNPH diet did not show decreased LA production compared to the CORN diet, but showed increased total VFA production ($P < 0.01$). The AC:PRO and MOEFF was not changed by controlling pH. We hypothesized that RDP level altered the dominant species of bacteria present, either by reducing the LA producing species or increasing the LA fermenting species, resulting in an increased pH and improved MOEFF. Alternatively, controlling pH could alter LA producing bacteria when N was not limiting. Concluded from this experiment was that the optimal RDP level was important in

controlling ruminal pH, and optimizing fermentation and efficiency of N use.

Key Words: Acidosis, All-concentrate diets, RDP

495 Effect of roughage level and calcium magnesium carbonate on ruminal metabolism and extent of digestion in steers. G. I. Crawford*¹, M. K. Luebbe¹, G. E. Erickson¹, T. J. Klopfenstein¹, C. R. Krehbiel², and G. A. Nunnery³, ¹University of Nebraska, Lincoln, ²Oklahoma State University, Stillwater, ³MIN-AD, Inc., Amarillo, TX.

Six ruminally and duodenally fistulated Holstein steers were used in a metabolism experiment to determine effects of adding a ruminal buffer to high-concentrate diets with increasing levels of roughage. A 6 x 6 Latin square design with a 3 x 2 factorial treatment arrangement was used with factors consisting of alfalfa hay level (4.5, 9.0, or 13.5%) and calcium magnesium carbonate (CaMg(CO₃)₂; MIN-AD[®], MIN-AD, Inc., Amarillo, TX) inclusion (0 or 1.0%) to replace MgO and partially replace limestone. Ruminal pH and DMI were continuously monitored throughout each collection period. An alfalfa x CaMg(CO₃)₂ interaction ($P < 0.05$) occurred as steers consuming 13.5% alfalfa, 1.0% CaMg(CO₃)₂ had greater DMI/meal than those consuming 4.5% alfalfa, no CaMg(CO₃)₂ and 9.0% alfalfa, 1.0% CaMg(CO₃)₂. Steers consuming 13.5% alfalfa, 1.0% CaMg(CO₃)₂ and 9.0% alfalfa, no CaMg(CO₃)₂ spent more time eating/meal ($P < 0.05$) than steers consuming 4.5% alfalfa, no CaMg(CO₃)₂. No other differences ($P > 0.10$) were observed in DMI, ruminal metabolism, or nutrient digestibility due to CaMg(CO₃)₂ or an alfalfa x CaMg(CO₃)₂ interaction. Ruminal pH increased linearly ($P < 0.05$) with alfalfa level, averaging 5.41, 5.52, and 5.58 for steers fed 4.5, 9.0, and 13.5% alfalfa, respectively. Total tract OM digestibility decreased linearly ($P < 0.05$) with increasing alfalfa level, measuring 85.7, 84.9, and 81.8% for steers fed 4.5, 9.0, and 13.5% alfalfa, respectively. A quadratic response ($P < 0.05$) due to alfalfa level occurred for propionate and acetate:propionate ratio (A:P), with propionate measuring 34.3, 40.3, and 30.3 mM and A:P measuring 1.38, 1.23, and 1.72 for steers fed 4.5, 9.0, and 13.5% alfalfa, respectively. Based on Ca and Mg digestibilities, CaMg(CO₃)₂ is similar to limestone and MgO in terms of availability, but did not produce ruminal pH responses similar to those observed by increasing alfalfa in high-concentrate diets.

Key Words: Acidosis, Feedlot steers, Ruminal buffer

496 Effect of method of adding a fibrolytic enzyme to a dairy cow diet on ruminal fermentation and TMR degradation. D. B. Dean*^{1,2}, A. T. Adesogan¹, C. R. Staples¹, S. C. Kim¹, and R. Littell¹, ¹University of Florida, Gainesville, ²Universidad del Zulia, Maracaibo, ZU, Venezuela.

This study evaluated the effect of applying a fibrolytic enzyme (Promote[®]) to different portions of a bermudagrass-based diet on ruminal fluid pH, VFA and ammonia-N concentrations and on in situ TMR degradation (ISD) in dairy cows. Dietary treatments were: no enzyme (Control), or enzyme applied (4 g/cow/d) at feeding to the concentrate (EC), TMR (ETMR), or forage (EF), and enzyme applied (1.3 g/kg of DM) at ensiling (TS) to bermudagrass. Diets contained Tifton 85 bermudagrass (*Cynodon* spp.) silage, corn silage and a concentrate mixed at 35, 10 and 55% of dietary DM, respectively. Five ruminally-fistulated cows were fed for three consecutive 15-d periods, each consisting of 12 d of diet adaptation, 2 days of ISD measurements, and 1 d of ruminal fluid collection at 0, 2, 4, 6, 8 and 10

h after feeding. During periods 2 and 3, ISD kinetics were measured by incubating TMR samples in nylon bags for 0, 2, 4, 6, 8, 24, and 48 h and fitting an exponential model to the data. Mean ruminal pH was lower in cows fed EC (pH=6.02) than cows fed the Control diet (pH=6.29). Cows fed ETMR had lower ruminal NH₃-N and total VFA concentrations, lower acetic acid concentration and a lower acetate:propionate ratio than cows fed the Control diet. Cows fed EF also had lower (P<0.01) acetic acid concentration and higher (P<0.01) isovaleric concentration acid than those fed the control diet. Cows fed TS had higher (P<0.05) isovaleric acid than those fed the Control diet. Kinetics of ISD were unaffected by enzyme addition, except that the TS TMR DM tended to be degraded at a faster (P=0.107) rate than the Control diet. Enzyme addition to the TMR was the most effective method of improving ruminal fermentation

Key Words: Fibrolytic enzymes, Dairy cows, Rumen fermentation

497 Effects of feeding oxidized fat supplemented with antioxidant AGRADO on rumen nutrient digestibility and protein synthesis. M. Vazquez-Anon^{*1}, J. Andrews¹, T. Webster², and T. Jenkins³, ¹Novus International, St. Louis, MO, ²West Virginia University, Morgantown, ³Clemson University, Clemson, SC.

A dual effluent continuous culture system was used to investigate in a 2 x 2 factorial design the effect of feeding fresh (FF) or oxidized

fat (OF) when supplemented with or without antioxidant on nutrient digestibility and bacterial protein synthesis. Twelve fermenters were fed twice a day for 9 days a diet that consisted of 48 % grain mixture and 52 % forage that contained 3% (DM basis) FF or OF blend of unsaturated fats (33% fish, 33 % corn, and 26 % soybean oil and 7 % inedible tallow) and supplemented with 0 or 100 ppm of AGRADO[®]. OF contained higher concentration of peroxides (215 vs 3.5 meq/kg), and lower EPA (C20:5; 3.6 vs 5.1%) and DHA (C22:6; 1.7 vs 2.4 %) than FF. Feeding OF reduced CP digestibility (P = 0.009), microbial N yield (P < 0.03) and efficiency (P =0.03) when compared to FF. Adding Agrado improved total CHO (P=0.05), NDF (P=0.02) and ADF (P=0.04) digestibility, non-ammonia-N (P =0.008), microbial N yield (P=0.08), and the amount of digested feed N converted to microbial N (P=0.01), and reduced ruminal ammonia-N (P=0.008). From this study it can be concluded that feeding OF reduced CP digestibility and microbial protein synthesis and efficiency. The negative effect of feeding OF on rumen fermentation was corrected in the presence of Agrado. In addition, Agrado improved fiber digestibility in the presence of both types of fat.

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Key Words: Oxidized fat, Antioxidants, AGRADO

Teaching/Undergraduate and Graduate Education

498 Comparing vocational agriculture and non-vocational agriculture student success on high stakes testing. D. Ritenour* and D. Nash, *Ferrum College, Ferrum, Virginia.*

The purpose of this study was to determine if participation in vocational education courses has an effect on high-stakes test scores, namely the Virginia Standards of Learning (SOL) exams. Previous research indicates that students with vocational concentrations did not score significantly higher or lower on high-stakes exams. For this study, data for 400 students from a semi-rural high school in southwestern Virginia was collected. Variables included gender, SOL scores, agriculture course participation (ACP) and cumulative grade point average (GPA). The ACP data represents the number of agriculture courses, including animal science, the student participated in grades 9-12. The SOL scores are on a scale of 400 to 600 and include the content areas of algebra, geometry, world and US history, earth science, biology, chemistry, reading, and writing. Students are required to take SOL tests until they achieve a passing score of 400. However, no more than five students were required to re-test for any SOL test. The GPA data was given on a 4.0 scale, though 69 cases exhibited a GPA above 4.0 due to weighted credits on advanced placement courses. The SOL scores were regressed on GPA, gender, and ACP. Standardized coefficients for ACP for math (average of algebra and geometry), history (average of world and US history), science (average of earth science, biology and chemistry), reading, and writing scores were .231, .205, .263, .225 and .217, respectfully, and were each significant at the .0001 level. The positive coefficients indicate that as students' participation in agriculture courses increases their SOL scores increase as well. These results show the positive effect agriculture course participation appears

to have on students' success on high-stakes testing, but also makes a valid argument for the continuation of vocational agricultural education in the public school system. On the undergraduate and graduate level this research should be important to teacher educators due to the fact that the role of the agricultural educator, as well as educators in general, is swiftly changing to meet the needs of high-stakes testing.

Key Words: Vocational, High-stakes, Education

499 Collegiate LifeKnowledge: A student-centered leadership development program. C. M. Wood*, *Virginia Polytechnic Institute and State University, Blacksburg.*

Collegiate LifeKnowledge (CLK), a leadership curriculum developed for members of collegiate agricultural student organizations, is an initiative of the National FFA Organization in partnership with the John Deere Corporation and CSREES. Collegiate LifeKnowledge was initiated and developed by stakeholder groups that included students, educators, student organization representatives, and industry representatives. A taskforce met in January 2005 to identify the direction of the project, followed by a writers' meeting in February. Lessons that focused on four facets of leadership—Personal, Organizational, Career, and Community—were completed in June. The lessons were developed to be taught by college students to college students—no lectures allowed. Each lesson can be taught in 15, 30 or 45 minutes and is divided into four parts. Part 1 gives the student leader all the logistical information related to the lesson. Part 2 has all the background information necessary to become an instant expert for

presentation of the lesson. Part 3 is an action plan, and Part 4 has all the required materials, handouts, activity sheets, etc. In September, CLK was released at an inaugural training event. Preliminary results from the 2005 National FFA Convention suggest that students have embraced the curriculum and are actively utilizing it. Industry leaders such as John Deere, Kraft, and Monsanto each have programmatic buy-in to CLK and stand to benefit from well-prepared individuals who will constitute their future labor force. Based on the success of this project, the 16 organizations originally involved in the development of CLK have since formed the Consortium of Collegiate Agricultural Organizations. This consortium offers member organizations the opportunity to share resources, offer a consistent leadership message to students, avoid duplication of efforts, and satisfy individual organization needs. At its first meeting, the consortium developed seven strategic action plans that include advisor training and developing career opportunities for students.

Key Words: Undergraduate education, Leadership development, Careers

500 Objective assessment of critically thinking ability of animal science undergraduates through use of the *Watson-Glaser Critical Thinking Appraisal*. I. P. Shann*, C. C. Carr, and E. P. Berg, *University of Missouri, Columbia*.

Employers of animal science graduates seek applicants possessing a strong base of knowledge balanced with the ability for independent thought and critical thought. The objective of this study was to quantify critical thinking skills of students enrolled in the Fall semester 2006 *Live Animal and Meat Evaluation* course. This course addressed animal anatomy, live animal evaluation and pricing, carcass grading, carcass pricing, and ranking philosophies for beef, pork, and lamb. The *Watson-Glaser Critical Thinking Appraisal* (WGA) was developed as a means to objectively quantify improvements in the ability to think critically. The WGA served as our means of assessment to meet the objective of this study. On the first day of class, half the students received Form A of the WGA and the other half Form B. The students that completed Form A on the first day of class completed form B on the last day and vice versa. A total of 63 students completed both forms of the WGA. The WGA has an Overall score of 80, yet it is divided into five subsets; 1) Inference, 2) Recognition of Assumptions, 3) Deduction, 4) Interpretation, and 5) Evaluation of Arguments. After 16 weeks of instruction, students significantly improved in all five categories of the WPA. Higher ($P < 0.001$) Overall scores were recorded from the first (Avg. = 39.9; SD = 4.3) to the last (Avg. = 55.5; SD = 8.9) day of the semester. Improvements in WGA scores over the semester did not differ across final course grades revealing that A, B, and C students improved ($P = 0.759$) their critical thinking ability in a similar fashion. Pearson Correlation Coefficients were run comparing the species section exams with the Overall and the five subunits of the WGA. The Lamb ($P = 0.015$) and Beef exam ($P = 0.015$) were the only parameters associated with the end of the semester WGA Deduction score ($r = 0.307$ and 0.305 , respectively). We find that the WGA is an effective means to quantify critical thinking of undergraduates. Furthermore, final course grade does not appear to be an indication of ability to improve critical thinking skills.

Key Words: Critical thinking, Undergraduate, Watson-Glaser

501 Student perceptions and performance when animals and animal specimens are used in an introductory animal science class. M. S. Nemechek and W. L. Flowers*, *North Carolina State University, Raleigh*.

Laboratory practical scores, responses to survey questions, and attendance at laboratories and help sessions from first semester freshman ($n=721$) between 2000 and 2005 were used to evaluate the educational value of animal and animal specimens in an introductory course. The course consists of 3, 1-hour lectures and 1, 3-hour laboratory each week. Two laboratory practical examinations are administered during the course. Practical 1 (P1) covers basic anatomy and uses fresh and preserved specimens. Practical 2 (P2) covers animal handling and behavior and uses live animals. Students receive a course CD with pictures and video footage covering all aspects of each laboratory. Prior to each practical, optional help sessions are offered in which animals and animal specimens are used. The assumption was made that the content on the course CD was the main way students who missed laboratories and chose not to attend help sessions learned laboratory subject matter. Students that missed one or more laboratory and did not attend help sessions ($n=105$) had lower ($P<0.01$) practical scores (-12 points) than their counterparts with perfect attendance. All of these students felt attending laboratories and help sessions would have improved their grade. Of the students with perfect attendance in laboratories ($n=616$), 405 and 259 participated in help sessions associated with P1 and P2, respectively. Attendance at help sessions for P1 did not affect scores ($P=0.30$). However, 98% of students thought it did. In contrast, attendance at help sessions positively affected test scores (+8 points) for P2 ($P<0.03$), yet only 78% of the students felt it was beneficial. Overall, use of animals and animal specimens enhanced the learning environment for first semester freshman. However, their use appeared to be more critical for topics dealing with live animals as opposed to animal specimens. Finally, students are of the opinion that use of animal and animal specimens are beneficial even in situations where there was no statistical improvement in test scores.

Key Words: Alternatives, Animals, Teaching

502 Dynamics of how students earn their final course grade in an introductory course. W. L. Flowers*, *North Carolina State University, Raleigh*.

Final grades in most courses are the sum of repeated observations on student performance. Thus, students have opportunities to make adjustments in study habits during a course. The objective of this study was to characterize the dynamics of how students earn their final course grades. Data from first semester freshman ($n=938$) in an introductory class between 1998 and 2005 were used. The final course grade was based on 600 points generated from: 4 quizzes (Q1-4); 2 lecture examinations (LE1-2); 2 laboratory practicals (LP1-2); and a final examination (FE). For quantitative estimates, survival analyses were used and assumed that each student began the semester with 600 points. This total was reduced as points were lost on each assignment. For qualitative estimates, polynomial regression analyses were used to evaluate changes in a student's current letter grade after the completion of each test. For students with an A+ ($n=12$), there was no change over time ($P=0.40$) in their grade and the points lost on each assignment were consistent ($P=0.37$). For those with an A, most (25/33) had an A- or B+ for the first two-thirds of the course and their grade increased ($P<0.05$) during the last third. They lost fewer ($P<0.05$) points on LE2 or FE than on previous tests compared with students that earned lower grades. For students receiving an A- ($n=89$) or a B+ ($n=120$), there

were two distinct patterns. Students either performed poorly ($P < 0.03$) on the LE1 or LP1 compared with subsequent tests and their grade increased ($P < 0.01$) as the semester progressed or their grade after LE1 and LP1 was an A and it decreased ($P < 0.05$) because their scores on tests progressively got worse ($P < 0.01$). The most common pattern for grades lower than a B+ was for student performance and grades to decrease as the semester progressed. In conclusion, there is considerable variation in how students earn their final grade, but most prevalent pattern was for performance to decrease as the semester progressed.

Key Words: Dynamics, Grades, Teaching

503 Assessment standardization of hands-on skills in equine studies courses. K. I. Meek* and R. E. Marean, *Midway College, Midway, KY.*

Measurement of objective-based learning of hands-on skills in Equine Studies courses is confounded by grading subjectivity and horse behavior. Although breed associations define judgment of riding skills, there is no national regulating organization for standardizing performance of hands-on skills. The objectives were: define standards for performing hands-on skills, provide valid student assessment using criterion-based evidence, reduce grading subjectivity, and engage students in procedural learning. Rubric development was accomplished by determining appropriate skills for each riding maneuver or hands-on skill, disaggregating each task into simple steps, scoring the tasks, and developing criteria for each step. Reliability and validity was defined by descriptive and systematic categories, clear differences in scoring of each step, and well-defined objectives. Functional use of the rubrics was determined by voluntary surveys of the raters. The first performance rubric was developed for use by Equine Studies faculty (FC; $N=5$) to assess a showmanship pattern and turnout of 57 first-year students (FY). All FC expressed that the rubric was useful and decreased discrepancies between raters. Western riding skills rubrics ($N=27$) were then developed. Internal standardization of riding skills enhanced student learning ($N=5$) by providing clearly defined assessment of critical points on which students could re-focus practices post-assessment. A total of 15 second-year (SY) students developed a rubric for injury bandages and assessed the FY performance of bandaging techniques. The SY (85%) students indicated that rubric use would reduce subjectivity in evaluating skills, and SY (90%) thought student success would be enhanced by providing the tool prior to assessment. Performance rubrics aided students in linking learning outcomes to skills and engaged students by providing focus on concrete evidence for skill performance. Further, hands-on skills rubrics standardize student assessment and can account for unpredictable horse behaviors that would traditionally affect student grading.

Key Words: Hands-on skills, Rubric, Assessment

504 Costs, benefits, and publics: Training undergraduates to interpret a broad scope of implications from using genetic technologies in food animal production. C. W. Ernst*¹ and S. C. Ernst², ¹*Michigan State University, East Lansing,* ²*The Ohio State University, Columbus.*

Training students in concepts and techniques of molecular genetics has become a standard part of Animal Science curricula. However, courses generally do not emphasize how these technologies are marketed to livestock breeders or, more critically, how they are positioned with end-product consumers. Graduates are likely to be faced with explaining their impact, risks and benefits to less knowledgeable and

increasingly skeptical clients or members of a broader public. While the scientific bases are frequently well covered, potential controversies and market implications of their adoption are not. This omission is most evident when real or perceived negative events create news and resulting market shocks felt by large sectors of the livestock industry. Thus, we incorporate concepts of economic value and understanding the policy implications of public reaction to genetic technologies into our undergraduate courses in animal genetics and livestock marketing. A collection of techniques is used to expose students to divergent positions and train them to anticipate all sides in a debate, thus preparing them to be better business and scientific leaders. Classroom activities include case studies analyzing a firm's market-facing position and the potential implications of a technology-driven spike. Group discussions and debates are used along with Socratic dialog to probe the implications of the science. Debates designed as role play simulations with students assigned to portray viewpoints of various stakeholders include topics such as DNA marker testing, patenting of DNA markers, animal cloning, genetic preservation and various disease-related issues. Additionally, students monitor industry and commercial media sources for news items related to such issues and lead class discussions on the implications. Similar discussions occur online using computer-mediated forums. This combination of approaches prepares students to interpret a broad scope of implications from using genetic technologies in food animal production.

Key Words: Undergraduate education, Genetic technologies

505 Teaching societal issues facing animal agriculture: A writing intensive course for sophomores. J. N. Spain* and G. W. Jesse, *University of Missouri, Columbia.*

Students in Animal Science at the University of MO have less direct experience with production animal agriculture. These future graduates need to have a comprehensive view of the contemporary issues facing animal agriculture. Therefore, a course was developed to address this growing disconnect while meeting a campus-wide general education requirement. According to the General Education Architecture of the University of Missouri, the graduates: must be able to grasp the meaning of problems that go well beyond their academic major; will develop computing and information literacy; and will learn to reason well, to recognize when the reason and evidence are not enough, to discover the legitimacy of intuition, to subject inert data to the probing analysis of the mind. These general education goals are central to the structure and the purpose of this course. This course is designed to help each student understand the far-reaching nature of issues facing the future of animal agriculture. These issues will impact animal agriculture and all of society during their careers. These issues are often associated with strong emotions of all those engaged in the debate. The goal of this course is to help the students develop a fundamental understanding of key issues presented by both sides that are the foundation of the debate. During this process, the students develop computing and information literacy skills associated with electronic literature searches. The search for diverse sources of information help students gain a more comprehensive understanding of the issues. Furthermore, students communicate this understanding through a number of writing assignments. These assignments are formatted to help students continue to develop strong writing skills. A key component is a comprehensive research paper developed individually by each student. The research paper addresses the key components of a societal issue facing animal agriculture. Through review of published scholarly works, in-class discussions and writing, students develop and improve critical thinking skills.

Key Words: Contemporary issues, Seminar, Writing intensive

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ADSA Production Division: Meeting the Research and Educational Needs of the Dairy Industry During the Next 25 Years

506 Changing how we feed dairy cattle. J. R. Newbold*, *Provimi Research and Technology Centre, Brussels, Belgium.*

As global demand for milk continues to rise, the next 25 years will see further differentiation between two general models of dairy farming: that in which the cow is the first limiting resource (aim: to maximize yield per cow) and that in which feed, labor or some other resource is limiting (aim: to maximize return per unit of land or labor). Within each general model, cows will be fed as cheaply as possible to achieve those mixes of outputs required by specific customers: production of milk as a cheap commodity food, milk quality (safety and nutritional value), environmental stewardship, animal health and welfare (including longevity) and calf production. Advances in animal breeding should allow farmers to choose a genotype consistent with their specific environmental constraints and to reduce variability within the herd. The mix of feed resources available to the global industry may grow more diverse, while that used on individual farms may be simpler, partly in response to rising fuel costs. Nutritionists will need to predict a range of responses to diet (short-term productivity, cow health, fertility, environmental impact, etc). To achieve the necessary precision, required outputs from nutritional research include: continual improvement in feed characterization, expansion of the field of nutrition to incorporate a wider range of feed components (e.g. specific plant molecules) and, in particular, improved quantitative understanding of the molecular biology of key organ systems (e.g. mammary gland) and how these systems are integrated and regulated. Local empirical developments will remain important, but coordinated efforts to address these core issues in nutritional physiology are vital.

Key Words: Nutrition, Dairy

507 Advancements and future challenges in understanding mammary gland function. A. V. Capuco*¹, E. E. Connor¹, M. J. Meyer², R. W. Li¹, C. P. Van Tassell¹, T. S. Sonstegard¹, M. E. Van Amburgh², and Y. R. Boisclair², ¹*Bovine Functional Genomics Lab, USDA-ARS, Beltsville, MD,* ²*Cornell University, Ithaca, NY.*

Examination of DHIA records demonstrates that the dairy industry has seen major increases in milk production due to improved management and genetic progress. Classical experiments discovered a great deal about hormonal regulation of mammary development and lactation. With the advent of molecular biology, greater detail has been learned about specific regulatory pathways and the multitude of interactions among them. The ability to produce quantities of bovine somatotropin through recombinant DNA technology led not only to greater elucidation of this hormone's biological effects and ultimately to its commercial application, but to a greater appreciation for the coordinated systemic regulation among tissues and organs that supports lactation and other critical physiological events such as pregnancy. Key studies in areas of photoperiodic regulation, immune function and milking management have led to further advances in production, efficiency and animal health. Beyond its impact on production, the effect of nutritional management on the myriad of physiological processes remains an active area of discovery. Transgenic approaches provide an additional means for studying mammary gland biology and, although controversial, provide a means for improving health of the mammary gland, altering milk composition, and utilizing the mammary gland as a bioreactor. Ever increasing sensitivity of

methods to identify, isolate and interrogate cells will permit greater understanding of the function and interactions among mammary cells and will permit continued advances in mammary gland biology. Availability of sequence information for the bovine genome will further accelerate these advances. However, the integration of regulation at the tissue level with systemic physiology will remain a substantial challenge.

Key Words: Mammary, Lactation

508 Opportunities for improvement in dairy cattle genetics. C. Sattler*, J. M. DeJarnette, C. Marshall, and R. Nebel, *Select Sires, Inc., Plain City, OH.*

Pressures to lower the cost of production have driven producers and industry to take advantage of new technologies and economies of scale. The trend toward fewer but larger herds is expected to continue. The trend toward consolidation and globalization among genetics companies is also expected to continue. To meet larger herds' needs, genetics companies will need to focus more on improving the genetics of fitness traits and to provide a higher level of service along with their products. These trends will have a huge impact on the industry's research and education needs. The most important products provided by research institutions are employable graduates. The industry's greatest employment needs in the future will be artificial insemination technicians, reproduction consultants and genetic consultants. Expansion of intern programs could be valuable to provide practical training for students. Land grant universities have an outstanding track record of delivering innovations in male and female reproduction as well as functional genomics. Universities are well positioned to continue this role. Consolidating research dollars into fewer and more specialized centers of excellence would help improve the cost-effectiveness of research. Emerging tools in this area will provide opportunities for genetics companies. To capitalize on these opportunities, genetics companies will need to accept a larger role in applied research and technology transfer. Also, much of the data that supports current genetics research has been gathered and supplied by industry. Genetic improvement in fitness traits will require a renewed commitment to identification and recordkeeping programs. Producers, industry and researchers will need to work together to accomplish this. Future industry growth will rely heavily on the people and technology resources generated by research institutions. Industry will need to play a larger role in providing the technical support for new technologies and everyone will need to work together to build effective data resources to support these efforts.

Key Words: Dairy, Genetic improvement, Industry trends

509 Transferring knowledge to students and the dairy industry. R. E. James*, *Virginia Polytechnic Institute and State University, Blacksburg.*

What will our students need to know for the dairy industry 25 years hence? Academics tend to focus on teaching new technologies, but this may not be the skill set needed. Surveys of industry leaders indicate that critical thinking, decision making, communication and management skills are essential and individuals should have a global

perspective of pertinent issues. In contrast, universities seem to be moving on a track which emphasizes biotechnology and income generation from research grants to offset shrinking state and federal dollars. Multiple opportunities exist to achieve educational goals. One model involves teaching management skills through centers of dairy science and management that possess the critical mass of personnel and facilities. Programs are geared towards use of case studies and development of problem solving skills. The Academic Common Market Program in the southeast and the National Student Exchange programs enable students to study at universities with specialized programs and pay lower resident tuition fees. The down side of such centers is that it may weaken support for home state institutions. Fortunately high speed access to the internet has increased attractiveness of distance learning programs which permit live classroom participation at multiple sites. Distance learning programs may not be the panacea as they require considerable development time and resources for which funding can be limited. Combinations of distance learning experiences with intensive onsite programs may provide the best of both worlds. It is becoming increasingly evident that knowledge transfer may best be served from partnerships between academia and dairy industry firms using multiple educational technologies.

Key Words: Education, Dairy industry, Students

510 Design and analysis of pen studies in the animal sciences. N. R. St-Pierre*, *The Ohio State University, Columbus.*

Increasingly, research is being performed where animals subjected to a common treatment are also housed in a common pen. Issues have

been raised regarding the proper planning of experiments and conduct of statistical analyses in these instances. This presentation reviews the problems associated with ignoring animal grouping during data analyses, and gives appropriate methods to use when animals are grouped in pens. Using animals as the error term when treatments are applied to pens can cause two types of biases. The first one is one of location, which biases point (parameter) estimates of the treatment effects. The pen effect includes unrecognized, systematic non-random effects other than that of the treatment, which is why pens must be replicated and randomized if treatment effects are to be estimated without biases. Pens also result in non-systematic random effects. These affect the variance of the sub-pen units (cows). That is, cows within a pen have more in common than cows across pens. In essence, pen studies have an implicit split-plot design where the main plots (pens) receive the treatments of interest, while the sub-plots (cows) receive all the same sub-plot treatment. Using the sub-plot error to test the effect of main plot treatment effects causes a second type of bias by creating artificial degrees of freedom, and hence biasing severely the test of significance for the treatment effects. Behind all statistical analyses is a mathematical model with its associated assumptions. The assumption with pen-based treatment is that pens have a random effect. Thus pens, or the interaction of pens with other model elements is/are the correct error term(s). The same statistical designs used with cows as experimental units can be used with pens. The number of experimental units to achieve a given power is considerably less with pens because the variance associated with pens is substantially less than the variance of cows within pens. Pens must be replicated, randomized, and included in the statistical model if treatment effects and their significances are to be estimated without biases.

Key Words: Pen studies, Statistical analysis

Animal Behavior and Well-Being

511 Behavioral time budget of dry cows: Photoperiod alters distribution of maintenance behaviors. K. E. Karvetski*, J. M. Velasco, E. D. Reid, J. L. Salak-Johnson, and G. E. Dahl, *University of Illinois, Urbana.*

In this study, we characterized the effect of photoperiod manipulation on the daily duration and distribution of maintenance and other behaviors during the dry period. Cows (n=22) were assigned to either short day photoperiod (SDPP, 8L:16D) or long day photoperiod (LDPP, 16L:8D) at dry-off, -42d prior to expected calving date. Cows were recorded for 24h at -41d and again at -20d using digital video recording. Using instantaneous scan sampling, individual behavior was classified at 10min intervals as drinking, feeding, lying, perching, standing, or walking. To obtain total daily time (h/d) spent engaged in a behavior, the total frequency of each behavior was calculated as a percentage of total observations and then multiplied by 24. To calculate average duration (in min) per hour of the day of each behavior, the frequency was summed hourly and multiplied by 10. During the dry period, cows spent an average of 14.1h lying, 5.3h standing, 2.2h feeding, 0.6h drinking, and 0.4h walking; there was no effect of photoperiod on total daily time for any behavior. However, LDPP increased total time spent perching from 1.6h at -41d to 2.3h at -20d (p=0.1), whereas SDPP decreased total time spent perching from 3.1h at -41d to 2.3h at -20d (p=0.14). There was a treatment by time of day interaction for feeding behavior (p<0.0001). Access to fresh feed at 1400h resulted in a peak in feeding times for both SDPP and LDPP cows (31.1 and 23.6min, respectively). SDPP cows had a smaller

decline in feeding time afterwards; at 1600h, the SDPP feeding time of 12.1min was higher in SDPP cows than 3.6min for LDPP cows (p<0.05). For 2100 through 2300h, LDPP increased feeding behavior again, as the mean hourly feeding time of 11.8min for LDPP cows was higher than 3.1min for SDPP cows (p<0.05). In summary, photoperiod did not affect total duration of maintenance behaviors. However, the distribution of feeding behavior was affected by photoperiod. These results suggest that an understanding of maintenance behaviors requires consideration in order to improve dry cow management schemes.

Key Words: Behavior, Dry cow, Photoperiod

512 A retrospective video analysis of the behavior of periparturient dairy cattle. L. Misch, H. Putnam*, T. Duffield, S. Millman, K. Lissemore, and K. Leslie, *Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada.*

The impact of calving difficulty on the behavior of periparturient dairy cattle has not been reported. The objective of this study was to measure variables associated with difficulty of calving, and to identify the associations of parameters with periparturient behavior. Previously recorded videotapes of 23 cows on day -1, 0 and +1 relative to calving were analyzed. Data included frequency and duration of standing and lying behavior, calving difficulty score, duration of calving and calf body measurements. Calving difficulty was scored as: 0-unassisted,

1-easy pull, 2-hard pull. Video information was analyzed, interpreted and entered. Data was analyzed using logistic and linear regression with Statistix. Heifers were more likely to require assistance during calving ($P < 0.01$). Male calves weighed significantly more than female calves ($P < 0.05$). Cow standing and lying behavior differed on the day of calving. Pre-calving, heifers lie for 18 fewer minutes per lying bout compared to cows (37.1 ± 3.8 versus 55.1 ± 6.4 minutes per bout, $P < 0.02$). Mean pre-calving lying time was also influenced by calving difficulty, as cows requiring assistance spent 15 minutes less lying down per bout ($P < 0.05$). Post-calving, heifers lie for 13 minutes less per bout than cows (40.4 ± 3.1 versus 53.7 ± 8.8 , $P = 0.09$). Cows taking longer to calve lie for fewer minutes each bout ($P < 0.02$). Finally, dams that had hard pulls lie for 12.5 fewer minutes each bout ($P = 0.11$). When mean lying bouts post-calving was analyzed, controlling for pre-calving mean lying time, only calving duration remained significant. Calving duration also positively influenced the number of post-calving lying bouts ($P = 0.05$). Lying behaviour, both pre and post-calving, was the most significant measurement related to calving. Cows with longer calvings spent less time lying down after calving. Differences between lying time for cows and heifers merits further investigation. It is possible that this difference is related to the presence of pain, and that there are opportunities for pain management at calving.

Key Words: Calving, Behavior, Lying

513 Hock lesion and hygiene score by stall bed type in commercial U.S. dairy cows. W. Fulwider*, T. Grandin, D. Lamm, N. Dalsted, D. Garrick, and B. Rollin, *Colorado State University, Fort Collins.*

A total of 7,432 cows were scored in 72 dairies from WI, MN, and IA between October 2005 and February 2006 to determine hock lesion incidence and level of hygiene. The data set included 28 rubber-filled mattress, 22 sand, and 22 waterbed dairies. Compost pack dairies were represented by an additional 596 cows on 6 dairies with 399 cows scored. Rubber-filled mattress dairies were represented by herd totals of 24,847 cows. Sand dairies were represented by herd totals of 11,381 cows. Waterbed dairies were represented by herd totals of 7,594 cows. One pen of early lactation cows to include cows in lactation 2 and greater was scored for hock lesions and hygiene on each dairy. *Tarsal* (hock) joints were scored for injury at the lateral and medial surface. The *tuber calcis* (point of hock) was scored at the dorsal, lateral, and medial surface. A score of 1 was hair loss, 2 was moderate, and 3 was severe. Hygiene scores ranged from 1 to 5, with 1 being a clean cow, and 5 being a soiled cow. Differences in lesion percentages between bed types were tested with a one-way analysis of variance by lesion severity and over all lesions. Percentage of cows on rubber-filled mattress dairies with score 1 lesions were 48.69 ± 3.97 ; on sand dairies 20.33 ± 4.48 , and on waterbed dairies 21.83 ± 4.48 . Preliminary analysis indicates that cows on sand or waterbeds had fewer ($P < 0.0001$) score 1 and 2 lesions and fewer ($P < 0.001$) score 3 lesions than those kept on rubber-filled mattresses. The most common lesion site on rubber-filled mattress cows was lateral *tarsal* (43%), and 21% of cows had two or more lesion sites. The lateral *tuber calcis* was the most common lesion site on both sand (8%), and waterbed (19%) cows. Eight percent of cows kept on waterbeds and 4% of cows on sand had more than one lesion site. Cows on compost pack had no lesions with the exception of cows purchased with injury. No significant difference was found for hygiene by bed type or times per day barns were cleaned.

Key Words: Stall bed, Injury, Lameness

514 Dairy farmers' perceptions and attitudes about lameness.

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Lameness reduces productivity and welfare of dairy cattle. Incidence rates (IR) and severity of lameness in some herds are unacceptable. Various management strategies are recommended to reduce lameness; however, success is not observed in many instances. Our objective was to try to better understand the perceptions and attitudes of dairy farmers about lameness. A survey was mailed to all Michigan dairy farmers in July ($n = 1,280$) and December ($n = 1,008$). The survey asked four Likert Scale and 22 forced-choice questions. Survey return rate was 33%. Herd size profile of respondents was similar to Michigan's overall herd size profile. Data were analyzed using Statistical Package for the Social Sciences® 13.0. Ninety-nine percent of respondents believed lame cows feel pain. Overall, 43% 'strongly agreed' or 'agreed' that lameness was a problem in their herds; 23% 'neither agreed nor disagreed', and 31% 'disagreed or strongly disagreed'. However, 53% of farmers indicated that their IR was $< 10\%$; 35% believed it was between 11 to 30%; and, only 7% believed their IR was $\geq 31\%$, suggesting that lameness was not perceived as a major issue. The actual severity and frequency of lameness in the survey herds was not known. Furthermore, 69% of respondents indicated that they do not use a specific method to record occurrence of lameness. In 38% of herds a professional hoof trimmer was not used, yet only 2% indicated a person on-staff who trimmed hooves. The owner was identified as the main person (79%) responsible for managing lameness; yet, 37% indicated that no other person was responsible to help the owner with lameness in their herd (e.g., no team approach). We conclude based on survey responses that Michigan dairy farmers may underestimate the potential seriousness of lameness on cow productivity and welfare; or, what they might do to reduce lameness. Thus, careful consideration should be given for the best approaches in extension education and research to affect perceptions and attitudes of dairy farmers about lameness to improve animal health, welfare and productivity.

Key Words: Dairy lameness, Animal welfare, Farmers' perceptions

515 Use of pattern recognition to develop an automated animal health classification system. R. Silasi*^{1,2}, K. S. Schwartzkopf-Genswein¹, T. A. McAllister¹, B. Genswein¹, T. G. Crowe², R. Bolton², and B. Hill¹, ¹*Agriculture & Agri-Food Canada, Lethbridge, Alberta, Canada,* ²*University of Saskatchewan, Department of Agricultural and Bioresource Engineering, Saskatoon, Saskatchewan, Canada.*

Computer algorithms are routinely used to aid in the identification of biological patterns not easily detected with standard statistics. Currently, observed changes in normal patterns of feeding behavior (FB) are used to identify morbid feedlot cattle. The objective of this study was to use pattern classification techniques to develop algorithms capable of identifying morbid (M) cattle earlier than traditional pen checking methods. Individual FB was obtained from 384 feedlot steers (228 ± 22.7 kg, initial BW) in a 226 d trial at a commercial feedlot using an automated feed bunk monitoring system. FB variables collected included feeding duration, inter-meal interval (min., max., avg., SD and total; min/d) and feeding frequency (visits/d). Animal health records including the no. of times treated, d in the hospital and d on feed were also collected. A total of 93 cattle identified as M were categorized into low, medium and high groups based on severity of sickness. The no. of times treated, and d in hospital after first pulled were used to classify severity. Healthy (H) animals were defined as never treated and having no lung lesions or liver abscesses at slaughter.

FB data of 68 (45 medium and 25 high) M animals was processed using principle component analysis resulting in the output of 5 new variables. K-means clustering was applied to the new variables to classify the animals into H or M clusters. The clusters produced resulted in an overall classification accuracy of 83% (73 and 95 % accuracy for H and M, respectively) for animals pulled after the first 5 d in the feedlot (N=80, 40 M and 40 H). Forty-seven percent of M animals were predicted as M 1 to 6 d, and 53%, 7 d prior to being pulled. The application of pattern recognition algorithms to FB shows value as a method of identifying morbid cattle in advance of overt physical signs of morbidity.

Key Words: Pattern recognition, Cattle morbidity, Feeding behavior

516 The effect of small doses of naloxone on sexual behaviour of the anoestrous bitch. V. O. Fuentes-Hernandez*¹, P. I. Fuentes-Castro², and S. Nuño-Hernandez¹, ¹Universidad de Guadalajara, Tepic, Jalisco Mexico, ²Hospital PEMEX SUR Alta Especialidad, Periferico Sur, Mexico DF, Mexico.

In previous work, administration of naloxone in low doses produced behavioral changes in female sheep, pigs, goats, and rabbits. The objective of this work was to observe the effect of low doses of naloxone on sexual behavior and vaginal cytology of the domestic dog. Twelve, crossbreed bitches, averaging $1.5 \pm .2$ years of age and weighing 13 ± 1.9 kg were used. Animals were dewormed and individually housed in covered pens with food and water offered ad libitum. Six bitches per group, randomly selected were housed 200 m from the others. Group 1 was administered 0.5 mg naloxone i.m. at 12 h intervals for 15 days. Group 2 was treated similarly using a saline solution. Animals showing changes in anoestrus were not included. Data were analyzed using ANOVA for repeated measurements. Vaginal cytology did not differ ($P = >0.05$) for days 1 to 6 in both groups. During days 7 to 15, vaginal cytology of naloxone treated bitches showed significant ($P = <0.01$) presence of, red blood cells, and white blood cells. The latter cells were not observed in the control group. Initially, both treatments showed aversive and aggressive behaviors when exposed to males. Beginning day 7, naloxone treated bitches were friendly and playful, accepting male company, and on occasion, permitted mounting with no intromission. With the exception of one bitch, vulvar size increased slightly. Control bitches were curious about the males but did not alter their behavior, nor did vulvar size vary across days. This results show that endorphins are important modulators of sexual behavior in the bitch.

Key Words: Naloxone, Behaviour, Bitch

517 Alternative piglet processing procedures given singly affect cortisol, behavior and growth. J. N. Marchant Forde*¹, D. C. Lay Jr.¹, R. M. Marchant Forde¹, K. A. McMunn¹, E. A. Pajor², and H. W. Cheng¹, ¹USDA-ARS, LBRU, West Lafayette, IN, ²Purdue University, West Lafayette, IN.

The effects of piglet processing procedures on behavior, growth and cortisol. Soon after birth, piglets undergo procedures that are a likely source of stress. Our aim was to evaluate stress responses evoked by two alternative methods for performing the following processing procedures: 1) teeth resection (TR) – clip vs. grind; 2) tail-docking (TD) – cold- vs. hot-clip; 3) identification (ID) – ear notch vs. tag; 4) iron administration (FE) – inject vs. oral; 5) castration (CA) – cords cut vs. torn. Ten litters of eight 2-3 day-old piglets were assigned to each procedure. Within each litter a male and a female piglet were assigned to one of 4 possible procedures: the two alternative methods,

a sham procedure, and a sham procedure plus blood sampling. Piglets were balanced for weight. Blood was sampled before processing and at 45 min, 4h, 48h, 1wk, and 2wks post-procedure and assayed for cortisol. Procedures were video-taped and analyzed to evaluate time taken to perform the procedure and the number of squeals, grunts and escape attempts exhibited. Piglets were weighed before the procedure and at 24h, 48h, 1wk and 2wks afterwards. Lesions were scored on a 0 to 5 scale on ID, TD and CA pigs at 24h, 1 wk and 2wks post-procedure. Statistical analysis was performed using Proc GLM of SAS. For TR, grinding took about 20s longer than clipping and resulted in higher cortisol levels overall, poorer growth rates and more escape attempts ($P < 0.05$). For TD, hot clipping took longer ($P < 0.05$) and resulted in more squealing ($P < 0.001$). For FE, oral delivery took longer and resulted in more squealing ($P < 0.05$). For ID, notching took longer, resulted in higher lesion scores ($P < 0.05$), more squealing ($P < 0.001$), more escape attempts ($P < 0.01$) and tended to result in higher cortisol concentrations ($P < 0.1$). For CA, tearing took longer and resulted in more squealing and escape attempts ($P < 0.05$). In general, procedures which took longer to perform resulted in the occurrence of more pronounced stress-related responses.

Key Words: Piglet processing, Behavior, Stress

518 Two alternative combinations of pig processing methods affect cortisol and behavior. D. C. Lay Jr.*¹, J. N. Marchant¹, K. A. McMunn¹, R. M. Marchant-Forde¹, E. A. Pajor², and H. W. Cheng¹, ¹Livestock Behavior Research Unit, Agricultural Research Service -USDA, West Lafayette, IN, ²Purdue University, West Lafayette, IN.

Pig processing procedures can cause distress to pigs. Alternatives exist for each procedure, thus our objective was to compare a combination of five different procedures. Least aversive procedures compared to the most aversive procedures were determined by previous research. Comparisons were made between processing pigs with the 'most' aversive methods (Most): teeth grinding, tail docking with a hot iron, oral administration of iron, ear notching, and castration with cord tearing, as compared to the 'least' aversive methods (Least): teeth clipping, tail docking with a cold iron, injection of iron, ear tagging, and castration with cord cutting. Two control groups were included, one which was blood sampled (Control) and another that served merely as a behavioral control and was not blood sampled or processed but was handled. A total of 8 pigs from each of 10 litters were used - one male and one female pig per treatment. Body weights were recorded prior to bleeding, at 24 h, 1 wk and 2 wk relative to application of treatments and blood was collected at 0 h, .75 h, 4 h, 48 h, 1 wk, and 2 wk in order to measure plasma cortisol. Behavioral data were collected to record escape attempts, squeals, and grunts. Body weight did not differ between treatments ($P > 0.10$). Females did not differ in their plasma cortisol response to processing ($P > 0.10$). In contrast, male pigs in both the Most and Least treatments exhibited elevated plasma cortisol at .75 h after processing as compared to Control pigs ($P < 0.0001$). Pigs in the Most treatment performed more squeals as compared to the Least ($P < 0.01$) and the two control treatments ($P < 0.001$). Pigs in the Least treatment performed more squeals than in the two control treatments ($P < 0.07$). However, when adjusted for the amount of time required to perform the two treatments, no treatment differences were noted ($P > 0.10$). These data indicate that both the Most and Least processing approaches reported in this study result robust stress responses as measured by plasma cortisol. In addition, the time required to perform procedures contributes significantly to the stress experienced by the pigs.

Key Words: Pig, Physiology, Behavior

519 Validation of a color automated tracking system for activity and pen location of group housed weanling pigs. J. W. Dailey*¹, N. Krebs², J. A. Carroll¹, and J. J. McGlone², ¹*Livestock Issues Research Unit, Agricultural Research Service-USDA, Lubbock, TX*, ²*Texas Tech University, Lubbock*.

Knowing where animals are located throughout the day can be important in some studies. While scan sampling methods can be imprecise, continuous video observation is precise but time-consuming. Commercial automated tracking systems (ATS) quantify animal behavior by assigning an X, Y coordinate for an animal's location at a given time. The objective of this study was to validate an ATS, *Ethovision*, using the 'color' tracking method compared with a human observer using the *Observer 5.0* (HOB). Nursery pigs (n = 44, 1 pig was removed from the study due to technical problems with the HOB) were group housed (n = 4/pen). Each pig in the pen had a different color tape around its shoulders (11 replications/color). Pigs were video recorded continuously for 1 h with color cameras at 30 frames/s. Videos were scored for a 1 h period for the time spent on the right half of the pen. Data obtained with the ATS were compared to data collected by HOB by ANOVA and regression analyses. The following results were obtained using 10 pixels as a parameter of detection in ATS. No difference ($P = 0.597$) was observed between HOB and ATS for the time spent on the right. A linear regression comparing the methods of observation for 'time spent on the right' yielded an r^2 of 0.9102 (or $r = 0.954$, $P < 0.01$) which indicated ATS as an assay was a precise predictor of HOB measurements (using 100 pixels, there was no difference in the means but the r^2 was 0.78). The simple linear regression model was $HOB = 0.962 \text{ ATS} + 3.6929$ ($SE_b = 0.047$). The number of pixels used in the ATS must be optimized to accurately interpret animal movement. Additionally, the surface area covered by the tape, the color and elasticity of the tape, and the lighting system in the room can also affect the efficiency of the ATS. In conclusion, the ATS generated mean values similar to behavioral data collected by HOB. The r^2 demonstrates that the ATS closely predicted data obtained by HOB. The ATS is recommended for collection of this type of behavioral information.

Key Words: Pigs, Behavior, Technique

520 The effects of prenatal stress on the ano-genital distance and growth hormone immuno-positive cells in the pituitary gland of the pig. E. L. Schenck*⁴, D. C. Lay Jr.¹, H. G. Kattesh², J. E. Cunnick³, M. J. Daniels⁵, M. J. Toscano^{4,6}, and K. A. McMunn¹, ¹*USDA-ARS Livestock Behavior Research Unit, West Lafayette, IN*, ²*University of Tennessee, Knoxville*, ³*Iowa State University, Ames*, ⁴*Purdue University, West Lafayette, IN*, ⁵*University of Florida, Gainesville*, ⁶*University of Bristol, Bristol, UK*.

Exposing pregnant mammals to prenatal stress has been shown to alter the stress response of their resulting offspring. Research in rodents has shown that prenatal stress can modify aspects of gender behavior and morphology. Ano-genital distance is the distance between the anus and genital area. A decrease in ano-genital distance in males indicates a decrease in masculinization. Our objective was to determine if prenatal stress altered the ano-genital distance and pituitary gland of piglets. Sow treatments consisted of i.v. injections of adrenocorticotrophin (1 IU/kg BW) (ACTH, n=11), exposure to rough handling for a 10-min duration (RH, n=13), or no treatment (CONT, n=13) once a week during d 42 to d 77 of gestation. Ano-genital distance (a ratio of body length:ano-genital distance) was measured after birth in all male piglets. One male piglet per dam was sacrificed at 2-mo of age and the pituitary gland was collected for immunocytochemistry for analysis of growth hormone. Data were analyzed using the GLM procedures of SAS. Male piglets born to dams who received ACTH had a larger ano-genital ratio (a smaller ano-genital distance) compared to piglets from the roughly handled sows or the control sows ($P < 0.0001$; 2.01 ± 0.03 ; 1.91 ± 0.3 ; 1.87 ± 0.02 respectively). There were no differences ($P > 0.10$) among treatment groups in the number of immuno-positive cells for growth hormone in the pituitary gland. Adjusted weaning weight was found to be greater for pigs born to the CONT and RH handled sows as compared to piglets from sows who received ACTH ($P < 0.05$). These data indicate that prenatal stress may decrease masculinization during development and possibly decrease reproductive success later in life. The weight differences in the ACTH group at weaning may be due to the high level of prenatal stress activated by the ACTH injections. The differences in weight may imply that an increase in prenatal stress (ACTH) alters pre-weaning weight gain; however, a 2-mo period appears to be sufficient for the quantity of pituitary cells positive for growth hormone to recover from stress.

Key Words: Swine, Prenatal, Gender

Animal Health II

521 Effect of maternity pen management on risk of early calfhood diseases in dairy heifer calves during the preweaning period. P. Pithua*, S. J. Wells, and S. M. Godden, *University of Minnesota, St. Paul*.

The objective of this study was to determine whether heifer calves born in individual maternity pens will have a lower risk for experiencing calfhood diseases versus heifer calves born in a multiple cow maternity housing area in a randomized clinical trial, conducted between January, 2005 and December, 2005. Four hundred and fifty two dairy heifer calves were recruited into the study from three Minnesota dairy farms. Pregnant cows were randomly allocated to calve in either the individual maternity pen (treatment group) or multiple cow maternity housing area. Fecal material and placental remains were removed from the individual maternity pens between each calving and calves were

separated from their dams and removed from the maternity area, within 2 hours of birth. Calves born in multiple cow pens had varying times of separation from their dams. All calves were housed in individual hutches for 8 weeks and later transferred to group pens of 10 calves each. Calves born in individual calving pens were not commingled with those born in the multiple calving areas during the follow up period. Standard disease monitoring and diagnosis protocols were developed for the study. Disease events (enteritis and pneumonia) experienced by the calves, during the first 3 months of birth and treatments administered, were recorded by the calf managers. Incidence risk of disease and mortality, experienced by calves in either group were compared using Chisq-Test statistic (Table1). Days at risk for calves born in either calving location were compared using product limit estimates of survivor functions and there was no evidence to suggest differences in survival experience between groups (Log-Rank

Test: Chisq=0.0744; df =1; p=0.79). Results suggest no difference in the incidence of calf morbidity and mortality between calves born in individual maternity areas when compared with those born in multiple cow maternity environments.

Table 1: Incidence risks and rates (cases/1000 calf-days at risk) for calfhood diseases and χ^2 -test comparing morbidity and mortality risks between calves born in individual calving area versus calves born in multiple calving area

Disease	Total (n=452)		Individual pen (n=241)		Multiple pen (n=211)		χ^2	df	p
	Risk	Rate	Risk	Rate	Risk	Rate			
Morbidity	0.38	6.8	0.38	6.9	0.38	6.7	0.002	1	0.9
Enteritis	0.32	5.7	0.32	5.8	0.31	5.5	0.061	1	0.8
Pneumonia	0.06	1.1	0.06	1.0	0.07	1.2	0.317	1	0.5
Arthritis	0.22	0.004	0.00	0.0	0.005	0.08	0.5*
Mortality	1.10	0.020	0.02	0.03	0.005	0.08	0.3*

* P-values based on Fisher's Exact Test.

Key Words: Randomized clinical trial, Maternity pen, Calfhood diseases

522 Effect of feeding heat-treated colostrum on serum immunoglobulin G concentrations in dairy calves. D. Hagman, S. Godden*, J. Johnson, T. Molitor, and T. Ames, *University of Minnesota, St. Paul.*

There has recently been increasing interest in feeding heat-treated colostrum to reduce transmission of infectious pathogens to calves. However early research pasteurizing colostrum using the same high temperatures as are typically used to pasteurize milk resulted in significant denaturation of colostral antibodies and often unacceptable feeding characteristics. Recent laboratory studies have suggested that heat-treating bovine colostrum at 60°C for 60 min would result in good pathogen kill while preserving antibodies. The objective of this study was to describe the effect of feeding heat-treated bovine colostrum on passive transfer in newborn calves. This study was conducted on a commercial transition cow management facility in Baldwin, WI. 8 to 16 L batches of fresh bovine colostrum were split into two equal aliquots. The first aliquot was maintained as raw, and refrigerated immediately in 4 L bottles. The second aliquot was heat-treated in a commercial batch pasteurizer at 60°C x 60 min, and then refrigerated in 4 L bottles. Fifty newborn singleton Holstein calves weighing > 70 lbs at birth were systematically (i.e. every other calf born) assigned to be fed 3.8 L of either raw (control) or heat-treated (treated) colostrum within 2 hrs of birth, using an esophageal feeder. Blood samples were collected at 0 and 24 hrs of age for determination of serum total protein (TP) and serum immunoglobulin G (IgG) concentrations. There was no effect of treatment on serum measures at 0 hrs of age. However mean (SD) calf serum TP and IgG concentrations were significantly greater at 24 hrs of age for calves fed heat-treated colostrum (TP = 6.3 ± 0.5 gm/dl; IgG = 22.3 ± 4.6 mg/ml) as compared to calves fed raw colostrum (TP = 5.9 ± 0.7 gm/dl; IgG = 17.5 ± 5.5 mg/ml) ($P < 0.05$). Though potential economic and health benefits still need to be described, these results suggest that farms can feed calves heat-treated colostrum to reduce pathogen exposure while maintaining, or even improving, passive transfer of colostral antibodies.

Key Words: Colostrum, Pasteurization, Immunoglobulin G

523 Effects of egg-derived antibody supplements on health and performance of veal calves. D. Wood*¹, J. Sowinski¹, and S. Hayes², ¹*Animix, Juneau, WI*, ²*Milk Products, Chilton, WI.*

An experiment was conducted to measure effects of egg-derived antibody supplements on calf health and performance. Sale-barn sourced Holstein bull calves (n = 128; initial BW = 39 kg; app. 1 wk of age) were randomly placed in individual stalls in 2 barns. Calves were randomly assigned to receive 1 of 3 treatments for app. 12 d, including 1) no supplement (Control; n = 44), 2) single source of commercially available egg-derived antibody (CEA; n = 42), or 3) blend of 3 egg antibody products with MOS, beta glucan, serum and probiotics (CEA-Fortified; n = 42). All egg antibody products were fed to manufacturer guidelines. Calves were started on 24:18 veal prestarter and transitioned to 22:16 starter. The single CEA source was from hens hyper-immunized with 8 calf pathogens. The blend of 3 egg antibody sources had titer to 12 calf pathogens. Individual calf BW was determined on d 0 and d 34 and 40 for rooms 1 and 2, respectively. Although there was a significant room effect ($P = 0.01$) for calf ADG (0.61 vs. 0.69 kg/d for rooms 1 and 2, respectively), there was no treatment x room interaction ($P = 0.84$). Calf ADG did not differ ($P = 0.53$) among treatments (0.67, 0.64, and 0.64 kg/d for Control, CEA, and CEA-Fortified, respectively; SEM = 0.03). The % of calves treated for illness did not differ ($P = 0.80$) among treatments. The avg. number of medical treatments/calf did not differ ($P = 0.80$, 0.41 treatments/calf; SEM = 0.10). The total number of medical interventions provided to ill calves did not differ ($P = 0.80$, 2.1, 2.2, and 1.8 total treatments for Control, CEA, and CEA-Fortified, respectively; SEM = 0.50). Mortality did not differ between treatments. Total mortality in the two rooms was 11%. Randomly pulled fecal swabs (17 swabs) were collected during peak scour period and analyzed for clostridium perfringens A, B, C & D, virulent E coli and presence of salmonella. Clostridium type A was the only pathogen detected (11 swabs). Under conditions in this study, egg antibody supplements had no effect on veal calf performance or health.

Key Words: Calf, Egg, Antibody

524 A survey of bovine practitioners to determine factors associated with acute bloat syndrome in pre-weaned dairy heifers. D. E. Shoemaker*¹, P. J. Rajala-Schultz², and L. Midla³, ¹*The Ohio State University, Wooster*, ²*The Ohio State University, Columbus*, ³*The Ohio State University, Marysville.*

Acute bloat syndrome (ABS) is an emerging problem in dairy herds. Affected calves suffer from the sudden onset of bloat/abdominal distension and die, generally within 4 to 24 hours. To identify factors associated with ABS, a survey was developed and sent to members of the American Association of Bovine Practitioners (AABP), self-identified as dairy or mostly large animal veterinarians (BPs). Response rate was 31% (708 of 2,312), with 39% (276 of 708) responding as having seen a case of ABS. In the previous 12 months, half of these BPs reported seeing ≥ 4 cases of ABS, with 5% seeing > 40 cases. Over half the BPs saw cases sporadically, with only 6.5% reporting multiple outbreaks (an outbreak is ≥ 3 cases in 3 weeks.) The abomasum was the primary organ involved in almost 2/3 and the rumen in 1/4 of the reported cases. No necropsy was performed in 27% of reported cases. No bacteria were isolated in 61% of samples submitted for laboratory analysis. In 31% of cases *Clostridium spp.* and in 8% of cases *Sarcina spp.* were reported. ABS cases were observed in all age groups (0 to >21 days). Less than 3% of cases were reported for calves <4 days old. No clear seasonal patterns emerged. Symptoms most frequently

reported included abdominal distension on both sides (66%), fluid slosh (56%), colic (47%), and dehydration (42%). Only 23% reported diarrhea. 60% of the cases resulted in death. Responses regarding management practices of the calf's herd reflected common management practices (MPs). No particular MPs were excluded. More than 62% of the time, BPs rated overall calf management as very good or excellent. 88.5% of the time, management was rated as at least good. This survey begins to identify factors associated with ABS. Further work is needed to clearly identify the cause(s) of this disease as well as potential therapies and preventive measures.

Key Words: Calves, Acute bloat syndrome

525 Descriptive epidemiology of adult dairy cow mortalities. J. A. Severid^{*}, F. B. Garry, G. H. Gould, J. R. Wenz, and J. E. Lombard, *Colorado State University, Fort Collins.*

Mortality rates for adult dairy cows have been increasing over the past couple of decades and are now between 4 and 12% at the state level. The objective of this study was to determine the cause of death of adult dairy cattle on a modern dairy farm and to identify risk factors associated with mortality. Adult mortalities from March 1, 2005 to January 31, 2006 on a 1400 cow dairy were examined by necropsy either in the field or at the Colorado State Veterinary Diagnostic Laboratory. Gross necropsy findings and histology were used to determine the cause of death. Previous health and production records were obtained and evaluated for every necropsied cow. Producer assigned cause of death was compared with necropsy findings. Serum was collected from enrolled fresh cows at 3-5 DIM and biochemistry panels were run on 10 cows that died within 10 days postpartum and 10 surviving herd mates matched by lactation and calving date. Of 81 cows that died, 70 were necropsied. Thirty percent of deaths were in first lactation animals and 46% of all of the deaths occurred within the first 30 days postpartum. Deaths were attributed to musculoskeletal injury (20%), digestive disorders (14%), and uterine disorders (11%). Miscellaneous health problems accounted for 21% of the mortalities, including such conditions as abdominal hemorrhage (non-uterine artery related), arterial thrombosis, and lymphoma. In 30% of the cases, the producer's reasons for death were incorrect when compared to necropsy findings. Of all the mortalities, 28% of the cases were reported as an unknown cause by the producer, whereas 6% were unknown after necropsy. A significantly larger proportion of cows that died had elevated creatinine kinase and aspartate aminotransferase, suggesting muscle damage, compared to cows that remained in the herd ($P < 0.02$). Results of this preliminary study suggest routine necropsy provides information about the causes of dairy cow mortality that is currently unavailable for making informed management changes. Many deaths are attributable to disease processes that could be minimized or avoided through directed management interventions, especially during the transition period.

Key Words: Mortality, Dairy

526 The effect of digit amputation or arthrodesis surgery on culling and milk production in Holstein dairy cows. R. C. Bicalho^{*}, S. H. Cheong, L. D. Warnick, D. V. Nydam, and C. L. Guard, *Cornell University, Ithaca, NY.*

The objectives of the study were to evaluate the effects of digit amputation and arthrodesis surgery performed in the field on culling and milk production during the early post-surgical period. Cows from three commercial dairy farms in New York State were recruited for

the study. A total of 49 cows that had digit amputation were matched with 68 control cows, while 17 cows that had arthrodesis surgery were matched with 20 control cows according to lactation, days in milk, and lactating at time of treatment of the case. Cumulative milk production for the first 60 days after the procedure was calculated in DC305 (Dairycomp305) for controls and treated cows. Milk production data was analyzed using PROC mixed of SAS ver. 9.1 (SAS Institute, Cary NC). The survival of cows with surgery was compared to survival of matched controls using Cox's proportional hazards model (SAS 9.1 Cary North Carolina, USA). Performance was not directly comparable between amputated and arthrodesis groups because cows were not randomly assigned to the two treatment groups. Therefore, each surgical group was evaluated relative to their respective matched control groups. Amputation cows had a significantly higher culling rate and estimated median survival of 68 days compared to 585 days for their control group. Arthrodesis cows had a median survival time of 286 days and their control cows had a median survival time of 246 days. Total milk production for the first 60 days post surgery was significantly lower for both amputation (1533 kg) compared to control (2121 kg) and arthrodesis (1883 kg) compared to control (2250 kg) groups. Septic arthritis of the distal interphalangeal joint was the most common condition treated by surgery accounting for 70.5% of arthrodesis cases and 73.5% for digit amputation. Toe necrosis accounted for 14.3% of amputation cases and retroarticular abscess made up the rest of the digit amputation (12.2%) and 29.5% of arthrodesis cases.

Key Words: Digit amputation, Arthrodesis, Milk production

527 Mechanical properties of the hoof horn of dairy cows during lactation. B. Winkler¹ and J. K. Margerison^{*2}, ¹*University of Plymouth, School of Biological Sciences, Plymouth, DEVON, UK,* ²*Massey University, Institute of Food, Nutrition and Human Health, Palmerston North, NZ.*

The objective of this experiment was to compare the mechanical strength and lesion score of hoof horn in dairy cows over the postpartum period when housed in a cubicle system. Mechanical tests were completed on sole horn taken from a total of 36 live cows at 50 (p1), 100 (p2) and 160 (p3) days postpartum (pp). Simultaneously, all claws were assessed for lesions score (LS) of the sole (S) and white line (WL) areas of the hoof. Horn samples were collected from all claws and analysed for elastic modulus (EM) and punch force (PR). Each measurement was repeated 8 times on the S and WL areas of each claw. Horn samples were scored for haemorrhage levels, using a 6 point scale (0- no haemorrhage and 5- severe). PR was significantly ($P < 0.001$) lower in samples with high haemorrhage scores, demonstrating a lower structural integrity (8.72^a, 8.53^a, 8.06^b, 7.75^b, 6.08^c and 4.99^d N for scores 0 to 5 respectively). Total LS of the S area increased significantly at day 160 (p1- 1241^b, p2-1295^b, p3- 1676^a) and the WL at day 100 pp (p1- 1042^b, p2- 1448^a, p3-1710^a) ($P < 0.001$). The S and WL areas of the hind outer (HO) claws had significantly higher lesion scores than other claws (sole HO- 340.2^a, other- 149.4 to 184.2^b; WL HO- 267.5^a, other- 168.4 to 228.9^b) ($P < 0.001$). PR of the sole area was significantly lower in the HO claws, which had higher lesion scores, when compared to other claws (HO- 7.2N^a, other- 8.0^a to 9.2N^a) ($P < 0.001$). PR decreased as day pp increased and lesion scores increased (p1- 9.0^a, p2- 8.6^{ab}, p3- 8.2^bN) ($P < 0.001$). PR of the WL area was significantly lower in the hind left (HL) claws compared to other claws (HL- 4.9N^b, other- 5.5 to 6.2N^b) and was significantly lower ($P < 0.01$) at day 160 pp (p1- 7.1^a, p2- 6.2^{ab}, p3- 5.6^b). EM of the sole and WL areas decreased ($P < 0.01$) at day 100 pp (S p1- 48.8^a, p2-

17.7^b, p3- 18.2^b N/mm²; WL p1- 32.2^a, p2-17.8^b, p3-19.7^b N/mm², but did not differ between claws. Mechanical tests accurately reflect changes in claw horn lesions following parturition.

Key Words: Lameness, Dairy cattle, Hoof

528 Evaluation of Excede for control of BRD when administered at initial processing or at revaccination within pasture and feedlot receiving systems. V. Bremer^{*1}, G. Erickson¹, T. Klopfenstein¹, D. Smith¹, K. Vander Pol¹, M. Greenquist¹, D. Griffin¹, G. Sides², and L. Bryant², ¹University of Nebraska, Lincoln, ²Pfizer Animal Health, New York, NY.

Preventing bovine respiratory disease (BRD) among incoming calves is a challenge for feedlot or backgrounding systems. The objective of this study was to determine the effect of Excede[®] at arrival or at revaccination on morbidity, mortality, and gain in both feedlot and pasture receiving systems. A total of 2,264 steer calves from 3 buyers were assigned randomly to pens receiving one of three treatments with 12 replications per treatment. Seven reps were in a feedlot receiving system (20 steers/pen; 36 m²/steer) and 5 reps were on cool-season pastures (88-152 steers/1.6-10.1 ha pasture). All calves received modified-live viral vaccine and *Haemophilus somnus* bacterin at initial processing and reprocessing. All calves received injectable anthelmintic at initial processing and 7-way *Clostridium spp.* bacterin-toxoid at reprocessing (median 18 d; d 16-27). Treatments included no antibiotic at arrival (CON), Excede (6.6 mg/kg BW) at arrival (ARR), or Excede (6.6 mg/kg BW) at revaccination (REVAC). Respiratory disease incidence and BW data were analyzed accounting for correlated observations of steer within pen. No differences ($P < 0.05$) of initial or final BW, or ADG were observed due to treatment. Initial BW, treatment, receiving system (pasture or feedlot), and buyer explained the cumulative incidence of respiratory disease for the study period ($P < 0.01$) in a generalized estimating equations logistic regression model. Cumulative incidence of BRD was $4.7 \pm 1.1\%$, $11.0 \pm 1.9\%$, and $13.8 \pm 2.1\%$ for ARR, CON, and REVAC, respectively. The ARR model-adjusted incidence of BRD was less than CON ($P < 0.01$). The model-adjusted incidence of BRD among REVAC steers was not significantly different from CON. Cumulative incidence of BRD was less ($P = 0.02$) for pasture receiving than feedlot receiving, $7.4 \pm 1.1\%$ and $11.0 \pm 2.1\%$ respectively. Most incidents of BRD occurred during the first 14 days of arrival and before the REVAC medication was administered. The ARR medication effectively improved animal health status by reducing BRD incidence.

Key Words: Respiratory disease, Antibiotic treatment, Feedlot cattle

529 Neural network modeling of feeding behavior to predict morbidity in a commercial feedlot. B. Hill^{*}, K. Schwartzkopf-Genswein, T. McAllister, B. Genswein, A. Banack, R. Silasi, L. Thompson, and F. Brown, *Agriculture & Agri-Food Canada, Lethbridge, AB, Canada.*

Trials were conducted in 1998 and 2002 at a commercial feedlot near Amarillo, TX. The objective was to model feeding behavior to predict cattle morbidity with 75% accuracy 2-6 d ahead of a pen checker. Feeding behavior of newly-received calves was monitored for 107 d using the GrowSafe[®] system which uses radio frequency to record feedbunk attendance. Thirteen variables were collected: initial BW, d on feed (DOF), feeding duration and inter-meal interval (min., max., avg., SD and total; sec/d), feeding frequency (visits/d) and max. daily temperature. Neural network (NN) modeling was then applied to

predict (classify) healthy and morbid animals on different d prior to morbid animals being pulled by a pen checker. Cattle were defined as morbid based on hospital diagnosis and drug treatment; healthy cattle as never pulled/treated. Data sets consisted of healthy and morbid animals (1:1 ratio matched by pen and DOF). In 1998, 60% of the morbid animals were pulled by 6 DOF; in 2002, 35% were pulled by 6 DOF. Animals that did not visit the feedbunk on a given d were excluded from data sets for that d. Individual feeding behaviors were highly variable and the NN typically required 6 to 12 variables to classify the animals. For the 1998 trial, animals (n=104) were classified with 76% accuracy 2 d before animals were pulled. The most important variables were min. feeding duration, min. inter-meal interval and DOF. Classification accuracies were 74% at 4 d before pull (n=82), and 78% at 6 d before pull (n=66). Results were similar for the 2002 trial. Accuracies were 73% at 2 d before pull (n=220) with min. inter-meal interval, min. feeding duration, and total feeding duration as the most important variables. Accuracies were 75% at 4 d before pull (n=192), and 76% at 6 d before pull (n=124). In both trials, classification accuracies were similar for healthy and morbid animals and accuracies did not decline between 2 d and 6 d before pull. We are investigating whether accurate predictions can be made 7 to 10 d before pull. NN modeling shows good promise for predicting morbidity in feedlot animals.

Key Words: Feeding behavior, Neural networks, Predicting morbidity

530 Physiological, hematological and immunological responses of 9-month old bulls (250kg) to transport at spatial allowances of 0.85m² and 1.27m²/animal on a 12-h journey by road. B. Earley^{*}, D. J. Prendiville, and E. G. O'Riordan, *Teagasc, Grange, Beef Research Centre, Dunsany, Co. Meath, Ireland.*

To investigate the effects of space allowance during transportation on physiological, haematological and immunological responses in 9-month old bulls before and after a 12-hour road journey, bulls were randomly assigned to one of 3 treatments: 1) control (250kg \pm 43.2s.d) (n=16); 2) transported at 0.85m²/animal (250kg \pm 20.1) (n=16); 3) transported at 1.27m²/animal (249.2kg \pm 18.8) (n=13) and transported by road on a 12 hour journey. Control bulls (250kg \pm 43.3 s.d.) were housed on slats (2m²/animal) and fed ad lib silage and 2 kg of concentrates at Grange Research Centre. Bulls were blood sampled immediately before and after transport. There was no change ($P \geq 0.05$) in liveweight, immunological responses (interferon- γ production) or in plasma concentrations of cortisol. Protein, globulin, urea and lactate concentrations and white blood cell numbers and the activities of the enzymes creatine kinase, aspartate aminotransferase and lactate dehydrogenase were not changed ($P \geq 0.05$) by transportation at either the 0.85 or 1.27 m² spatial allowances. Following transportation all transported groups had higher ($P \leq 0.05$) albumin levels than the control animals. Animals transported at a stocking density of 1.27m² had higher ($P \leq 0.05$) non-esterified fatty acid (NEFA) concentrations compared with controls. Post-transport, mean blood glucose concentrations were higher ($P \leq 0.05$) in all transported animals (0.85m² (5.01 \pm 0.41 mmol/l); 1.27m² (4.79 \pm 0.45 mmol/l) compared with controls (4.21 \pm 0.28 mmol/l). The lymphocyte % were reduced ($P \leq 0.05$) at 0.85m² (40.8 \pm 10.13) and 1.27m² (44.7 \pm 8.84) compared with control animals (57.5 \pm 10.9) post transport. Neutrophil numbers were increased ($P \leq 0.05$) in the transported animals at the 0.85m² (7.1 \pm 2.6) and 1.27m² (6.0 \pm 1.7) spatial allowances. It is concluded that there was no significant biological effects on the variables chosen of transporting bulls at a space allowance of 1.27m²/animal compared with a spatial

allowance of 0.85 m².

Key Words: Transport, Welfare, Physiology

531 Gene expression changes in neutrophils of young bulls during transportation stress. K. R. Buckham^{*1,2}, J. L. Burton³, B. Earley², and M. A. Crowe¹, ¹University College Dublin, Dublin, Co. Dublin, Ireland, ²Teagasc, Grange Beef Research Centre, Dunsany, Co. Meath, Ireland, ³Michigan State University, East Lansing.

The inevitable practice of transporting beef cattle results in a stress response that is associated with increased disease susceptibility to opportunistic respiratory pathogens. Other stress models have shown pronounced neutrophilia that correlates with an increase in blood glucocorticoids, implying that these stress steroids may impact innate immunity. The hypothesis of this study was that transport would alter expression of three genes known to be important for neutrophil-mediated immunity, including functions of transendothelial migration (CD62L and MMP-9) and apoptosis (Fas). To test this hypothesis, blood was collected, plasma harvested, and neutrophils isolated from 6 Belgian Blue bulls (231 ± 7.0 kg) at -24, 0, 4.5, 9.75, 14.25, 24, and 48 h relative to commencement of an 8 h transport by truck. Plasma cortisol concentrations, measured by RIA, were elevated at 4.5 and 9.75 h (50.64 ± 4.46 and 37.67 ± 4.15 ng/mL, respectively, $P < 0.05$) compared to -24 h (22.15 ± 2.43 ng/mL), confirming that the animals were stressed by transport. Blood neutrophil counts were elevated between between 4.5 and 14.25 when compared to -24 h ($1.36 \times 10^6 \pm 5.9 \times 10^4$ cells/mL), reaching a peak of $1.73 \times 10^6 \pm 2.8 \times 10^4$ cells/mL at 9.75 h ($P < 0.01$). A weak positive correlation was observed between cortisol and neutrophil count ($r = 0.25$; $P = 0.11$). Neutrophil gene expressions for MMP-9 and Fas were also affected, although no difference in CD62L expression was detectable. Quantitative real-time RT-PCR analyses showed a ≥ 14-fold increase up-regulation of MMP-9 between 4.5 and 14.25 relative to -24 h ($P < 0.01$), while Fas expression was depressed about 2-fold during the same time period ($P < 0.05$). While these gene expression changes require validation at the protein level, our results suggest that transport stress may enhance pro-inflammatory activity of longer-lived circulating neutrophils, potentially compromising immunocompetence with the alteration of

these cells' natural protective functions and contributing to disease severity during respiratory tract infections.

Key Words: Transportation stress, Neutrophil, Gene expression

532 Effects of lairage during transport on innate immune function of swine. J. L. Williams^{*1,2}, S. D. Eicher¹, J. A. Patterson², and J. N. Marchant-Forde¹, ¹USDA-ARS, West Lafayette, IN, ²Purdue University, West Lafayette, IN.

Long distance transports may significantly affect the health of pigs; thus, adding a rest stop (lairage) during long journeys may improve their well-being. The objective of this study was to determine whether a mid-journey lairage was beneficial to swine immune variables during a 16-h transport. Four replications were conducted, one in each of four seasons. Eighteen-kg pigs were blocked by weight and assigned to one of two transport treatments. The pigs were housed in 16 pens (13-16 pigs/pen) with 8 pens/treatment. Lairage (La) pigs were transported for 8 h, given a rest with food and water for 8 h, then transported 8 h. Continuous (Co) pigs were continuously transported for 16 h. Jugular blood samples were collected from 16 pigs (8/treatment) on d 1, 3, 7 and 14 post-transport. Hematocrit and white blood cell (WBC) counts were obtained and neutrophil cell functions (phagocytosis and oxidative burst) and phenotypic cell markers (CD14 and CD18) were analyzed using flow cytometry. There were no treatment by block interactions. In Co pigs, total WBC count was higher on d 1 than La pigs ($P < 0.001$). As expected, granulocyte count in Co pigs was higher than in La pigs on d 1 ($P < 0.001$); further, granulocyte count was lowest on d 3 in Co pigs ($P < 0.05$). In both treatments, lymphocyte count was lower on d 14 than on d 1 ($P < 0.05$). There were more cells expressing CD14 in Co pigs than La pigs on d 1 ($P < 0.05$). In addition, Co pigs on d 1 and 14 had the highest percentage of CD14 and CD18 positive cells ($P < 0.05$) and La pigs had the highest percentages of both on d 14 ($P < 0.05$). Percent phagocytosis was highest on d 7 in the Co pigs ($P < 0.05$); however, in both treatments oxidative burst was highest on d 7 ($P < 0.05$). In both treatments, CD18 percentage was lowest on d 0 ($P < 0.05$). This study indicates that extended transport without lairage alters immune functions which may cause greater susceptibility to pathogens. Partial funding of this study was provided by the National Pork Checkoff.

Key Words: Stress, Immune function, Transport

Beef Species

533 Relationship between residual feed intake and onset of puberty in Brangus heifers. P. A. Lancaster^{*1}, G. E. Carstens¹, D. W. Forrest¹, R. D. Randel², T. H. Welsh, Jr.¹, and T. D. A. Forbes³, ¹Texas A&M University, College Station, ²Texas A&M University, Overton, ³Texas A&M University, Uvalde.

Objectives of this study were to examine relationships between residual feed intake (RFI) and onset of puberty and ultrasound estimates of carcass composition in growing, purebred heifers. Average (± SD) initial ages of Brangus heifers (Camp Cooley Ranch) used in this study were 225 ± 9 and 236 ± 11 d for years 1 (N = 114) and 2 (N = 115). Heifers were individually fed a roughage-based diet (ME = 2.2 Mcal/kg) using Calan-gate feeders, and BW and DMI were measured

weekly for 70 d. RFI was calculated as the residual from the linear regression of DMI on mid-test BW^{0.75} (MBW) and ADG. Ultrasound measures of 12th rib fat thickness (BF), longissimus muscle area (LMA), and percent intramuscular fat (IMF) were measured on d 0 and 70. Progesterone analyses of weekly blood samples were used to determine onset of puberty. Heifers exhibiting a progesterone concentration ≥ 2 ng/mL for one wk or ≥ 1 ng/mL for two consecutive wk were considered to be pubertal. Ovarian ultrasound performed on d 63 of each year's study was used to confirm pubertal heifers. Average (± SD) ADG, DMI and RFI were 0.90 ± 0.15 and 1.06 ± 0.16 kg/d, 9.1 ± 1.1 and 9.5 ± 1.0 kg/d, and 0.00 ± 0.75 and 0.00 ± 0.68 kg/d for year 1 and 2, respectively. RFI was phenotypically correlated ($P < 0.01$) with DMI (0.67) and feed conversion ratio (FCR; 0.56), but not ADG

or initial BW. RFI tended to be correlated ($P < 0.10$) with LMA (-0.16) and BF (-0.12) on d 0, but not with LMA or BF on d 70. Heifers with low RFI (< 0.5 SD; $n = 73$) consumed 17% less ($P < 0.01$) DMI and had 16% lower ($P < 0.01$) FCR than heifers with high (> 0.5 SD; $n = 66$) RFI, even though final BW and ADG were similar. Across both years, 29% of the heifers were pubertal by d 70. Chi-square analysis revealed that the percentage of heifers that were cycling by d 70 within low (35.6%), medium (27.8%) and high (22.7%) RFI phenotypes were similar ($P > 0.20$). Moreover, of those heifers that were pubertal by 70 d, age at puberty and maximum progesterone concentration were similar between low and high RFI heifers. These data suggest that onset of puberty had a negligible association with phenotypic variation in RFI.

Key Words: Residual feed intake, Reproduction, Carcass traits

534 Variation in number of calves sired/bull in a natural mating multiple sire breeding herd. K. J. Wells*, Q. Xiao, X. Wu, Z. Jiang, and J. J. Reeves, *Washington State University, Pullman.*

In a large commercial ranch setting it is common practice to run multiple sires with large groups of cows. Little is known about the serving capacity or calf output of bulls in these herds. In this study the calf output of 19 individual, mature Wagyu bulls being utilized as a single multiple sire breeding group was evaluated using DNA parentage verification. Four hundred twenty (420) first calf Angus cross heifers were bred in a 3,000 acre pasture on a western Montana ranch, over a 45 day breeding period. All bulls passed a semen evaluation prior to the breeding season. A total of 392 calves were tested for paternal identity. Of those calves, 364 (92.8%) were assigned a sire with at least an 80% probability of paternity, 24 (6.1%) were unassigned and 4 were unable to be tested. The most probable sire of each calf was determined using a panel of 8 microsatellite markers. A chi-square goodness-of-fit test indicated a significant difference in the number of calves sired per bull ($P < 0.001$). Of the 19 bulls used, 10 (52.6% of bulls) sired 70.6% of the calves to which parentage was assigned. Amongst those bulls, 5 (26.3% of all bulls) sired 42.6% of the assigned calf crop. Alternately, the 5 (26.3%) least prolific bulls sired only 12.4% of the calves, with the two bottom ranking bulls siring only 6 (1.6%) calves each. Scrotal circumference (SC) measurements were available for 15 of 19 bulls; there was no correlation between SC and number of calves sired. The results of this study indicate that there are differences in serving capacity of individual bulls used in multiple sire breeding herds.

Key Words: DNA, Paternity, Cattle

535 Integrating the beef cattle foodchain – A case study of the first organic beef cattle enterprise in Veracruz, Mexico. P. Fajersson*¹ and P. Parada², ¹*Colegio de Postgraduados, Campus Veracruz, Veracruz, Mexico,* ²*Carnes Orgánicas La Rumorosa, Poza Rica, Veracruz, Mexico.*

After abolishment of agricultural tariffs by NAFTA, the state of Veracruz, Mexico's number one beef cattle producer, is suffering from declining profits in the beef cattle sector. The 3.3 million ha of mostly native pasture utilized for cattle production in extensive grazing systems, with little or no chemical inputs, require innovative use and offer excellent premises for conversion to organic beef production (OBP). A project to develop integrated sustainable OBP systems in the Mexican tropics and market value-added beef began 2002. The hypothesis was that a strategic alliance of researchers, an organic

certification agency, and ranchers would enable a pioneer producer to convert to OBP and integrate his enterprise. The methodology used was to offer producers guided implementation of the European norm 2091 for organic livestock production and extension activities on enterprise integration. The pioneer producer used to raise Zebu cattle on 550 ha of native pastures, supplied minerals, applied limited chemical herbicides and tick treatments, and marketed live cattle at 400 kg BW and 27 mo of age with a dressing percentage (DP) of 55%. In 2002, he obtained organic certification of his 565-head integrated OBP with Zebu crosses in a rotational, agroforestry grazing system with mechanical weed and organic parasite control. Finishing cattle are fed 2 kg/d of concentrate with 18% CP during 4 mo and ADG is 830 g until slaughter at 22 mo of age and 450 kg BW with a DP of 58%. In 2003, a butcher shop, packaging and sales of beef were added and the post-harvest chain was certified as organic. Income increased 157% with the enterprise integration, followed by 14.8% in 2004, while variable costs rose 19.6 and 11.1%, respectively. Since 2003, yearly volume of boneless beef sold with 10% added value to the producer grew from 10 to 18 tons in a total of five states. In 2005 income rose 140 and costs 16.6% and a positive balance of USD 51,920 was achieved. In conclusion, the pioneer producer has proven that it is possible to integrate an OBP enterprise in Veracruz. He is now consolidating a group of producers joining him in this effort.

Key Words: Organic, Beef, Enterprise

536 Influence on weaning weights and growth rate of nursing beef calves dewormed 90 days prior to weaning. J. N. Carter*¹, M. J. Hersom², R. O. Myer¹, M. M. Brennan², M. K. Maddox¹, J. T. Matthews¹, and D. Driver², ¹*University of Florida, NFREC, Marianna,* ²*University of Florida, Gainesville.*

Winter and spring born beef calves ($n=568$; 177.7 kg \pm 34.0) at three different locations in Florida (MAR, BRU, SFE) were used to determine the effectiveness of deworming prior to weaning in order to achieve heavier weaning weights. At least three breed types were available at each location and included Angus, Brangus, Brahman, and Romosinuano. Calves were individually weighed unshrunk on d 0 and randomly assigned to treatment groups. Unshrunk BW were also obtained at a mid-point and on d 90. Treatments included no deworming (CON) or deworming (DW; doramectin injectable, 1 mL / 50 kg BW). Bahiagrass (*Paspalum notatum*) pastures were grazed at all locations; within a location, cow-calf pairs from both treatment groups were managed identically and forage allowances were monitored to minimize any potential bias due to variations in pasture conditions. Data were analyzed using Proc GLM and Proc Mixed of SAS. In the GLM procedure, data were blocked by location and treatment differences were tested using location x treatment as the error term. In Mixed, an analysis of covariance was performed with d 0 BW as the covariate; the Mixed model contained treatment as a fixed effect and the random effect was location. Within location, total gain and ADG was not different. Across all locations, DW calves gained more total weight ($P < 0.001$; 59.5 kg vs 55.0 kg) and ADG was greater ($P < 0.001$; 0.66 kg/d vs 0.62 kg/d) compared with CON. Although weight gain was greater ($P = 0.002$; 38.3 kg vs 35.5 kg) for DW calves during period 1, the difference was not as great during period 2 ($P = 0.06$; 21.1 kg vs 19.9 kg). Deworming costs averaged \$1.57/hd. DW calves returned \$1.94/hd more net revenue than CON calves when considering only the deworming product costs. Under these experimental conditions, our data indicated both an animal performance advantage and a positive ROI from deworming early. This management practice may improve the value of calves beyond that of simply more weight at

weaning. Providing a healthier calf to the stocker or feedlot with process verification of this practice may garner additional premiums.

Key Words: Beef calves, Deworming, Prewearing

537 Effect of number of feeding places per pen on performance, blood metabolites and haptoglobin during the first month of adaptation to the feedlot. L. A. González*¹, A. Ferret¹, X. Manteca¹, J. L. Ruiz-de-la-Torre¹, S. Calsamiglia¹, M. Devant², and A. Bach^{2,3}, ¹Universitat Autònoma de Barcelona, Bellaterra, Spain, ²Unitat de Remugants-IRTA, Barcelona, Spain, ³ICREA, Spain.

Seventy two Holstein female calves (104.7 ± 1.25 d of age; initial BW 110.36 ± 2.54 kg) were randomly assigned to a 3 × 3 complete block design to study the effect of the number of feeding places per pen on performance and blood profile during the first month after arrival at the feedlot. Calves were blocked by BW and treatments consisted of 1 (T1), 2 (T2) or 4 (T4) feeding places/pen (8 calves/pen). Concentrate (3 Mcal/kg ME, 16.4% CP, 20.3% NDF, DM basis) and barley straw, both fed once a day, and water were offered ad libitum and in different containers. The DMI and ADG were recorded, and blood samples were taken weekly during the first 4 weeks after arrival at the feedlot. Data were analyzed with a mixed model considering the fixed main effects, and their possible interactions, of treatment, block and week, which was the repeated measure subjected to pen nested within block by treatment interaction. Treatments affected total DMI ($P < 0.01$) and ADG ($P = 0.03$). The T1 calves ate less DM and gained less ($P < 0.05$) than T2 and T4 (3.72, 4.05 and 4.00 ± 0.07 kg DMI/d; 0.86, 1.05 and 1.05 ± 0.05 kg ADG/d, respectively). However, the gain to feed ratio was similar among treatments (0.25 ± 0.07 kg/kg). Blood haptoglobin (0.30 ± 0.08 mg/mL) and β-hydroxybutyrate (0.180 ± 0.004 mM) were not affected by the number of feeding places per pen. Non-esterified fatty acids (mM) were affected ($P = 0.006$), being lowest for T4 (0.176) compared to T2 (0.226) and T1 (0.233, SEM ± 0.01). Total blood leucocytes (10.00 ± 0.17 × 10³ cells/mL) and the neutrophile to lymphocyte ratio (0.58 ± 0.02) were not affected by treatments. The lowest number of feeding places (T1) resulted in a lower performance compared with T2 and T4. However, immune status and haptoglobin levels were not affected by increases in the number of feeding places.

Key Words: Calves, Feeding places, Performance

538 Effect of number of feeding places per pen on performance, blood metabolites and haptoglobin of Holstein heifers on high-concentrate diets. L. A. González*¹, A. Ferret¹, X. Manteca¹, J. L. Ruiz-de-la-Torre¹, S. Calsamiglia¹, M. Devant², and A. Bach^{2,3}, ¹Universitat Autònoma de Barcelona, Bellaterra, Spain, ²Unitat de Remugants-IRTA, Spain, ³ICREA, Spain.

Seventy two Holstein heifers (initial BW 138.0 ± 2.4 kg) were randomly assigned to a 3 × 3 complete block design to study the effect of the number of feeding places per pen on performance, blood metabolites and haptoglobin. Heifers were blocked by BW and treatments consisted of 1 (T1), 2 (T2) or 4 (T4) feeding places/pen (8 heifers/pen). Pelleted concentrate (3 Mcal/kg ME, 16.4% CP, 20.3% NDF, DM basis) and barley straw, both fed daily at 0800, and water were offered ad libitum and in different containers. After five weeks of adaptation, DMI and ADG were recorded at 28-d intervals during 6 periods. Blood samples were taken at 1600 of d 23, 24 and 25 of each period, for high, medium and low block of BW, respectively. Data were analyzed with a mixed model considering the fixed main effects, and their

possible interactions, of treatment, block and week, which was the repeated measure subjected to pen nested within the block by treatment interaction. Total DMI (6.76 ± 1.15 kg/d), ADG (1.24 ± 0.10 kg/d), gain to feed ratio (0.188 ± 0.031 kg/kg) and final BW (389.47 ± 3.85 kg) were not affected by treatments. Blood haptoglobin was affected by treatments ($P = 0.02$; 0.178, 0.170 and 0.157 ± 0.005 mg/mL for T1, T2 and T4, respectively). Plasma non-esterified fatty acid concentrations (0.097 ± 0.002 mM) were not affected by treatments, whereas β-hydroxybutyrate ($P = 0.05$; mM) was greater for T1 (0.281) than T4 (0.251) but similar to T2 (0.276 ± 0.009). Low feeding places per pen did not affect performance, but blood haptoglobin and β-hydroxybutyrate levels were increased.

Key Words: Heifers, Feeding places, Blood

539 Effects of ractopamine and days on feed on performance and carcass traits of calf-fed steers. C. D. Reinhardt¹, G. L. Parsons*¹, B. J. Johnson¹, J. P. Hutcheson², and W. T. Nichols², ¹Kansas State University, Manhattan, ²Intervet, Inc., Millsboro, DE.

Two-thousand sixty English × Continental steer calves (avg. 252 kg) were used in a randomized complete block study to evaluate the effects of ractopamine and DOF on performance and carcass traits. Steers were blocked by arrival time at the research facility. On each arrival d cattle were processed and randomly allotted to 6 pens of 75 to 125 head each. All steers received Revalor-IS (16 mg estradiol-17β (E₂) and 80 mg trenbolone acetate (TBA)) upon arrival and were reimplanted with Revalor-S (24 mg E₂ and 120 mg TBA) on d 75. Within each block, three pens were randomly selected to receive ractopamine at the rate of 200 mg/hd daily for the final 28 d on feed (RAC) and the remaining three were fed no ractopamine (CON). Within each treatment and block combination, pens were randomly assigned to be fed for either 181, 202, or 223 d. There were 4 reps per treatment × DOF combination for a total of 24 pens. When measured over the entire feeding period, feeding RAC increased ADG 2.7% and increased final weight 6.8 kg. There was an interaction between DOF and treatment for feed conversion ($P < 0.10$), as RAC improved G:F ($P < 0.05$) in steers fed 202 d but had no effect on steers fed either 181 or 223 d. Feeding RAC also increased HCW 4.6 kg, increased the percentage of Yield Grade 1 carcasses by 6% units and decreased the percent grading Choice by 8% units ($P < 0.05$). All other carcass measurements were similar. Additional DOF resulted in linear increases in final wt and DMI and linear decreases in ADG and G:F ($P < 0.05$). There were no interactions between treatment and DOF for carcass traits. Increasing DOF caused linear increases in dressing percentage, HCW, fat thickness, marbling score, percentage Prime combined with Choice, and Yield Grade ($P < 0.05$). Increasing DOF decreased performance and increased carcass fatness but increased carcass quality and carcass weight. Feeding RAC improved performance regardless of DOF; however, RAC had a less pronounced effect on growth in this study with calves than has been reported elsewhere using yearling steers.

Key Words: Ractopamine, Feedlot, Steers

540 Effects of ractopamine and days on feed on performance and carcass traits of yearling heifers. C. D. Reinhardt¹, J. P. Hutcheson*², W. T. Nichols², R. S. Swingle³, and K. J. Karr³, ¹Kansas State University, Manhattan, ²Intervet, Inc., Millsboro, DE, ³Cactus Research, LTD, Amarillo, TX.

English × Continental yearling heifers (n=2,252, avg. 286 kg) were used in a randomized complete block study to evaluate the effects of

ractopamine and DOF on performance and carcass traits. Heifers were blocked by arrival time at the research facility. On each arrival d cattle were processed and randomly allotted to 6 pens of 91 to 97 hd each. Within each block, three pens were randomly selected to receive ractopamine at the rate of 200 mg•hd⁻¹•d⁻¹ for the final 28 d on feed (RAC) and the remaining three were fed no ractopamine (CON). Within each block and treatment combination pens were randomly assigned to be fed for either 129, 150, or 171 d. All heifers were implanted with Revalor-IH (8 mg estradiol-17β (E₂) and 80 mg Trenbolone acetate (TBA)) on arrival and re-implanted with Revalor-200 (20 mg E₂ and 200 mg TBA) on d 75. There were 4 reps per treatment × DOF combination for a total of 24 pens. When measured over the entire feeding period, feeding RAC increased final BW 8.5 kg and G:F 2.0%. Feeding RAC tended (*P* < 0.15) to increase HCW and REA. All other carcass measurements were similar. Additional DOF had a significant (*P* < 0.05) effect on final BW, ADG, G:F, dressing percentage, HCW, Yield Grade distribution, and marbling score. There were interactions (*P* < 0.10) between treatment and DOF for ADG and dressing percentage. Feeding RAC improved some performance parameters regardless of DOF. Increasing DOF decreased performance but resulted in increased carcass weight and marbling score.

Key Words: Ractopamine, Feedlot, Heifers

541 Effect of Optaflexx and days on feed on muscle gene expression in calf-fed steers. G. L. Parsons^{*1}, S. J. Winterholler¹, C. D. Reinhardt¹, J. P. Hutcheson², D. A. Yates², W. T. Nichols², and B. J. Johnson¹, ¹Kansas State University, Manhattan, ²Intervet Inc., Millsboro, DE.

Calf-fed steers (n=2060, 252 kg) were used to determine the effects of Optaflexx and days on feed on finishing performance and carcass characteristics. Treatment consisted of serial harvest dates 181, 202, or 223 d. Within each harvest group, steers received either (200 mg/hd daily of ractopamine-HCl) for the final 28 days, or a control diet consisting of no Optaflexx. All steers were implanted with Revalor-IS (80 mg trenbolone acetate 16 mg estradiol) at processing (d 0), and Revalor-S (120 mg trenbolone acetate and 24 mg estradiol) at 75 days on feed (DOF). At harvest, samples were taken from the inside round for analysis of IGF-I and the β-adrenergic receptors (AR) mRNA abundance. Four samples per treatment per DOF group totaling twenty-four samples were analyzed. Days on feed did not increase abundance of β₁-AR (*P* ≥ 0.38), β₂-AR (*P* ≥ 0.89), β₃-AR (*P* ≥ 0.90) mRNA, but numerically increased the abundance of IGF-I levels (*P* = 0.21). Addition of Optaflexx had no effect on expression of IGF-I and β-adrenergic receptors (βAR). The data obtained from these calf-fed steers contradict results obtained from older yearling steers in which expression of β₂-AR mRNA increased with advanced DOF. Increased understanding of receptor abundance related to DOF and age may explain some response differences in calf-feds vs. yearlings.

Key Words: Skeletal muscle, β-Adrenergic receptors, Steers

542 Effect of optaflexx™ and days on feed on feedlot performance, carcass characteristics, and skeletal muscle gene expression in yearling steers. S. J. Winterholler^{*1}, G. L. Parsons¹, J. P. Hutcheson², D. A. Yates², W. T. Nichols², R. S. Swingle³, and B. J. Johnson¹, ¹Kansas State University, Manhattan, ²Intervet, Inc., Millsboro, DE, ³Cactus Research, LTD, Amarillo, TX.

Yearling steers (n=2,252; avg. 314 kg) were used to evaluate the effects of Optaflexx™ and d on feed on finishing steer performance and carcass characteristics. This study utilized a randomized complete block with a 3×2 factorial arrangement. Treatment groups included serial harvest dates of 150, 171, or 192 d. Within harvest date, steers either received Optaflexx (200 mg/steer daily of ractopamine-HCl) for the final 28 d, or did not receive Optaflexx. All steers were initially implanted with Revalor-IS and were re-implanted with Revalor-S after 75 d on feed. At harvest, muscle samples from the inside round were obtained for analysis of β-adrenergic receptor (AR) mRNA levels. Optaflexx increased daily gains, hot carcass weight, ribeye area, and G:F (*P* ≤ 0.05). Optaflexx did not affect dressing percent, USDA yield grade, or quality grade (*P* > 0.3). There was no change in overall feed intake across the entire feeding period; however, feed intake was increased during the 28-d period that steers were fed Optaflexx (*P* 0.05). As expected, greater d on feed decreased daily gains, overall feed intake, the number of yield grade 1 and 2 carcasses, and G:F (*P* ≤ 0.05). Also, greater d on feed increased hot carcass weight, dressing percent, and the number of prime and choice carcasses, as well as the number of yield grade 4 and 5 carcasses (*P* ≤ 0.05). Increasing d on feed decreased the abundance of mRNA for β₁-AR and β₃-AR, and increased the abundance of β₂-AR mRNA (*P* ≤ 0.05). Optaflexx had no effect on abundance of mRNA for β₁-AR, or β₃-AR, but it increased the abundance of mRNA for β₂-AR (*P* = 0.09). Further studies with primary muscle cell cultures revealed that advancing time in culture increased the β₂-AR mRNA (*P* ≤ 0.01) but had no effect (*P* > 0.10) on β₁-AR or β₃-AR mRNA. These data suggest that d on feed and Optaflexx are affecting βAR mRNA levels which could in turn impact the response to Optaflexx feeding in cattle.

Key Words: β-adrenergic receptors, Ractopamine, Steers

543 Evaluation of a single Revalor-200 compared to Revalor-IH and Finaplix-H in a reimplant program for finishing heifers. C. D. Reinhardt^{*1}, J. P. Hutcheson², and W. T. Nichols², ¹Kansas State University, Manhattan, ²Intervet, Inc., Millsboro, DE.

Data from 3 studies utilizing 2,417 head of feedlot heifers (avg. BW=273, 248, and 283 kg for studies 1, 2, and 3) and 17 pen replicates per treatment were pooled to evaluate the use of Revalor-200 (20 mg estradiol 17-β (E₂) and 200 mg trenbolone acetate (TBA); R200) in a single implant program and Revalor-IH (8 mg E₂ and 80 mg TBA) followed by Finaplix-H (200 mg TBA) in a reimplant program (IHFH). All studies were conducted at a common research facility feeding similar diets using heifers of similar background. Heifers were randomized to treatments within each study. For studies 1, 2, and 3 heifers were fed for 171, 193, and 182 d and IHFH-treated heifers were reimplanted on d 68, 47, and 58, respectively. There were no differences in performance or Yield Grade between implant treatments, but compared to heifers receiving IHFH, those receiving R200 did have lower marbling score and percentage grading Choice (*P* < 0.10). These studies indicate that although implanting heifers with Revalor-200 initially provided similar growth performance compared to using 2 lower dosage implants sequentially in a reimplant program, these data also provide evidence that use of a higher dosage implant on arrival

in lightweight heifers may adversely affect the relationship between marbling and external fatness.

Table 1. Effects Rev200 vs IHFH on Performance and Carcass Traits

Trt	ADG, kg	G:F	HCW, kg	YG	MarbScore ¹	%Ch
IHFH	1.36	0.187	330	2.85	417 ^a	48 ^a
R200	1.39	0.187	333	2.87	407 ^b	40 ^b

¹ 400=Small⁰; 500=Modest⁰; ^{a,b} Columns without common superscripts differ ($P = 0.07$).

Key Words: Anabolic implants, Trenbolone acetate, Feedlot

Breeding and Genetics: Phylogenetics and Genetic Diversity

544 An overview of phylogenetics. M. Cronin*, *University of Alaska, School of Natural Resources and Agricultural Sciences, Fairbanks.*

Phylogeny generally refers to the genealogy of a group of organisms. For example, the phylogeny of the ruminants would include all of the ancestors, including the common ancestor, of the extant species of cattle, sheep, goats, deer, etc. In this paper, I present basic concepts of phylogenetics, and give examples of phylogenies of domestic and wild species above and below the species level. Taxonomic classifications are based on phylogenetic relationships, which can be inferred from paleontology, morphology, or genetics. Phylogeny can also be inferred for genes, as the genealogy of genes derived from a common ancestral gene. Gene phylogenies and species phylogenies are not always concordant for a variety of reasons. It is also important to recognize that phylogenetics is an historical science, and phylogenetic relationships can only be inferred. Nevertheless, phylogenetic inference has become a rigorous science, with important empirical and theoretical advances in the last few decades. The phylogeny of the horse, including ancestors with progressively decreasing numbers of toes over time, is an example of classical phylogenetic inference from fossils and morphology. The advances of molecular genetics have greatly enhanced and expanded phylogenetic inference from DNA sequences. In general, DNA sequences are assumed to evolve as a function of time, and similarity of sequences indicates recent common ancestry. However, is important to understand the factors affecting molecular sequences that may invalidate this assumption, including linkage, selection, modes of inheritance, lineage sorting of ancestral alleles, and gene duplication. The importance of distinguishing molecular sequence data from gene frequency data is also discussed. Examples are given of mitochondrial DNA (mtDNA) and nuclear DNA sequences that have been used to infer relationships of taxa at the levels of family, genus, species, and intra-species. At the level of higher taxa, the phylogeny of artiodactyls (even toed ungulates) has been inferred from molecular sequences for several genes. This includes the relationships among artiodactyls including non-ruminants (e.g. pig), ruminants (e.g., cattle sheep, deer), and more distantly related groups (e.g. whales). At the level of species, subspecies, and breeds, examples of cattle, bison, and several deer species are described. This includes groups in which molecular phylogenies are discordant with classical understanding of relationships from morphology, distribution, and natural history. The phylogenies of some domestic and wild ruminants are compared, and the concepts of wild subspecies and domestic breeds are discussed.

Key Words: Phylogenetics, Genealogy

545 Measuring diversity among breeds and populations. P. W. Hedrick*, *Arizona State University.*

There are a number of new genetic markers and approaches that can be used to measure and evaluate genetic diversity among different breeds and among populations of a breed. I will first evaluate the relative merits of different types of markers for these purposes, including microsatellite loci, mtDNA variants, SNPs, and QTLs. I will then discuss various approaches to measure the pattern of diversity among and within breeds, including FST, genetic distance, assignment, and clustering. The comments about these markers and approaches will be illustrated with data from recent studies in various cattle breeds.

Key Words: Microsatellite loci, FST, Clustering

546 Applications of phylogenetic inference to livestock science. A. R. Freeman*, *Smurfit Institute, Trinity College Dublin, Dublin, Ireland.*

The phylogenetics of domestic animals are profoundly influenced by domestication. The gene pools which these species possess today are the result of episodes of capture and taming of the wild progenitors which were restricted both spatially and temporally. In this presentation I will outline some of the wide-ranging applications of phylogenetics with reference to livestock science. More specifically, I will show how well-constructed phylogenies can be use to test varying hypotheses about the history of a population. Firstly, livestock species are not genetically homogenous, but rather are usually the result of two or several separate episodes of domestication. These scenarios have been confirmed by mitochondrial DNA phylogenetic analysis in many species. Secondly, phylogenies describe patterns of diversity which reflect both the history and biology of a species. In the case of a domesticated species, the number of original wild founders that created the population, the diversity levels in the wild ancestral populations, continual introgression from wild relatives and hybridization can affect the diversity levels in the modern population. Thirdly, the relationship between different breeds within a species may be clarified with careful interpretation of phylogenetic data. Finally, and perhaps most interestingly, different selection pressures acting in the two populations can also result in divergence at particular genetic loci which can be detected using phylogenetics. These loci are likely to relate to traits that have been selected in particular breeds, but also to the historical disease challenge that a species has faced. Thus, identification of these loci that show signatures of natural selection

is likely to be critical in understanding differences between breeds in terms of productivity and disease resistance.

547 Current efforts in conservation of animal genetic diversity. H. Blackburn*¹ and D. Bixby², ¹ARS-National Animal Germplasm Program, Ft. Collins, CO, ²American Livestock Breeds Conservancy, Pittsboro, NC.

Changing consumer demand, threat of disease, and contraction of genetic diversity drive the need to establish vibrant livestock conservation activities. For effective in-situ and ex-situ conservation strategies to function, dialog and synergetic action between public and private sectors must occur. This type of interaction exists and provides a basis for the operation of the National Animal Germplasm Program (NAGP), the American Livestock Breeds Conservancy (ALBC), other non-governmental organizations, and livestock breeders. Both NAGP and ALBC have increased the security of genetic diversity for a number of rare, minor and major livestock breeds in the US. In-situ security has improved with ALBC efforts to increase breed population size for 21% of the breeds in Critical/Threatened/Watch conditions between

1977 and 2005. These 16 breeds are now in the Recovering category. Since 1999, NAGP has developed an ex-situ collection of germplasm of approximately 250,000 units of semen, embryos and blood from 104 major, minor and rare breeds of cattle, sheep, goats and pigs. A key element in the public-private sector dialog is the collection, evaluation and utilization of information. Information such as, population census data, pedigrees, and number of breeders raising a breed have been collected and utilized to varying degrees. This information can serve as a basis for dialog and actions by the public and private sector. While some information is available for some breeds, the US has not fully engaged its capacity to measure genetic diversity by using molecular information. Such information would greatly add to the ability to assess diversity levels and contribute to decisions concerning conservation strategies. Additionally phenotypic assessments of many US rare and minor breeds are out of date and not relevant to populations today. This information void could dampen consumer demand for niche products as well as the effort to explore for unique genes and gene combinations. While conservation activities to date have strengthened genetic security, there are still significant knowledge, information and collection voids.

Key Words: Genetic diversity, Livestock conservation

Dairy Foods: Cheese II

548 Effect of mountain and sea level pasture on monoterpene composition in milk, curd and Ragusano cheese at 4 and 7 months of aging. S. Carpino*¹, T. Rapisarda¹, and G. Licitra^{1,2}, ¹CoRFiLaC, Regione Siciliana, Ragusa, Italy, ²D.A.C.P.A. Catania University, Catania, Italy.

Dynamic headspace extraction (P&T) (Tekmar 3100) in combination with GC/MS using chiral stationary phase was employed to analyze the monoterpene composition of milk, curd (during cheese making), and cheese at 4 and 7 months aged from a farm of the Hyblean region sited on mountain level (ML) in Spring 2004. In farm ML we had three groups of Holstein cows (10 per group): group 1 fed TMR (ML0) no pasture; group 2 fed TMR supplemented with 30% DM of pasture (ML30), and group 3 fed TMR supplemented with 70% DM of pasture (ML70). Another farm sited on sea level (SL) was also tested. In this farm we selected only one group of Holstein cows, at similar lactation days and milk production level to the ML farm, fed TMR supplemented with 30% DM of pasture (SL30). The aim of this work was to study the impact of different level of pasture in the diet and the farm location on monoterpenes profile. A total of 16 milk and curd samples and 32 cheeses were analyzed. The general monoterpenes composition detected in ML0 showed significant lower level compared with the ML30 and ML70 samples. The general terpene composition of samples obtained from mountain level (ML) farm was more abundant than the samples from sea level (SL). The monoterpene composition showed compounds like (-)- β -pinene, (+)-d-limonene, (+)- α -pinene in common between the ML30 and SL30 samples. It is important to note that some exclusive compounds were detected in ML samples: β -myrcene, (+)-sabinene, (-)-d-limonene, (+) δ -3-carene (ML), (+)- β -pinene, (+)- α -terpinolene, α -terpinene instead (-) Camphene was exclusively detected in the SL samples. These results indicate that the altitude may influence the type of pasture and the terpene profile that are transferred directly to the dairy products. The terpene composition, in fact, in dairy products depends on the type of pasture and therefore on the territory and its relative macroclimate. These compounds might be useful

and used as valuable biomarkers for dairy products with Protected Designation of Origin.

Key Words: Ragusano cheese, Pasture, Monoterpene composition

549 Characterization of calcium lactate crystal growth on Cheddar cheese. P. Rajbhandari* and P. S. Kindstedt, *University of Vermont, Burlington.*

Previous research demonstrated that the total area collectively occupied by calcium lactate crystals on Cheddar cheese surfaces increased during storage in approximately linear manners but at different rates for different cheese samples. Evidence of substantial migration of calcium and lactate ions from cheese interior to surface during surface crystal growth was also observed. The objective of the present study was to characterize the growth of individual calcium lactate crystals on the surface of Cheddar cheese during refrigerated storage. A random weight (ca. 300g) retail sample of naturally smoked Cheddar cheese exhibiting white surface crystals was obtained from a commercial source. The sample was stored at 4°C for 30 weeks and a digital photograph was taken of one of the surfaces (ca. 55x120mm) at 3 wk intervals. The total area occupied by crystals on the photographed surface was measured at 3 wk intervals using image analysis. In addition, five small (ca. 0.3 mm radius) individual crystals on the first photographed surface were chosen for observation over the 30 wk period. The crystals were evaluated for area, radius and shape factor (circularity) every 3rd week using image analysis. The area collectively occupied by crystals on the photographed surface increased in a linear manner ($R^2=0.95$) from about 0.44% to 7.42% of the total surface area over the 30 wk period. Throughout this period, the shapes of the five individual crystals closely approximated perfect circles, and the area occupied by each of the five crystals increased in a near linear manner ($R^2=0.85-0.96$). The radii of each of the 5 crystals increased in a non-linear manner that conformed most closely to a second order

polynomial relationship ($R^2=0.84-0.97$). The rate of increase in crystal radii decreased over time as the crystals grew larger and occupied greater area. The data are consistent with the hypothesis that crystal growth occurs in 2 stages, the first governed primarily by the level of supersaturation of calcium lactate in the serum phase and the second by the rate of migration of calcium and lactate ions through the serum phase from the cheese interior to the surface.

550 Influence of emulsifying salts on functionality of sliced process cheese. N. Shirashoji*, T. Abe, K. Takahashi, and K. Iwatsuki, *Food Research & Development Laboratory, Morinaga Milk Industry Co., Kanagawa, Japan*.

Sliced process cheese (PC) is produced using a chill roll apparatus, which enables hot cheese to quickly cool as it revolves over a cold drum. Viscosity of hot melted cheese and tensile strength of the cooled cheese sheet are key characteristics in PC processing with a chill roll apparatus. Model pasteurized PC slices were prepared from Cheddar cheeses with 2.5% of various types of emulsifying salts (ES); trisodium citrate (TSC), disodium phosphate (DSP), tetrasodium pyrophosphate (TSPP) and sodium hexametaphosphate (SHMP). Cheese mixture was heated at 86°C using a Stephan cooker. Hot melted cheeses were poured into thin plastic bags and rolled to a thickness of 2 mm. Moisture content of model PC was 46%, which is common for pasteurized sliced PC in Japan. A modified Bostwick-type consistometer was used to determine the flowability of hot melted cheeses immediately after cooking. A burst test which is a large deformation test using a ball probe was performed to create a texture map of the PC slices made with different types of ES. Peelability of PC measured by a Yamaden creep meter was also evaluated as a textural property. Melting properties were analyzed using the Schreiber test. Water soluble protein as a % of total protein of cheese was measured. PC made with TSPP exhibited the lowest flow and meltability. There was no significant difference between TSC cheese and DSP cheese for flow and meltability. The texture map demonstrated that there were no significant differences in the burst stress of TSC and DSP cheeses. However, there were significant differences ($P < .0001$) in burst strain. TSPP and SHMP cheese had good peelability values, while TSC cheese and DSP cheese had poor peelability. There were large amounts of water soluble protein in TSC and DSP cheese (95% and 85%, respectively), while lower levels were observed in TSPP and SHMP cheeses. Water soluble protein levels may be related to the peelability of PC slices. This study indicated that different types of ES influenced the characteristics of PC that were important for use on a chill roll apparatus.

551 Quantitative analysis of cheese microstructure by scanning electron microscope images. M. Caccamo*¹, G. Impoco², L. Tuminello¹, and G. Licitra^{1,3}, ¹CoRFiLaC, Regione Siciliana, Ragusa, Italy, ²D.E.E.I. Trieste University, Trieste, Italy, ³D.A.C.P.A., Catania University, Catania, Italy.

Image analysis may represent a powerful tool to accurately quantify and rapidly process digital pictures from high-resolution images by scanning electron microscope (SEM). Nine traditional Sicilian cheese varieties, five pressed and four pasta filata, were observed by SEM to quantitatively characterize the porosity of their microstructure. Freeze-fracture sampling procedure according to McManus et al. (1993) was used. Ten sequential images, from two random fields of each specimen, were recorded at 500X and 1000X in order to obtain a more complete observation of the microstructure of each cheese. The obtained images were then analyzed using a Java language tool written

as a plug-in of the ImageJ software. Gray-scale images were binarized using the threshold function, after having applied specific filters to remove noise, and alterations produced by the acquisition system. Images were firstly processed using a despeckle and then a Gaussian smoothing filter to remove noise. A further band-pass filter was applied to flatten lighting effects by cutting off high and low frequencies. A radius one erode filter before and a dilate-filter after thresholding were finally applied to regularize the pore shape and enhance borders. The processed images were then automatically measured to calculate microstructure porosity. No significant differences were found among the different magnitude factors. Pressed cheeses showed higher overall porosity ($P < 0.01$) than pasta filata cheeses, 0.15 vs. 0.24. Among the pressed cheeses it was observed a significant ($P < 0.01$) porosity variation ranging from 20.7% for Maiorchino, 16 mo aged hard cheese, to 29.8% for Fiore Sicano, 1 mo aged soft cheese. Similar porosity variation was observed on pasta filata cheeses, ranging from 11% for Provola dei Nebrodi, 3 mo aged semi-hard cheese, to 22% for Ragusano cheese, 9 mo aged. Three-dimensional analysis through X-ray microtomography could be used to further study without altering the internal microstructure of cheeses.

Key Words: Sicilian cheeses, SEM, Quantitative image analysis

552 Predicting curd moisture content, whey fat concentration and curd yield from near infrared light backscatter. C. C. Fagan¹, M. Leedy², M. Castillo*², F. A. Payne², C. P. O'Donnell¹, and D. J. O'Callaghan³, ¹University College Dublin School of Agriculture, Dublin, Ireland, ²University of Kentucky, Lexington, ³Moorepark Food Research Centre, Teagasc, Fermoy, Cork, Ireland.

Cheese yield and quality are strongly affected by milk coagulation conditions, syneresis kinetics, and the extent of whey separation. Prediction of important cheese making performing parameters using inline measurements of milk coagulation and curd syneresis could play a decisive role in optimizing cheese processing efficiency and profits. The objective of this study was to determine if several frequently used cheese making efficiency metrics such as curd yield, whey fat concentration and curd moisture content could be predicted using optical parameters concurrently obtained during milk coagulation and syneresis from a large field of view (LFV) light backscatter sensor. A wide range of both coagulation and syneresis rates were tested at different levels of temperature and calcium chloride addition. Cutting time was an additional experimental factor in order to evaluate the impact of gel properties at cutting on cheese making efficiency. A three-level factorial, central composite rotatable design ($\alpha=1.682$) with two start points and six replicates of the center point was chosen for this experiment. This experimental design allowed for the estimation of curvature and detection of levels at which the experimental factors will minimize/ maximize the efficiency metrics. The experiment was randomly replicated three times. Curd and whey samples were removed from the cheese vat at 10 min intervals during syneresis up to 85 min after cutting. Whey fat, total solids of both curd and whey, and curd yield were determined. Several optical parameters describing the rate of coagulation and/ or syneresis were found to be correlated to the cheese making metrics studied, allowing the prediction of curd yield, whey fat concentration and curd moisture content using light backscatter parameters from the LFV sensor. These results support the potential of the proposed technology for in-situ monitoring of coagulation and syneresis using a single sensor, which would result in improved cheese manufacture process control.

Key Words: Sensor, Light backscatter, Syneresis

553 Development and application of an image analysis method to measure and characterize calcium lactate crystals on uncolored Cheddar cheese. P. Rajbhandari* and P. S. Kindstedt, *University of Vermont, Burlington.*

Previous research demonstrated that image analysis can accurately and precisely measure the area occupied by calcium lactate crystals on the surface of smoked Cheddar cheese. Naturally smoked cheese is well suited for image analysis because the dark discolored smoked surface contrasts sharply with white calcium lactate crystals. Uncolored cheese is more problematical because of insufficient contrast between crystal and background. The objective of this study was to modify the previous image analysis method to measure calcium lactate crystals on uncolored Cheddar. Combinations of image contrast and sharpening settings of the digital camera and light options were systematically evaluated to identify settings that optimized the contrast between white crystals and the straw colored cheese background. Five replicate analyses of an uncolored cheese surface containing crystals were performed using the modified settings. The area occupied by crystals was determined to be $4.85 \pm 0.16\%$ of total surface area. The coefficient of variation of 3.26% was comparable to repeatability measurements previously reported for smoked Cheddar. The thresholding error (error of underestimation) for the 5 replicate measurements was 0.05%, which was less than that previously reported with smoked Cheddar. Thus, the efficacy of the revised image analysis method was comparable to that of the original method. The revised method was used to evaluate crystal growth on a smoked surface and a non-smoked (uncolored) surface, respectively, from the same Cheddar cheese sample that was stored for 10 wk under conditions chosen to accelerate crystal growth (1°C, loose packaging). The percentage of total surface area occupied by crystals increased in a non-linear manner from 0 to ca. 4.5% for both smoked and non-smoked surfaces. The pattern of area increase for both smoked and non-smoked surfaces conformed most closely to a second order polynomial relationship ($R^2=0.97-0.98$). Thus, crystal growth on uncolored cheese was effectively quantified using the revised image analysis method.

554 Computer vision analysis to monitor syneresis of cheese curd in a cheese vat. C. D. Everard*¹, C. P. O'Donnell², C. C. Fagan², D. J. O'Callaghan¹, M. Castillo³, and F. A. Payne³, ¹*Teagasc, Moorepark Food Research Centre, Fermoy, Co. Cork, Ireland,* ²*University College Dublin, Dublin, Ireland,* ³*University of Kentucky, Lexington.*

Syneresis, which follows the cutting of milk coagulum into cubes and is promoted by stirring, is the main phase separation process in cheese making. The extent of syneresis influences cheese quality as a result of its effect on moisture, mineral and lactose content of curd. The kinetics of curd syneresis is complex and there are no technologies currently available for monitoring it. The objective of this study was to investigate image analysis techniques for monitoring syneresis as a means of improving the control of curd moisture content in cheese making. The visual effect of syneresis during the curd agitation phase was monitored in a ten-litre cheese vat using a computer vision system in which curd and whey were distinguished by means of colour differences. The proposed monitoring system was evaluated within a wide range of curd syneresis kinetics using a completely randomized factorial design combining two levels of milk pH and two curd agitation speeds. Whey was found to have a filtering effect on light reflectance. As syneresis progressed, the reflected light became increasingly yellow in hue for circa 20 min., after cutting the gel. The changes leveled off after circa 30 min. Colour differences were found to be in proportion to percentage of whey expressed from the curd ($R^2 = 0.99$, $P < 0.001$). The results obtained show that a computer vision system could be used for monitoring syneresis. The proposed method would allow improving the control of the curd moisture content before ripening, which would decrease the production of down-graded ripened cheese.

Key Words: Computer vision analysis, Image analysis, Syneresis

International Animal Agriculture: Alternatives to Antibiotics if Feeding Ruminants for Optimal Production and Health

555 Differing objectives and key target microbes for manipulation of ruminal fermentation. R. J. Wallace*, *Rowett Research Institute, Bucksburn, Aberdeen, United Kingdom.*

The main objectives of manipulating ruminal fermentation have changed with time, and are different in different parts of the world. In North America, the emphasis remains on production efficiency, so avoidance of high-input problems like acidosis and high protein breakdown have greatest priority. In Europe, health issues, both in animals and man, which are associated with animal production have in recent years taken precedence over production efficiency. In Australasia, the environmental consequences of ruminant production, particularly methane formation, have received much recent attention. And in the developing world, priority is inevitably on making the most of scarce resources of low nutritive value. Paradoxically, the objectives of the different systems often have similar microorganisms as their target. For example, if methane formation were to be inhibited, not only would the emission of a greenhouse gas be decreased, but production efficiency would be increased. Thus, targeting methanogenic archaea

may have both environmental and efficiency benefits in both low- and high-input systems. Decreasing the bacteriolytic activity of ciliate protozoa would improve nitrogen retention in low-input systems scarce in N as well as enabling lower protein inputs into high-production systems that release environmentally damaging amounts of N to the environment. In terms of human health, minimising the biohydrogenation of unsaturated fatty acids to stearate by controlling key *Butyrivibrio*-related bacteria will, it is hoped, lead to ruminant products with a healthier fatty acid profile. Control of *Escherichia coli* is a high priority in all production systems. The means available to achieve the desired manipulations also vary geographically. Ionophores and antibiotics can still be used in North America but they are not permitted in Europe and are beyond the means of farmers in the developing world. Thus, natural products, including plants and their extracts, are increasingly being investigated throughout the world as potentially cheap, environmentally friendly means of manipulating ruminal fermentation.

Key Words: Manipulation, Rumen, Fermentation

556 The use of yeast-based probiotics to meet new challenges in ruminant production. C. Newbold* and A. Olvera-Ramirez, *Institute of Rural Science, University of Wales, Aberystwyth, Wales, UK.*

The importance of rumen fermentation in governing the response of productive ruminants to dietary changes is well accepted and considerable efforts have been made to understand and ultimately manipulate the rumen microbial population to improve animal productivity. However, the targets for manipulation are changing and no longer can the productivity of the animal be considered in isolation. There is a growing awareness of the health, safety and environmental issues associated with animal agriculture. Thus while numerous studies have investigated the use of yeast cultures based on *Saccharomyces cerevisiae* to stimulate ruminant production in both growing and lactating animals, our recent studies have investigated the role of *S. cerevisiae* in limiting pathogen passage through the rumen and linking this to microbial changes therein. Some, but not all, strains of yeast inhibited the growth and survival of *Escherichia coli* H0157 and *Listeria monocytogenes* in both batch cultures and rumen simulating fermentors. In sheep supplemented with *S. cerevisiae* the flow of pathogens from the rumen decreased by up to 50%. This decreased flow of pathogens was associated with a more than doubling in the total bacterial population and an even greater increase in the numbers of cellulolytic bacteria that could be recovered from the rumen. There is increasing agreement that the ability of yeast to remove oxygen from the rumen is at least partially responsible for the stimulation in bacterial numbers when yeast is fed. We have shown in vitro that some bacteria such as *Selenomonas ruminantium*, *Megasphaera elsdenii* and *Fibrobacter succinogenes* are both the most sensitive to oxygen and are stimulated by yeast addition while others such as *Streptococcus bovis* are neither oxygen sensitive nor stimulated by yeast. When the bacterial population in the sheep used above was examined by molecular profiling it was clear that while yeast causes a shift in the type of bacteria within the rumen the exact response varied between animals. We are currently investigating this shift in bacteria diversity and its relationship to pathogen survival in more depth.

Key Words: Yeast, Probiotic, Rumen

557 Use of essential oils and other plant extracts to modify rumen fermentation. S. Calsamiglia*, M. Busquet, L. Castillejos, P. W. Cardozo, and A. Ferret, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Ionophore antibiotics have been very effective in improving the efficiency of energy and N utilization in ruminants. However, the use of in-feed antibiotics in the EU has been banned. Some plant secondary metabolites (which include saponins, tannins, and essential oils) are able to modulate microbial activity, but scientific evidence of their effects and mechanisms of action on rumen microbial fermentation is limited. Saponins have been shown to have antiprotozoal effects resulting in reduced ammonia N concentration and increased flow of microbial protein. Results indicated that garlic oil, cinnamaldehyde (main active component of cinnamon oil), thymol (active component in thyme and oregano oils), eugenol (main active component of clove buds), capsaicin (active component of hot peppers) and anise oil, among others, may improve the efficiency of energy (by increasing total VFA or propionate, and/or reducing acetate or methane production) and protein utilization (by modifying proteolysis, peptidolysis and/or

deamination) in the rumen. However, the effects of some of these essential oils are pH and diet dependent, and its use may only be beneficial under specific conditions and production systems: for example, while eugenol may improve energy and protein utilization in the rumen of lactating animals (high fiber diets, high pH), the fermentation profile does not support its use for beef cattle diets (high concentrate, low pH). In contrast, capsaicin appears to have little benefit for dairy cattle, while changes observed in beef cattle may improve the efficiency of energy and protein utilization. Because plant extracts may act at different levels in energy and protein metabolism, their careful selection and combination may provide a useful tool to effectively manipulate rumen microbial fermentation. However, data on their effects on animal performance is limited or non-existing. Scientific evidence for their effect on rumen microbial fermentation, the potential synergism and animal performance will be discussed.

Key Words: Plant extracts, Rumen fermentation

558 Immunisation to manage fermentative acidosis and methane production. J. B. Rowe*, *Australian Sheep Industry Cooperative Research Centre, Armidale, NSW, Australia.*

Increasing concern about the use of antibiotics and chemicals in animal production makes use of the immune system to help manage fermentation in the digestive tract an attractive option. This paper describes progress in use of the immune system to address two problems of modern animal production. Methane from ruminant animals is regarded as a major contributor to greenhouse gases and its reduction is an important goal. Acidosis from fermentation of starch and soluble plant carbohydrates poses a serious risk to animal health in ruminant production systems based on use of grain and/or rapidly growing pastures. Immunisation with methane or lactic acid producing organisms have been shown to change patterns of fermentation in the rumen and colon. Immunisation against key methanogens has induced levels of antibodies capable of inhibiting methane production under in vitro fermentation. Sustained in vivo inhibition of methanogenesis is the subject of on-going research. Rumen protozoa harbor methanogens and immunisation against these organisms is also a target in the quest to reduce methane production. *Streptococcus bovis* and *Selenomonas ruminantium* appear to play a critical role in the transition from stable volatile fatty acid (VFA) production and neutral pH (6.5 to 7.0) on roughage diets to production of lactic acid and low pH with introduction of grain. Immunisation against these bacteria has been shown to reduce lactic acid production and maintain higher pH in sheep and cattle subjected to carbohydrate overload. The model of carbohydrate overload is important in testing efficacy. Extreme carbohydrate overload, suitable for study of the pathophysiology of fermentative acidosis, does not appear to involve *S. bovis* or *S. ruminantium* and such challenges are not effectively controlled by immunisation. In experimental models based on natural intake of grain, or administration of a single dose, immunisation has been shown to reduce lactic acid accumulation, maintain higher pH and higher levels of feed intake. Long term effects of immunisation are suited to protection against sporadic risk and management of life-time production.

Key Words: Immunisation, Acidosis, Methane

Lactation Biology: Local Control of Mammary Function

559 Regulation of gene expression in the bovine mammary gland by ovarian steroids. E. E. Connor^{*1}, M. J. Meyer², R. W. Li¹, M. E. Van Amburgh², Y. R. Boisclair², and A. V. Capuco¹, ¹*Bovine Functional Genomics Laboratory, USDA-ARS, Beltsville, MD*, ²*Cornell University, Ithaca, NY*.

It is well established that estrogen is required for mammary epithelial cell proliferation and ductal development in the growing animal, and that lobuloalveolar development during gestation is dependent upon progesterone. Effects of these steroid hormones on gene expression in the mammary gland are mediated primarily by their respective nuclear hormone receptors that function as hormone-bound transcription factors. To gain insight into how estrogen and progesterone regulate mammary gland growth and function in cattle, we and others have characterized the expression patterns of their cognate receptors in bovine mammary gland throughout development, pregnancy and lactation. This work has identified a lack of expression of ER beta and a greater abundance of PR during lactation in bovine mammary gland versus the rodent gland. We speculate that interactions among the ER isoforms that regulate PR expression may contribute to these species differences. Further, demonstrated expression of substantial quantities of ER within the prepubertal bovine mammary fat pad, along with coordinated IGF-1 expression, suggests this tissue may stimulate parenchymal growth via an estrogen-responsive paracrine mechanism. In addition, the recent availability of bovine genomic sequence information and microarray technologies has permitted the study of global gene expression in the mammary gland in response to the steroid environment. We have identified >100 estrogen-responsive genes of which the majority were not previously reported to be estrogen-responsive. Estrogen-induced changes in gene expression were consistent with increased mammary epithelial cell proliferation, increased extracellular matrix (ECM) turnover in parenchyma, and increased ECM deposition in the fat pad. A comparison of estrogen-responsive genes in the mammary glands of humans, mice and cattle suggests considerable variation among species, as well as potential differences in regulatory elements in common ER gene targets. Continuing studies using advanced molecular techniques should assist in elucidating the complex regulation of mammary function at the transcript level.

Key Words: Gene expression, Steroid hormones, Mammary function

560 Dynamics of lactogenic hormone induced recruitment of transacting-factors to a milk protein gene promoter. E. Kabotyanski¹, M. Rijnkels^{*2}, M. Huetter¹, and J. M. Rosen¹, ¹*Baylor College of Medicine, Houston, TX*, ²*ARS /USDA Children's Nutrition Research Center, Houston, TX*.

The main goal of this work is to understand the mechanisms by which hormones and growth factors regulate mammary gland development and lactation. We study the mechanisms by which the lactogenic hormones hydrocortisone (HC) and prolactin (P) regulate milk protein gene expression. We investigated the dynamics of assembly of the different transacting-factors and co-activators that mediate beta-casein (b-CSN) expression (CAAT/enhancer binding protein beta (C/EBP-beta), Yin Yang-1 (YY-1), signal transducers and activators of transcription 5 (STAT5), glucocorticoid receptor (GR), and p300) as well as the histone acetylation status at the hormonally induced endogenous b-CSN promoter and enhancer (BCE, -6kb) in murine mammary epithelial cells (HC11), using Chromatin Immunoprecipitation (ChIP) analysis. P stimulates the recruitment of STAT5

to the promoter and BCE, but HC+P are needed for expression and synergistically increase STAT5 recruitment. P and the recruitment of STAT5 result in the loss of YY1 bound at the promoter correlating with the relief of repression of b-CSN expression. HC stimulates the recruitment of GR to the promoter but is not enough to initiate b-CSN expression. P and STAT5 recruitment enhance GR presence on the promoter and are required for b-CSN expression. Each hormone separately increases recruitment of C/EBP with an additive effect with both hormones. Either hormone recruits P300 with an additive effect with both hormones, correlating with the increase of histone H3 acetylation. RNA polymerase-II is recruited rapidly to the promoter and the appearance of phospho-pol-II correlates with the detection of b-CSN transcripts. These data suggest a model for the assembly of a multi-protein complex at the beta-casein regulatory regions that helps to understand how the signaling pathways regulated by lactogenic hormones and local growth factors are integrated in the nucleus to direct milk protein gene expression.

Key Words: Lactation, Casein, Gene regulation

561 Udder changes and milk production in dairy ewes induced to lactate. B. Ramírez Andrade^{1,2}, A. A. K. Salama¹, G. Caja^{*1}, V. Castillo¹, E. Albanell¹, and X. Such¹, ¹*Grup de Recerca en Remugants, Universitat Autònoma de Barcelona, Bellaterra, Spain*, ²*Facultad de Agronomía, Universidad Autónoma, San Luis Potosí, México*.

A total of 22 ewes (17 nulli- and 5 multi-parous) of 2 breeds differing in milk yield and milkability (MN, Manchega; 62 kg BW, n=8; LC, Lacaune; 64 kg BW, n=14) were used to evaluate a modified protocol for inducing lactation. Dimethyl sulfoxide (DMSO) replaced 96% ethanol as a steroid solvent to avoid the necrotic wounds caused by ethanol in sheep skin. Estrus was synchronized over 12 d using 40 mg FGA sponges and 400 IU PMSG. Induction started 5 d after sponge withdrawal, and consisted of s.c. injection of estradiol (0.5 mg/kg BW) and progesterone (1.25 mg/kg BW) for 7 d, s.c. bST (200 mg) at d 11, and i.m. hydrocortisone acetate (50 mg) from d 18 to 20. Machine milking with hand stimulation and i.v. oxytocin (2 IU) began on d 21. Standard milking routine (x2 daily) was applied from d 4 to 56. Milk was measured and sampled daily during the first 10 DIM and weekly thereafter. Teat length, and udder volume and depth were measured before induction and at 50 DIM. All ewes responded to the induction but 1 MN (5%) yielded <200 mL/d and was excluded. Milk at the first milking (d 21) was similar between breeds (536 ± 130 mL), but multiparous ewes had more milk than nulliparous (834 ± 155 vs 237 ± 98 mL, respectively; $P < 0.01$). Milk from 1 DIM was similar in both breeds, mimicked colostrum (fat, 7.48%; protein, 10.2%; whey protein, 6.0%; TS, 21.7%) and decreased to normal values thereafter. Average milk yield for 56 DIM was lower ($P < 0.05$) in MN (404 ± 50 mL/d) than in LC (545 ± 45 mL/d). Milk peaked at 35 DIM and tended ($P < 0.12$) to be greater in LC (711 ± 57 mL/d) than MN (566 ± 65 mL/d). Teat length increased from 20.5 ± 1.1 mm before treatment to 27.7 ± 1.1 mm at 50 DIM with no differences between breeds. Udder volume (269 ± 50 mL) and udder depth (7.2 ± 1.3 cm) before treatment were similar between breeds. However, at 50 DIM, LC showed greater udder volume (898 ± 63 vs 632 ± 78 mL; $P < 0.05$) and tended to have a greater udder depth (18.0 ± 1.5 vs 15.0 ± 1.5 cm; $P < 0.14$) than MN ewes. Despite yield and milkability differences, both breeds responded to the DMSO based treatment (95% on average), avoiding the use of ethanol as steroid solvent for lactation induction.

Key Words: Lactation, Milk, Sheep

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562 Comparative genomics of the Tammar Wallaby and Fur Seal; model systems to study local regulation of mammary gland function. K. Nicholas^{*1,2}, M. Digby^{1,2}, C. Lefevre^{1,2}, J. Sharp^{1,2}, S. Mailer^{1,2}, A. Brennan^{1,2}, J. Arnould⁴, and K. Cane^{1,2}, ¹*Cooperative Research Centre for Innovative Dairy Products, Melbourne, Australia*, ²*Department of Zoology, University of Melbourne, Melbourne, Australia*, ³*Victorian Bioinformatics Consortium, Monash University, Clayton, Australia*, ⁴*School of Biological and Chemical Sciences, Deakin University, Burwood, VIC, Australia*.

Comparative genomics is providing opportunities to identify key genes regulating mammary gland development, milk production and composition. The application of this technology to species with extreme adaptation to lactation allows the identification and study of regulatory mechanisms that are present but not readily apparent in other species, and secondly allows the identification of novel molecules and processes for application in the biotechnology market. For example, the tammar wallaby has adopted a reproductive strategy that includes a short gestation (26 days), birth of an immature young and a relatively long lactation (300 days). Both the rate of production and the composition of milk change progressively during the lactation cycle to meet the nutritional demands for investment in considerable development of the pouch young (PY) prior to weaning. The lactating mother, not the sucking pattern of the PY, regulates these changes which in turn determines the rate of PY growth and development. Furthermore, the tammar can practice concurrent asynchronous lactation; the mother provides a concentrated milk high in protein and fat for an older animal which is out of the pouch and at heel, and a dilute milk low in fat and protein but high in carbohydrate from an adjacent mammary gland for a newborn pouch young. Our second study species, the fur seal, has a lactation characterized by a repeated cycle of long at-sea foraging trips (up to 28 days) alternating with short suckling periods of 2-3 days ashore. Lactation almost ceases while the seal is off shore but the mammary gland does not progress to apoptosis and involution. Our studies have exploited these models by using microarray analysis and comparative genomics to investigate how mammary function is regulated by endocrine factors, milk and factors intrinsic to the gland.

563 Acute physical distension of rat mammary glands induces apoptosis and decreases β 1-integrin and tight junction (TJ) protein signalling. C. V. C. Phyn^{*1,2}, J. M. Dobson¹, S. R. Davis³, K. Stelwagen¹, and K. Singh¹, ¹*AgResearch Ltd., Hamilton, New Zealand*, ²*Dexcel Ltd., Hamilton, New Zealand*, ³*ViaLactia Biosciences (NZ) Ltd., Auckland, New Zealand*.

The change in epithelial cell shape during mammary engorgement from a cuboidal to a flattened morphology may initiate changes in protein and gene expression (mechanotransduction) causing loss of secretory activity and apoptosis. Down-regulation of β 1-integrin and TJ protein expression reflect a loss of cell-extracellular matrix communication and TJ integrity, respectively, during mammary apoptosis. This study examined the effect of acute physical distension of rat mammary glands on apoptosis and the protein expression of β 1-integrin and TJ components (occludin, claudin-1 and zonula occludens-1 (ZO-1)). Sprague-Dawley rats at peak lactation each had two teats sealed to induce mammary engorgement. Another gland was acutely distended by infusing 1 ml of isosmotic sucrose solution (6h of milk secretion) up-the-teat prior to sealing. The remaining unsealed teats served as suckled controls. Mammary tissue was collected post-mortem at 0, 1, 3, and 6h after teat sealing (n=6 per time point). A dramatic increase ($P < 0.001$) in the number of apoptotic nuclei

occurred at 1, 3 and 6h in infused glands, and at 6h in engorged glands, compared with controls. By 3h and at 6h, apoptosis in infused glands was also significantly greater than engorged glands. This was accompanied by a reduction in the expression of β 1-integrin in infused glands compared with control ($P < 0.05$) and engorged ($P < 0.1$) glands by 6h. Occludin protein expression was significantly up-regulated in infused glands immediately following physical distension at 0h compared with control and engorged glands, but then declined to be down-regulated within 6h of teat-sealing. Claudin-1 and ZO-1 protein expression were significantly decreased in engorged glands, but not infused glands, compared with controls by 6h. These results indicate that acute physical distension of rat mammary glands accelerates the induction of apoptosis and loss of β 1-integrin and occludin protein expression compared with milk accumulation alone. In conclusion, we suggest a role for mechanotransduction during apoptosis and involution of mammary glands.

Key Words: Mammary apoptosis, Mechanotransduction, Tight junction

564 Effects of frequent milking during early lactation on milk yield in dairy cows are locally regulated. E. H. Wall* and T. B. McFadden, *Lactation and Mammary Gland Biology Group, University of Vermont, Burlington.*

We hypothesized that the effects of frequent milking during early lactation on milk production in dairy cows are regulated via local mechanisms. A unilateral frequent milking model (UFM; 2X left side, 4X right side) was used to test our hypothesis. Ten multiparous cows were assigned at parturition to UFM for days 1 to 21 of lactation. After treatment, cows were milked twice daily for the remainder of lactation. At the first milking post-calving, cows were quartermilked to verify that udder halves produced equal amounts of milk prior to treatment. Thereafter, quartermilking was performed on days 3 and 7, then weekly for the first 5 wks of lactation and once every 3 mo for the remainder of lactation. Cows responded quickly to treatment, producing $2 \pm .5$ kg more milk/d from the 4X side than the 2X side by day 3 ($P < 0.01$). During UFM, cows produced $3.9 \pm .7$ kg more milk/d from the 4X side than the 2X side ($P < 0.001$). Upon cessation of treatment, milk production from the 4X side decreased ($P < 0.01$), but remained at $1.8 \pm .5$ kg more milk/d than the 2X side for the remainder of lactation ($P < 0.01$). It was noteworthy that the difference in milk production between udder halves remained throughout lactation and was still significant at 270 DIM. After correcting milk yield to the equivalent of a whole udder basis, acute milk yield responses to frequent milking were consistent with previous reports. However, we observed greater persistency in the milk yield response, which lasted throughout lactation. We conclude that both immediate and persistent effects on milk production of frequent milking during early lactation are regulated at the level of the mammary gland. Our results also demonstrate that UFM is a valid and efficient model for investigating the effects of frequent milking during early lactation in dairy cows.

Key Words: Dairy cow, Frequent milking, Half-udder

565 Expression and regulation of glucose transporters in the bovine mammary gland. F.-Q. Zhao* and A. F. Keating, *University of Vermont, Burlington.*

Glucose is the primary precursor for synthesis of lactose, which controls milk volume by maintaining the osmolarity of milk. Glucose uptake in the mammary gland is considered to be a rate-limiting step

for milk production. Glucose transport across the plasma membranes of mammalian cells is carried out by two distinct processes: facilitative transport which is mediated by a family of facilitative glucose transporters (GLUT) and the sodium dependent transport mediated by the Na⁺/glucose co-transporters (SGLT). Glucose transport kinetic studies show that glucose transport across the plasma membrane of the lactating mammary epithelial cell has a Km value of 8.29 mM for 3-O-methyl-D-glucose and can be inhibited by both cytochalasin B and phloretin, indicating a facilitative transport process. This is consistent with the observation that in the lactating bovine mammary gland, GLUT1 is the predominant glucose transporter. However, the bovine lactating mammary gland also expresses GLUT3, GLUT4, GLUT5, GLUT8, GLUT12, and sodium dependent SGLT1 and SGLT2 at different levels. Studies of protein expression and cellular and subcellular localizations of these transporters are needed to address their physiological functions in the mammary gland. From late pregnancy to early lactation, expression of GLUT1, GLUT8, GLUT12, SGLT1 and SGLT2 mRNA increases from at least five-fold to several hundred-fold, suggesting that these transporters may be regulated by lactogenic hormones and have roles in milk synthesis. The GLUT1 protein is detected in the lactating mammary epithelial cells with subcellular distribution in both the plasma membrane and cytoplasm. Its level decreases from the early to late lactating stages and becomes barely detectable in the non-lactating stage. Both GLUT1 mRNA and protein levels in the lactating mammary gland are not significantly affected by administration of exogenous bovine growth hormone, and in addition, GLUT1 mRNA expression does not appear to be affected by leptin.

Key Words: Glucose uptake, Milk synthesis, Mammary gland

566 Hormonal interactions between the mammary fat pad and mammary cells affect lactation. Y. Feuermann^{*1}, S. J. Mabeesh², and A. Shamay¹, ¹*Agriculture Research Organisation The Volcani Center, Bet Dagan Israel*, ²*Faculty of Agriculture, The Hebrew University of Jerusalem, Rehovot, Israel*.

Locally produced growth factors are believed to mediate the bovine mammary adipocyte-epithelial cell interactions and alter the actions of several steroid and peptide hormones in these tissues. In a series of in vitro studies, we showed that leptin is secreted from the mammary fat pad, and is regulated by prolactin, the highest level of leptin secretion (16ng/ml) was observed at prolactin concentration of 1μg/ml ($P<0.05$, $n=5$). The expression of alpha-casein in a co-culture of primary epithelial cells and bovine fat explant was enhanced 4.1 times by prolactin in comparison to epithelial cells cultured alone ($P<0.05$, $n=3$). Prolactin (1μg/ml) and leptin (100ng/ml) enhanced the expression of StAR mRNA by 2.8 times in the mammary fat but had no significant effect on StAR mRNA expression in primary culture of mammary epithelial cells. The highest level of estrogen receptor mRNA expression in mammary primary culture cells was observed with the combined treatment of prolactin (1μg/ml) and leptin (100ng/ml), the expression

was enhanced by 3.1 times ($P<0.05$, $n=3$) (determined by real time PCR). A significant amount of udder fat was found in calves grown on milk compared to calves grown on milk replacer. Milk-yield of heifers that had high fat udder content (285±27.1g, $n=6$) was higher than heifers that had low fat udder content (151±11.6g, $n=6$), (37.7Kg/per day versus 33.6Kg/per day respectively, $P<0.003$). We believe that the difference between the groups was a result of the fat content of the udders, which directly affected the local leptin secretion. Based on the results from the in-vivo and the in vitro experiments, we hypothesize that the amount of fat in the udder affected the level of local leptin and estrogen secretion, the interaction between leptin, which is secreted from the mammary fat pad and prolactin affects the expression of estrogen receptor in the mammary cells.

Key Words: Leptin, Estrogen receptor, Prolactin

567 Growth hormone stimulates the expression of milk protein genes in bovine mammary epithelial cells overexpressing growth hormone receptor. Y. Zhou^{*}, R. M. Akers, and H. Jiang, *Virginia Tech, Blacksburg*.

Growth hormone (GH) can increase milk production in cattle and this effect is widely believed to be mediated by indirect action of GH on the mammary gland. However, recent findings that both GH receptor (GHR) mRNA and protein are expressed in the epithelial cells of the bovine mammary gland suggest that GH may have a direct effect on the milk-producing cells. The objective of this study was to determine whether GH could affect milk protein gene expression, nutrient transport and proliferation of the bovine mammary epithelial cells. The bovine mammary epithelia-derived cell line MAC-T cells did not express detectable GHR (perhaps as a result of immortalization) and they were rendered GH responsive by GHR overexpression. Growth hormone treatment of these cells markedly increased ($P<0.01$) the expression of α_{s1} -casein, α_{s2} -casein, β -casein and α -lactalbumin mRNA, whereas it had no effect ($P>0.05$) on the expression of κ -casein, β -lactoglobulin, insulin-like growth factor I (IGF-I), IGF-II or IGF binding protein-1 (IGFBP-1) to IGFBP-6 mRNA. Growth hormone also had no effect on glucose, amino acid or fatty acid transport into, or the proliferation of, these cells. A sequence analysis revealed that the promoters of the bovine α_{s1} -casein, α_{s2} -casein, β -casein and α -lactalbumin genes contain putative binding sites for signal transducer and activator of transcription 5 (STAT5). Cotransfection analyses confirmed that GH could stimulate ($P<0.05$) reporter gene expression from these promoters in MAC-T cells. These in vitro observations, together with the fact that GH receptor mRNA and protein are expressed in the epithelial cells of the bovine mammary gland, suggest that GH may directly stimulate transcription of major milk protein genes through STAT5 in the mammary gland, thereby increasing milk production in cattle.

Key Words: Growth hormone, Cattle, Milk production

Nonruminant Nutrition: Enzyme Supplementation and By-Products in Swine Diets

568 Chemical composition, phytate phosphorus release during steeping and feeding value of corn steep water for pigs. S. J. Niven^{*1}, O. A. Izquierdo², C. Zhu¹, D. Columbus¹, and C. F. M. de Lange¹, ¹University of Guelph, Ontario, Canada, ²Corn Products International, Westchester, IL.

Corn steep water (CSW) is a co-product of the wet milling industry and may be used as a liquid feed ingredient for pigs. Samples of CSW (n=3) were analyzed to have a pH of 4.3 45% DM and contain, within DM, 50% crude protein, 2% lysine, 18.0% ash, 5% potassium, 3.3% phosphorus (P), 1.5% magnesium, 0.5% crude fat and 20% lactic acid. The high lactic acid content may reduce pathogen load and stimulate gut development in pigs. In a performance study (4 pens of 8 pigs per treatment; 63 to 105 kg BW), pigs were fed with a computer controlled liquid feeding system, and corn and soybean meal based diets that contained 0, 5 or 10% CSW on a dry matter basis. Growth rate (1.10, 1.17, 1.06 kg/d; SE 0.03) and gain:feed (2.46, 2.30, 2.45; SE 0.05; 88% DM basis) were not influenced (P>0.10) by dietary treatment. In corn condensed distillers' solubles (CDS) most P is phytate-bound. In an attempt to release phytate-bound P, 200 ml samples of CSW were steeped with a commercially available phytase (Natuphos) at 4 inclusion levels (125, 250, 500 and 750 FTU kg⁻¹ DM), at two temperatures (40°C and 50°C), and with 3 replicates per treatment combination. The samples were continuously agitated. Release of phytate P was measured as the appearance of soluble P at 0, 3, 6, 12, 24, 48 and 96 h after adding phytase. At 0 h, CDS contained 6 gP kg⁻¹ DM (SE 0.11) soluble P and 30.7 gP kg⁻¹ DM (SE 0.43) total P. Rate of phytate P release was increased (P<0.05) with both temperature and phytase inclusion level. At 50°C and with 750 FTU kg⁻¹ appearance of soluble P was maximized at 27.17 gP kg⁻¹ DM (SE 0.28) of total P after 24 h. For all treatment combinations, there was no further increase (P>0.10) in soluble P after 48h of steeping. These studies indicate that CSW can be an effective feed ingredient for pigs and can supply significant amounts of available P.

Key Words: Corn steep water, Phytase, Pig

569 Addition of phytase and xylanase to wheat-based diets fed to growing pigs using growth performance and nutrient balance as response criteria. O. A. Olukosi^{*1}, J. S. Sands², and O. Adeola¹, ¹Purdue University, West Lafayette, ²Danisco Animal Nutrition, Marlborough, UK.

The study was designed to investigate the response of growing pigs to xylanase and phytase when used in a wheat-based diet. The wheat-based diet also contained wheat middlings and canola meal. The experiment consisted of a 6-wk growth trial and 14-d nutrient balance. One-hundred fifty pigs weighing 23 kg were used for the 6-wk growth trial. The pigs were blocked by weight and gender and assigned to 5 dietary treatments in a randomized complete block design. The treatments were a positive control (PC); negative control (NC) diet marginally deficient in phosphorus (P) and metabolizable energy (ME);

NC plus phytase added at 500 FTU/kg; NC plus xylanase added at 4,000 U/kg; and NC plus phytase and xylanase added at 500 and 4,000 units/kg, respectively. Nutrient balance study was conducted using 24-kg pigs in metabolism cages that allowed total but separate collection of urine and feces. Final weight and daily gain were higher in the PC than NC (P < 0.05); there were no effects of enzyme addition on these response criteria. Feed intake and gain:feed were not significantly different in all the treatments. Addition of phytase alone or in combination with xylanase improved (P < 0.05) P digestibility. Metabolizable energy was higher (P < 0.05) in the PC compared with NC, but there were no effects of the addition of the enzymes on ME. Phosphorus excretion was highest (P < 0.01) in the PC and lowest (P < 0.05) in the diet with combination of phytase and xylanase. Combination of the two enzymes improved P retention (P < 0.01) above the NC diet to a level similar to the PC. In conclusion, the combination of phytase and xylanase was efficient in reducing excretion and increasing P retention in growing pigs fed wheat-based diet.

Key Words: Xylanase, Phytase, Retention

570 Effects of xylanase and wheat middlings in diets for finishing pigs. C. Feoli^{*}, J. D. Hancock, C. R. Monge, C. L. Jones, and C. W. Starkey, Kansas State University, Manhattan.

A total of 312 finishing pigs (avg initial BW of 64.5 kg) was used in a 62-d experiment to determine the effects of xylanase and wheat middlings on growth performance and carcass characteristics. Treatments were a corn-soybean meal-based diet without and with 826 mg/kg xylanase product (to supply none and 2,313 units of xylanase activity per kg of diet) and wheat middlings (none, 15%, and 30%) arranged as a 2 x 3 factorial. The pigs were sorted by sex and ancestry and blocked by BW with 13 pigs/pen and four pens/treatment. Feed and water were consumed on an ad libitum basis until the pigs were killed (avg BW of 121 kg) at a commercial slaughter facility. Overall, there were no interactions among xylanase addition and concentration of wheat middlings for ADG, ADFI, G:F, dressing percentage, last-rib backfat thickness, or percentage carcass lean (P > 0.26). As for the main effects, addition of xylanase did not change overall growth performance or carcass measurements (P > 0.16). As concentration of wheat middlings was increased from none to 30%, there were linear decreases in overall ADG (P < 0.003), G:F (P < 0.002), dressing percentage (P < 0.002), and last-rib backfat thickness (P < 0.06) while percentage carcass lean increased (P < 0.03). However, the effects on carcass fatness and lean percentage disappeared (P > 0.71) when hot carcass weight was used as a covariate. In conclusion, increasing the concentration of wheat middlings in diets for finishing pigs reduced rate and efficiency of gain and addition of xylanase did not prevent these effects.

Table 1.

Item	Without xylanase			With xylanase			SE
	0	15	30	0	15	30	
ADG, kg	0.944	0.918	0.885	0.951	0.916	0.893	0.038
ADFI, kg	2.87	2.96	2.91	2.97	2.96	3.01	0.14
G:F	0.329	0.310	0.304	0.320	0.309	0.297	0.016
Hot carcass weight, kg	91.5	89.9	86.9	91.5	89.6	88.1	1.6
Adjusted dressing percentage	74.5	74.3	73.3	74.4	74.1	73.6	0.3
Adjusted back fat, mm	21.3	21.0	21.3	22.0	20.8	22.3	2.6
Adjusted lean percentage	53.3	53.3	53.3	53.0	53.4	52.8	1.1

Key Words: Pig, Wheat middlings, Xylanase

571 Toxicity of Fusarium mycotoxins and detoxification by mycotoxin degrading enzymes. G. Schatzmayr^{*1}, U. Hofstetter¹, and C. Yeong-Hsiang², ¹BIOMIN GmbH, Herzogenburg, Austria, ²National I-Lan University, I-Lan, Taiwan.

Deoxynivalenol (DON) and zearalenone (ZON) are the most frequently occurring mycotoxins in the United States (US), Canada and Central Europe. They are produced by *Fusarium* species on a great variety of commodities. Amongst all animal species pigs are most affected by the uptake of these fungal toxins. The aim of this study was to test the synergistic effects of deoxynivalenol (DON) and zearalenone (ZON) on performance parameters, blood biochemistry and immune parameters of pigs. Further the effect of Mycofix[®]Plus (MP), a product based on mycotoxin degrading enzymes, was investigated in this experiment. A total of 48 weaning pigs were allocated to four treatments including control, toxin (DON and ZON), toxin + MP (DON, ZON, and MP), and MP alone for a 6 wk challenge trial. The concentration of DON (1mg/kg) and ZON (0.25mg/kg) were below the recommended tolerance levels for swine diets in the US. After 6-wk the growth performance parameters of the toxin group (BW = 26.2kg; ADG = 412g) were significantly ($P \leq 0.05$) affected by DON and ZON (control group; BW = 29.08kg; ADG = 495g). The addition of MP (0.15%) neutralized the negative impact of the mycotoxins on BW (29.1kg) and ADG (476g). The addition of MP alone did not show any improvement in comparison to the control group. Besides performance parameters also serum biochemistry parameters, alveolar macrophages activity, antibody titers for pseudorabies (PR) vaccine and cytokines secretion profile were significantly impaired ($P \leq 0.05$) by the combination of DON and ZON. The addition of MP counteracted the detrimental effect on aspartate aminotransferase and alleviated the negative influence of the mycotoxins on chemotaxis and phagocytosis. Some improvement (not significantly different) of the PR vaccination response was also noted when MP was added to the toxin containing diet. This study showed that mycotoxin concentrations below the recommended tolerance levels in the United States and Canada occurring together in animal diets can lead to significant economic losses and the addition of MP is useful in alleviating toxic effects.

Key Words: Mycotoxin, Deactivation, Enzymatic degradation

572 Energy and phosphorus digestibility in high-protein distillers dried grain with solubles fed to growing pigs. M. R. Widmer^{*1}, M. L. Gibson², L. M. McGinnis¹, C. Pedersen¹, and H. H. Stein¹, ¹South Dakota State University, Brookings, ²Dakota Gold Marketing, Sioux Falls, SD.

Two experiments were conducted to measure the digestibility of energy and phosphorus in a new co-product from the ethanol industry. This product is produced by de-hulling and de-germing corn before it enters the fermentation process. The resulting distillers grain with solubles (DDGS) contains approximately 38% CP and 0.40% P. In Exp. 1, six growing pigs were placed in metabolism cages and fed a corn-based diet (97.6% corn) and a corn-DDGS based diet (50% corn, 47.7% DDGS). The DE and ME were measured for each diet and the DE and ME were then calculated for DDGS by subtracting the contribution of corn to the energy in the corn-DDGS diet. Results of this experiment showed that the DE and ME in high-protein DDGS is 4,763 and 4,476 kcal per kg DM, respectively. These values are greater ($P < 0.001$) than the DE and ME in corn (4,056 and 3,972 kcal per kg DM, respectively). Experiment 2 was conducted to measure the apparent total tract digestibility (ATTD) of Ca and P and the true total tract digestibility (TTTD) of P in high-protein DDGS. A P-free diet based on gelatin, cornstarch, and sugar, and a DDGS-based diet containing DDGS (60.0%), cornstarch, and sugar were formulated. Each diet was fed to eight growing pigs during one 14-d period with total collections of urine and fecal matter during the last five d of the period. The ATTD and the retention of Ca and P were calculated for the diet containing DDGS and the endogenous loss of P was estimated from the pigs fed the P-free diet. Results of this experiment showed that the ATTD for Ca and P in high-protein DDGS are 75.0 and 59.6%, respectively and the retention of Ca and P are 52.6 and 58.9%, respectively. The endogenous loss of P was estimated at 211 ± 0.04 mg per kg DMI. By correcting the ATTD of P for the endogenous loss, the TTTD of P was calculated at 69.3%. It is concluded that high-protein DDGS has a high digestibility of energy, Ca, and P and it is expected that this feed ingredient will have a greater value than conventional DDGS when fed to pigs.

Key Words: Digestibility, High-protein DDGS, Pigs

573 Effects of replacing corn with triticale in diets for nursery and finishing pigs. C. R. Monge^{*}, J. D. Hancock, T. L. Gugle, and C. Feoli, Kansas State University, Manhattan.

Two experiments were conducted to determine the effects of replacing corn (none, 33.3%, 66.7%, and 100%) with triticale on growth performance and nutrient digestibility in pigs. For the 34-d nursery experiment, 168 weaning pigs (avg initial BW of 6.7 kg) were sorted by sex, weight, and ancestry, and allotted to pens. The control diet had 27, 40, and 61% corn for d 0 to 7, 7 to 21, and 21 to 34, respectively. On d 24, fecal samples were collected and feed (0.25% chromic oxide used as an indigestible marker) and feces were analyzed for DM, N, and GE. Overall, ADG (cubic effect, $P < 0.08$) and G:F (linear effect, $P < 0.01$) were increased by 4% as replacement of corn with triticale was increased from none to 100%. Digestibility of DM, N, and GE were not affected by increasing the concentration of triticale in the diet ($P > 0.18$). For the finishing experiment, 184 pigs (avg initial BW of 59 kg) were sorted and allotted to pens as in the nursery experiment. The control diet had 70 and 81% corn for d 0 to 40 and 40 to 59, respectively. On d 46, fecal samples were collected and feed and feces were analyzed as in Exp. 1. Overall, ADG (linear effect, $P < 0.02$) and ADFI (linear effect, $P < 0.05$) were decreased by 6% as replacement

of corn with triticale was increased from none to 100%. However, G:F and digestibility of nutrients were not affected ($P > 0.16$) by concentration of triticale in the diet. In conclusion, replacing corn with triticale improved growth performance in nursery pigs but reduced ADFI and, thus, ADG in finishing pigs.

Table 1.

Item	Triticale, %				SE
	None	33.3	66.7	100	
Nursery Exp					
ADG, g	528	555	534	549	9
ADFI, g	707	728	696	709	14
G:F, g/kg	747	762	767	774	7
DM dig, %	82.2	82.5	83.3	82.9	0.9
N dig, %	77.9	76.7	79.3	77.3	1.3
Finishing Exp					
ADG, g	1.08	1.07	1.02	1.03	0.02
ADFI, g	3.03	3.09	2.93	2.86	0.13
G:F, g/kg	356	346	348	360	13
DM dig, %	84.3	81.4	82.2	82.0	1.3
N dig, %	79.4	76.0	77.8	77.5	2.0

Key Words: Pig, Triticale, Growth

574 Impact of a varying number of random out-of-feed events on grow-finish pig performance. M. Brumm^{*1}, S. Colgan¹, and K. Bruns², ¹University of Nebraska, Concord, ²South Dakota State University, Brookings.

Two hundred forty barrows (initial wt 18.1 kg) were used to evaluate the effect of repeated out-of-feed (OOF) on performance to slaughter. There were 15 pigs (0.69m²/pig), one bowl drinker, and one 2-hole feeder per pen in a fully slatted, naturally ventilated wean-to-finish facility. There were 4 pens per treatment and OOF treatments applied on random days every 2 weeks were 1) never OOF (0x), 2) OOF 1 time (1x), 3) OOF 2 times (2x), and 4) OOF 3 times (3x). Out-of-feed was accomplished by closing the feed delivery mechanism on the feeder from 1200 hr to 0800 hr. Diets were corn-soybean meal based in meal form with a mean particle size of 933 microns and 1.8 SD. At the end of the 112 day trial, there was a quadratic ($P=0.097$) impact of treatment on final weight (117.0, 117.6, 117.5 and 113.8 kg for the 0x, 1x, 2x and 3x treatments respectively). This contrasted with the linear ($P=0.014$) effect on BW on day 56 (64.7, 64.3, 63.3 and 59.9 kg) and linear ($P=0.003$) decrease in daily gain for the 0-56 d period (0.838, 0.826, 0.803 and 0.753 kg/d) for the 0x, 1x, 2x and 3x treatments respectively. However there was no effect ($P>0.1$) of treatments on daily gain for the 56-112 d period. For the entire 112-d trial, there was linear reduction ($P=0.03$) in daily gain due to increasing numbers of OOF events (0.887, 0.888, 0.883, 0.857 kg/d for the 0x, 1x, 2x, and 3x treatments, respectively). There was a linear ($P<0.05$) reduction in ADFI for increasing number of OOF events for every 2 wk period for the first 8 wk and no difference ($P>0.1$) in ADFI for any treatment for any 2 wk period during the second 8 wk. There was no effect ($P>0.1$) of treatment on feed conversion for any time period measured. These results suggest that pigs adjust to repeated, random OOF events. The penalty for repeated OOF events is an initial reduction in ADG and ADFI which was clearly not compensated for later in the growth process by pigs on the 3x treatment. However, pigs on the 1x treatment compensated for the missed feed events, while pigs on the 2x treatment

appeared to be on the edge of being able to compensate completely for OOF events.

Key Words: Pigs, Feed availability, Welfare

575 Effects of flaxseed and carbohydrase enzyme supplementation on growth performance, plasma urea nitrogen and nutrient digestibility in piglets. E. Kiarie^{*}, B. A. Slominiski, and C. M. Nyachoti, University of Manitoba, Winnipeg, Canada.

The effect of including flaxseed in starter diets with or without carbohydrase enzyme supplementation was investigated in a 28 d study involving 96 weaned pigs (6.1 kg initial BW). The diets were based on wheat, barley, pea, soybean and canola meals with 0% or 12% flaxseed and fed alone or supplemented with multi-carbohydrase enzyme (0.05%) containing cellulase, pectinase, mannanase, xylanase, glucanase and galactanase activities. Diets were formulated to similar CP and lysine levels and flaxseed was added by proportionately reducing other feedstuffs to balance for CP and energy. Each diet was assigned to 6 replicate pens (each with 4 pigs) in a completely randomized design. Pigs were weighed and bled weekly to determine plasma urea nitrogen (PUN). Fresh fecal samples were collected from each pen on d 28 and at the end of the study 1 pig per pen was killed to sample ileal digesta. Treatments effect on performance was only evident in wk 3 when ADG in flaxseed diets was lower (268 vs. 353 g/d; $P<0.01$) than in non-flaxseed diets. There was a tendency ($P=0.08$) for flaxseed and carbohydrase to interact in G:F in wk 3 such that in absence of enzyme flaxseed diets resulted in lower G:F ($P<0.01$) compared to non-flaxseed diets, however, no difference ($P>0.15$) was observed between the two diets in presence of enzyme. Flaxseed diets increased PUN in wk 3 (4.95 vs. 3.92 mmol/L; $P<0.05$), ileal viscosity (3.4 vs. 1.5; $P<0.01$) and reduced ileal apparent digestibility of ($P<0.01$) of DM, N and non-starch polysaccharides (NSP) compared to non-flaxseed diets. Compared with unsupplemented diets, enzyme supplemented diets resulted in higher ileal DM digestibility (53 vs. 46 %; $P<0.05$). Compared with all other diets, flaxseed diet without enzyme supplementation reduced ($P<0.05$) fecal DM digestibility. Results suggest that the depressive effect of flaxseed on performance and nutrient utilization in nursery pigs fed wheat-barley diets can be minimized by carbohydrase enzyme supplementation.

Key Words: Flaxseed, Multi-carbohydrase enzyme, Piglet performance

576 Flaxseed and carbohydrase enzyme supplementation affects gut microbial populations and activities in nursery pigs. E. Kiarie^{*}, C. M. Nyachoti, B. A. Slominiski, and G. Blank, University of Manitoba, Winnipeg, Canada.

The effects of flaxseed and carbohydrase enzyme supplementation on ileal microbial populations, organic acids as well as ileal and fecal ammonia in nursery pigs were investigated in a 28 d trial. Ninety-six pigs (17±1 d, 6.1kg BW) were weaned and based on BW; four pigs were housed per pen with six pens per diet. The diets were based on wheat, barley, pea, soybean and canola meals with 0% or 12% flaxseed and fed alone or supplemented with multi-carbohydrase enzyme (0.05%) containing cellulase, pectinase, mannanase, xylanase, glucanase and galactanase activities. Fresh fecal samples were collected from each pen on d 28, and at the end of the study, 1 pig per pen was killed to sample ileal digesta. Microbial populations and organic acid contents were analyzed in ileal digesta samples only. Ammonia content in samples was measured as ammonia-N. There tended ($P=0.10$) to

be an interaction between flaxseed and enzyme for ileal *Lactobacilli* concentrations; in absence of flaxseed, enzyme tended to increase ileal *Lactobacilli* concentrations compared to unsupplemented diets. Flaxseed diets reduced ileal anaerobic spore formers (2.6 vs. 3.1 log₁₀ CFU/g; *P*0.05), lactic acid (1115 vs. 2354 μmol/L; *P*<0.01) and total organic acids (2220 vs. 4133 μmol/L; *P*<0.01) compared to non-flaxseed diets, however, ileal pH was not affected by dietary treatments. Enzyme supplementation tended to increase (*P*=0.10) ileal lactic acid and total organic acids compared to non-enzyme diets.

Inclusion of enzyme blend in non-flaxseed diets resulted in reduced (*P*=0.06) ileal ammonia content. Flaxseed diets had a lower fecal pH (6.4 vs. 6.8; *P*<0.01) and tended to have lower fecal ammonia content (32.4 vs. 40.4 mg/L; *P*=0.07) than non-flaxseed diets. Results suggest that flaxseed suppressed ileal microbial numbers and organic acids concentration while enzyme supplementation increased organic acids and tended to increase *Lactobacilli* concentration.

Key Words: Flaxseed, Multi-carbohydrase enzyme, Ileal microbial activities

Physiology and Endocrinology: Reproductive Physiology

577 Effect of decreasing the interval from GnRH to PGF_{2A} and lengthening proestrus on reproductive performance in GnRH-CIDR-PGF_{2A} synchronization programs. L. A. Helsner^{*1}, G. A. Bridges¹, D. E. Grum¹, M. L. Mussard¹, C. L. Gasser², D. M. Lantz¹, and M. L. Day¹, ¹The Ohio State University, Columbus, ²Southern Utah University, Cedar City.

We have previously reported similar reproductive performance in GnRH-based programs when the interval from the initial GnRH injection to CIDR withdrawal and PGF_{2α} (PGF) was reduced from 7 to 5 d and two PGF doses were given 12 h apart. In order to determine the efficacy of a single PGF injection at CIDR withdrawal in a 5 d program, two experiments were conducted to compare reproductive performance between a 7 d (7SS) or 5 d (5SS) Select Synch + CIDR program. Lactating beef cows (n = 137; Expt 1) and yearling heifers (n = 159; Expt 2) received the 7SS or 5SS program with a single PGF. In cows, estrus response was greater (*P* < 0.05) in the 7SS (98.5%) than 5SS (89.9%) treatment. Treatment by status (cyclic, anestrus; *P* < 0.05) and age (2 yr-old, mature; *P* < 0.05) interactions implied that cyclic and mature cows benefited from the 7SS treatment, whereas the 5SS treatment favored the anestrus and 2 yr-old cows. In heifers (Expt 2), estrus response (92.5%) and pregnancy rates (59.7%) were similar between treatments. In a third experiment (n = 216; Expt 3), reproductive performance was compared for a 7 (7CO) and 5 (5CO) d CO-Synch + CIDR program in postpartum cows. Based upon results of Expt 1, two injections of PGF, 12 h apart, were used. In the 7CO treatment, timed AI, concurrent with GnRH, was performed at 60 h after the initial PGF, whereas this interval (proestrus) was extended to 72 h in the 5CO treatment. Timed-AI pregnancy rate was greater (*P* < 0.05) in the 5CO (80.0%) than 7CO (66.7%) treatment. In conclusion, it is questionable if decreasing the Select-Synch program to 5 d is advantageous in either cows or heifers if a single PGF is administered. Conversely, the modified CO-Synch + CIDR program increased timed-AI pregnancy rates in postpartum beef cows. The relative contributions of the shorter GnRH to PGF interval and the longer duration of proestrus to enhance fertility warrants further investigation.

Key Words: Beef cattle, CIDR, Synchronization

578 Effects of PES during in vitro culture of bovine embryos on pregnancy rates. M. Barcelo-Fimbres^{*}, Z. Brink, and G. E. Seidel Jr, Colorado State University, Fort Collins.

Phenazine ethosulfate (PES) is an electron acceptor that oxidizes NADPH to NADP, which increases flux of glucose through the pentose phosphate pathway and decreases lipid accumulation in embryos (Reprod. Fert. Dev. 17:218). The aim of this experiment was to evaluate the effects of PES, days post estrus of the recipient at

embryo transfer (synchrony), and embryo transfer grade (ET grade) on pregnancy rates. Oocytes were collected from slaughterhouse ovaries, matured, fertilized, and the resulting embryos cultured in vitro by standard procedures in a chemically defined medium (J. Anim. Sci. 78:152). Day 0 of culture was 18±2h after the onset of IVF. From 2.5 to 6.5 d of culture, half of the eight cell embryos were exposed to 0.3 μM PES, and the rest were controls. Day 7 PES or control blastocysts of good quality, were transferred nonsurgically (ET) to synchronized recipients. Only recipients in estrus 6 to 7.5 d earlier, with a detectable corpus luteum were used. The ET grades were: 1, good; 2, some cow movement; and 3, problematic (much cow movement and/or bloody transfer gun). Pregnancies were evaluated at 35 and 105 d post estrus by ultrasonography, by detecting an amniotic vesicle or live fetus. Use of PES during in vitro culture had no effect on pregnancy rates compared to control at 35 or 105 d (*p*>0.1) (Table 1). There was a significant effect of synchrony on pregnancy rates; (*p*<.05) (Table 1). ET grade 1 was superior to grades 2 and 3 (*p*<0.05) (Table 1). There was no interaction among treatments (*p*>0.1). Use of PES during in vitro culture did not affect pregnancy rates nor conceptus losses between d 35 and 105 of pregnancy, and 7 to 7.5 d recipients and grade1 ET were superior.

Table 1. Pregnancy rates after transfer of in vitro-produced embryos (%)

Pregnancy day	Treat-ment	Treat-ment	Syn-chrony	Syn-chrony	ET grade	ET grade	ET grade
	Control (n=35)	PES (n=38)	6-6.5 (n=38)	7-7.5 (n=35)	1 (n=40)	2 (n=20)	3 (n=13)
35	37	40	29 ^c	49 ^d	53 ^a	30 ^b	8 ^b
105	26	24	15 ^a	34 ^b	38 ^a	15 ^b	0 ^b

a,b,c,d Values with different superscripts within treatments in the same row differ (^{a,b} *P*<0.05; ^{c,d} *P*<0.06) by Fisher's exact test.

Key Words: *In vitro* produced embryos, Phenazine ethosulfate, Embryo transfer

579 Influence of a CIDR insert after a fixed-time AI on pregnancy rates and return to estrus of nonpregnant cows. K. N. Thielen¹, J. E. Larson^{*1}, B. J. Lovaas², D. J. Kesler³, J. S. Stevenson⁴, T. T. Marston⁴, and G. C. Lamb², ¹University of Minnesota, St. Paul, ²University of Minnesota, Grand Rapids, ³University of Illinois, Urbana, ⁴Kansas State University, Manhattan.

We determined whether resynchronization of an ovulatory estrus could be accomplished in nonpregnant cows without compromising

pregnancy in cows pregnant from a previous synchronized estrus or to those inseminated to the resynchronized estrus. Ovulation was synchronized in 937 suckled beef cows at 6 locations using a CO-Synch + CIDR protocol (a 100- μ g injection of GnRH at the time of CIDR insertion, followed in 7 d by a 25-mg injection of PGF_{2 α} at CIDR removal. At 60 h after PGF_{2 α} , cows received a fixed-time AI [TAI] plus a second injection of GnRH. After initial TAI cows were assigned randomly to 4 treatments; 1) untreated (control; n = 237); 2) CIDR inserted 5 d after TAI and removed 14 d after TAI (CIDR5-14; n = 234); 3) CIDR inserted 14 d after TAI and removed 21 d after TAI (CIDR14-21; n = 232); or 4) CIDR inserted 5 d after TAI and removed 14 d after TAI and then a new CIDR inserted at 14 d and removed 21 d after TAI (CIDR5-21; n = 234). After TAI, cows were observed twice daily until 25 d after TAI for estrus and inseminated according to the AM-PM rule. Pregnancy was determined at 29 and 59 d after TAI to determine conception to first- and second-service AI. Pregnancy rates to TAI were similar for control (55%), CIDR5-14 (54%), CIDR14-21 (48%), and CIDR5-21 (53%). A greater proportion of nonpregnant cows were resynchronized during a 2-d peak period in the CIDR5-21 (76/109, 70%) and CIDR14-21 (77/119, 65%) than controls (44/106, 42%) and CIDR5-14 (39/109, 36%) cows. Although overall pregnancy rates after second AI service were similar, conception rates of nonpregnant cows detected in estrus and inseminated seemed to be compromised ($P < 0.05$) in CIDR5-21 (41/76, 54%) and CIDR14-21 (71/77, 53%) compared with CIDR5-14 (28/39, 72%) cows, whereas controls (29/44, 66%) were intermediate. Insertion of a CIDR 5 d after a TAI did not compromise or enhance pregnancy rates to TAI, however, conception rates were compromised in nonpregnant cows that were resynchronized with a CIDR from d 5 or 14 until 21 d after TAI.

Key Words: Estrous synchronization, CIDR, Artificial insemination

580 Effects of estrous synchronization with a CIDR prior to the breeding season in bull-breeding herds on pregnancy rates. G. C. Lamb¹, C. R. Dahlen^{*2}, K. A. Vonnahme³, G. R. Hansen⁴, J. D. Arseneau⁵, G. A. Perry⁶, J. Clement⁷, and J. D. Arthington⁸, ¹University of Minnesota, Grand Rapids, ²University of Minnesota, Crookston, ³North Dakota State University, Fargo, ⁴University of Florida, Mariana, ⁵Purdue University, West Lafayette, IN, ⁶University of South Dakota, Brookings, ⁷Clement Cow-Calf Consulting, Mandan, ND, ⁸University of Florida, Ona.

We determined whether insertion of a CIDR prior to the breeding season enhanced pregnancy rates and altered the date of conception in suckled beef cows mated naturally. One thousand seven hundred and fifty suckled beef cows from thirteen locations were randomly assigned to one of two treatments: 1) cows received a CIDR 7 d prior to the breeding season for 7 d (CIDR; n = 866); 2) cows received no treatment (Control; n = 884). On the first day of the breeding season bulls were introduced to the herd at a rate of 15 to 25 cows per yearling bull or 20 to 30 cows per mature bull. Cows were evaluated by transrectal ultrasonography for pregnancy at 56 d and 120 d after initiation of the breeding season to determine pregnancy status and date of conception. Overall pregnancy rates ranged from 59.3 to 98.9% among the 13 locations. Pregnancy rates within the first 30 days of the breeding season were similar between CIDR (64.4%) and Control (64.7%), and overall pregnancy rates were similar between CIDR (89.7%) and Control (89.6%). The average day of conception after initiation of the breeding season was shorter ($P < 0.05$) for CIDR (20.1 ± 0.8 d) compared to Control cows (23.2 ± 0.8 d). Of cows conceiving during the breeding season, more ($P < 0.05$) CIDR cows

(43%) conceived during the first ten days of the breeding season than Control cows (35%). Body condition score and parity did not affect pregnancy rates or days to conception, whereas pregnancy rates and days to conception were affected ($P < 0.01$) by location and days postpartum. Days to conception were similar between treatments for cows calving within 50 d of initiation of the breeding season (28.2 ± 1.0 d), whereas cows calving earlier in the calving season treated with a CIDR (16.1 ± 0.9 d) conceived earlier ($P < 0.05$) than Control cows (20.7 ± 0.9 d). We concluded that insertion of a CIDR prior to the breeding season failed to increase overall pregnancy rates, but did influence the average day of conception in earlier calving cows.

Key Words: Estrous synchronization, CIDR, Beef cows

581 Prevalence and risk factors for postpartum anestrus in dairy cows. R. B. Walsh^{*1}, J. S. Walton², K. E. Leslie¹, and S. J. LeBlanc¹, ¹University of Guelph, Ontario, Canada, ²University of Guelph, Ontario, Canada.

An observational study was conducted in 18 Ontario Dairy herds between January 2004 and April 2005. Milk samples were collected at 46 and 60 (± 7) DIM for progesterone (P4) analysis. Anestrus was defined as P4 < 1ng/ml in both skim milk samples. A total of 1341 animal had complete data for analysis with logistic regression and survival analysis controlling for the effects of clustering at the herd level. Overall, the prevalence of anestrus was 19.5% (95% confidence interval = 17.4 to 21.6%). The estimated herd specific prevalence varied from 5% to 44%. The prevalence of anestrus was not different among parities. Calving in the spring increased the odds of anestrus 1.7 times ($p=0.02$) relative to animals calving in the summer. In a representative subset of 1046 animals, milk b-hydroxybutyrate (BHBA) was measured once in each of the first two weeks after calving. Among these, 26% had subclinical ketosis (≥ 100 mmol/ml BHBA) in week 1 (range among herds, 5 to 82%) and 25% (range, 5 to 84%) in week 2 of lactation. Accounting for season and clustering at the herd level, cows with ketosis in week 1 were 1.5 times more likely ($P=0.02$) than non-ketotic animals to be classified as anestrus. Ketosis in the second week was not a significant risk factor. Other risk factors included displaced abomasum (OR 2.5; 95% CI 1.2 – 5.0), twins (OR 2.1; 95% CI 1.1-3.9), and dystocia (OR 1.3, 95%CI 1.1 – 1.7). The risk of anestrus decreased as first DHI test projected 305ME increased to 9500 kg (OR= 0.9998/kg milk; $p=0.03$) while there was no change in the risk of anestrus associated with first projection > 9500 kg. Controlling for parity, season of calving and the impact of clustering at the farm level. Anovulatory cows were inseminated 3 days later than cycling animals (76 vs. 73; HR 0.8, $p=0.03$), and they were 40% less likely to conceive at first insemination (OR 0.6; 95% CI .42 - .83). Conception was delayed by 27 days (156 vs. 129) in anestrus cows. Anestrus animals were 1.4 times (95% CI 1.1 – 1.9) more likely to be culled than cycling cows at 60 DIM.

Key Words: Anestrus, Milk progesterone, Risk factors

582 Effect of feeding flax or linseed meal on progesterone clearance rate in ovariectomized ewes. C. W. Galbreath^{*}, M. R. O'Neil, J. D. Kirsch, J. W. Schroeder, K. G. Odde, G. P. Lardy, and K. A. Vonnahme, North Dakota State University, Fargo.

Evidence suggests feeding flax can increase fertility in dairy cows, and women who consume linseed meal (LSM) had a longer luteal phase during their menstrual cycle. We hypothesized that flax or LSM

decreases the rate of progesterone (P4) metabolism in cyclic females. Our objective was to determine if flax or LSM decreases the clearance rate of P4 in ovariectomized ewes receiving a P4 releasing device (CIDR). Mature ewes (n = 21) were ovariectomized and fed a phytoestrogen (PE)-free diet based on beet pulp, for at least 30 d post-ovariectomy. Ewes were fed at maintenance based on metabolic body wt and were weighed every 2 wk throughout the feeding period. Thereafter, ewes were assigned randomly to control (PE-free; n = 7), flax (n = 7), or LSM (n = 7) diets. All diets were isocaloric and isonitrogenous. Body condition score (BCS; scale 1-5) was also measured at the onset and conclusion of the trial. On d 20 of feeding, a CIDR was inserted vaginally. Beginning on d 25, blood samples were obtained via jugular venipuncture. Samples were collected before CIDR removal (0 h) and at 0.5, 1, 2, 6, 12, and 24 h post-CIDR removal. Serum was assayed for P4. There was no difference in initial body wt (P = 0.97) or BCS (P = 0.47; 63.8 ± 1.7 kg or 3.3 ± 1.8, respectively) and no difference in final body wt (P = 0.89) or BCS (P = 0.56; 67.5 ± 1.9 kg or 3.4 ± 0.2, respectively). There was no time by diet interaction (P = 0.15) on P4 concentrations. From 0 to 24 h, P4 decreased (P < 0.01; 1.55 ± 0.09 to 0.27 ± 0.01 ng/ml). Ewes fed LSM had greater (P < 0.04) P4 across all sampling times compared to control- and flax-fed ewes (LSM = 0.65 ± 0.08; control = 0.57 ± 0.06; flax = 0.56 ± 0.05). Progesterone at 0 h was greater (P < 0.05) in LSM-fed ewes (1.82 ± 0.20 ng/ml) compared to flax- (1.39 ± 0.07 ng/ml) and control-fed (1.45 ± 0.13 ng/ml) ewes. Although clearance rates did not differ, LSM-fed ewes appeared to absorb a greater level of P4 from the CIDR. Feeding LSM to cyclic females may increase circulating P4 aiding in maintenance of pregnancy. Further investigation is warranted to determine the mechanism by which LSM influences P4 concentrations.

Key Words: Ewes, Flax, Progesterone

583 Digital infrared thermal imaging of the eye as correlated to rectal and vaginal temperature measurements in the ewe.

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The determination of body temperature using non-invasive means would decrease the need to handle animals to obtain such measures, and may have applications in non-domestic species where handling is impractical or impossible. To this end, we have investigated the use of digital infrared thermography (DITI) for quantifying maximum (MAX) eye temperature as a correlate to body temperature. The objective of this study was to correlate DITI of the eye with rectal (RT) and vaginal temperature (VT) in ewes. St. Croix White (STX; n = 10) and Dorper x STX (DX; n = 10) ewes were outfitted with intravaginal temperature loggers set to acquire a VT every 5 min. Data collected from the ewes at five sampling times (AM and PM daily) over a 48 hr period included RT and DITI of the right and left eye, orbital gland and facial hair coat (a background measure). Ambient temperature and humidity were recorded at the beginning and end of each sampling period. Analysis consisted of determining the correlation between DITI of the eye (MAX temperature) and VT and RT. Thermography of the eye revealed no difference in MAX temperature between the right and left eyes (P > 0.10). Right and left MAX eye temperatures were highly correlated (R = 0.88; P < 0.01). Right and left MAX eye temperatures were highly correlated to their respective corneal (R = 0.81 and 0.83; P < 0.01) and orbital gland (R = 0.76 and 0.77; P < 0.01) MAX temperatures. The gradient of temperatures obtained was (all differed at P < 0.01): VT (39.6 ± 0.04) > RT (39.5 ± 0.04) > MAX Eye (39.4 ± 0.06) > MAX

Orbital gland (39.1 ± 0.09) > MAX Corneal (38.1 ± 0.07). As expected, RT and VT were highly correlated (R = 0.95; P < 0.01). Right and left eye MAX temperatures were significantly correlated (P < 0.01) with RT (R = 0.48 and 0.46, respectively) and VT (R = 0.50 and 0.44, respectively), and average eye MAX temperature (right eye MAX + left eye MAX / 2) was even more highly correlated (P < 0.01) with RT (R = 0.76) and VT (R = 0.77). These data suggest that thermography of eye (MAX temperature) may have application as a non-invasive method to measure body temperature in the ewe.

Key Words: Thermography, Ewe, Body temperature

584 The effects of immunization against LHRH using recombinant LHRH fusion protein OL on testicular development, ultrasonographic and histological appearance of the testis in buck kids.

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The purpose of this study is to evaluate the effectiveness of recombinant ovalbumin-LHRH-7 (OL) fusion protein on reproductive traits in buck kids. Twenty buck kids at 18 wk of age were divided into control (C, n = 10) and immunization (I, n = 10) groups. Immunized animals received OL protein generated by recombinant DNA technology. Ultrasonographic and histological examination of the testes was performed. Animals were slaughtered at 44 wk of age. Semen and epididymis were evaluated for the presence of sperm cells. Testicular and accessory glands development and sperm production were suppressed in the immunized animals. Semiferous tubule diameters decreased, basal membrane of the tubule was thickened and hyalinized in immunized buck kids. Immunization affected ultrasonographic appearance of the testes drastically. While testes of control animals gained their normal ultrasonographic appearance as the age increased, immunized animals had uniform hypoechogenic testicular structure as observed at 18 wk of age until slaughter. In conclusion, these results indicate that recombinant ovalbumin-LHRH-7 fusion protein is effective in immunocastration in buck kids and has a potential to be used as an alternative to physical castration.

Key Words: Immunocastration, LHRH fusion protein, Buck kids

585 Using novel chimeric gonadotropins with single (FSH) or dual (LH and FSH) activity to induce follicle development in sheep. E. P. Lemke^{*1}, B. M. Adams¹, I. Boime², and T. E. Adams¹, ¹University of California, Davis, ²Washington University, St. Louis, MO.

Follicle and corpus luteum (CL) development was examined in yearling lambs receiving novel chimeric gonadotropins with single (FSH) or dual (LH and FSH) activity. The gonadotropins were produced by CHO cells transfected with chimeric human genes that incorporate the coding regions of α , LH β , and FSH β subunits into single gene constructs (FSH β -CTP- α [FC α] and FSH β -CTP-LH β -CTP- α [FCLC α], where CTP represents the sequence encoding the C-terminal portion of hCG). The constructs encode proteins with FSH (FC α) or dual (LH and FSH; FCLC α) activity. Estrous activity was synchronized using vaginal inserts (CIDRs). To negate the confounding effects of endogenous gonadotropins, animals were passively immunized against GnRH 1 d prior to CIDR removal. Sheep (bwt = 61 ± 1 kg; n = 6/treatment) received a single injection (iv) of vehicle or the FC α or FCLC α (5 IU/kg) at CIDR removal. Ovulation was induced 3 d thereafter using hCG (1000 IU, iv). Follicle development was assessed by monitoring serum concentrations of estradiol (E2). Ovaries were collected at

slaughter 11 d after CIDR removal. Basal serum concentrations of E2 were maintained in control animals receiving vehicle. Conversely, serum levels of E2 were significantly increased 1-2 d after administration of either the FC α or FCLC α and peak concentration of E2 were noted 7-9 d thereafter. Combined ovarian weight 11 d after CIDR removal was 1.3 \pm 0.1 gm in control animals. Ovarian weight was increased ($P < 0.05$) in animals receiving the FC α (14.0 \pm 1.4 gm) or FCLC α (10.5 \pm 1.0 gm) chimeras. Most of the ovarian enlargement in chimera-treated animals was attributed to the formation of CLs. Although no CLs were noted in control animals, multiple CLs were evident in animals treated with FC α or FCLC α (9.5 \pm 1.1 and 6.7 \pm 1.2 CLs/sheep, respectively). Collectively, these observations demonstrate that both chimeric human gonadotropins induce profound follicle development in sheep. Supported by the USDA (NRI Grant 5-35203-16274).

Key Words: Ovulation, Sheep, Chimeric gonadotropin

586 Estrus and luteal activity of postpartum beef cows after treatment with estradiol. N. M. Long*, M. P. Davis, M. J. Prado-Cooper, I. Rubio, and R. P. Wettemann, *Oklahoma Agriculture Experiment Station, Stillwater.*

Multiparous Hereford x Angus postpartum cows (n = 49) were used to determine the effects of days post partum (25 or 50 d) and body condition score (BCS) at calving ($M \geq 5$ or $T < 5$) on estrus and luteal activity after treatment with estradiol cypionate (ECP). Cows were fed 1.8 kg/d of a 40% CP supplement and ad libitum hay after calving. An estrus detection system (Heatwatch, DDX inc.) was used commencing at 10 d before treatment. Cows were treated (im) with 1 mg ECP or corn oil (C) at 25 or 50 d after calving. Progesterone was quantified in plasma samples obtained from cows twice weekly for 2 wk before treatment, daily for 7 d after treatment, and twice weekly until the second estrus or 90 d after calving. Ovaries were examined by ultrasonography at treatment and concentrations of progesterone in plasma were used to ascertain the absence of corpora lutea. Data were analyzed with the GLM procedure (SAS). Treatment of cows with ECP at 25 d after calving increased ($P < 0.001$) the incidence of estrus within 4 d after treatment in M (55 vs 11 %) and T (50 vs 0 %) cows. Treatment of T cows at 50 d after calving increased ($P < 0.001$) estrus within 4 d (50 vs 0 %). Only 10 % of M cows were anovulatory at 50 d after calving and response to ECP could not be evaluated. Treatment with ECP did not influence the onset of ovarian luteal activity (LA, progesterone > 1ng/ml for 1 d) within 10 d after treatment. Onset of LA after calving was 53 \pm 16 d for M cows compared with 82 \pm 18 d for thin cows ($P < 0.001$). Days to LA were greater ($P < 0.05$) for T and M cows treated with ECP at 25 d post partum (74 \pm 23 d) compared with C cows (53 \pm 16 d), and ECP tended to increase ($P = 0.07$) days to LA for T cows treated at 50 d post partum. BCS of cows did not influence the incidence of estrus when cows were treated with ECP at 25 d after calving. Although ECP induced estrus in beef cows during the first 50 d after calving, normal luteal function was not initiated.

Key Words: Beef cows, Estradiol, Estrus

587 Timed AI conception rates after variations of the Ovsynch protocol in dairy cattle. M. A. Portaluppi, J. S. Stevenson*, and D. E. Tenhouse, *Kansas State University, Manhattan.*

Our objective was to determine fertility in dairy females after altering time of the second GnRH injection and AI relative to PGF2 α (PGF). Replacement heifers (n = 87) and 614 lactating cows previously

inseminated were diagnosed not pregnant at biweekly intervals to form 78 breeding clusters spanning 36 mo. At not-pregnant diagnosis (d 0), females received 100 μ g of GnRH, were blocked by lactation number (0, 1, 2, and +), and received 25 mg of PGF 7 d later. Females in 2 treatments received GnRH 48 h (G48) after PGF injection and TAI at the time of the second GnRH injection (G48 + TAI48) or 24 h later (G48 + TAI72). Females in the third treatment received GnRH 72 h after PGF when inseminated (G72 + TAI72). Ovaries of females in 66 clusters were scanned at d 0 (first GnRH injection) and 7 d later (PGF injection). Ovarian structures were mapped and ovulation in response to the first GnRH injection was detected on d 7. When estrus was detected before scheduled TAI, females were inseminated; otherwise TAI conception of remaining females was based on timing of GnRH and AI. On d 7, new corpora lutea (CL) were detected in 43.2% of females. Incidence of ovulation increased ($P < 0.05$) with increasing lactation number and total number of follicles ≥ 8 mm, but decreased ($P < 0.001$) with increasing number of CL on d 0. Follicle diameters on d 0 did not differ between females that did (13.2 \pm 0.2 mm) and did not ovulate (12.9 \pm 0.2 mm). Follicle diameters increased ($P < 0.05$) with increasing lactation number, but decreased ($P < 0.01$) with increasing numbers of CL and follicles ≥ 8 mm on d 0. Conception rate was 26.5% in 98 females that showed estrus and were inseminated early. Although timed AI conception rates or pregnancy rates did not differ among treatments, the G48 + TAI72 treatment resulted in the best timed AI conception rates, especially for heifers and cows in their third or greater lactation. When number of CL on d 0 and ovulation incidence was included in the model with 603 females, conception rate tended ($P = 0.06$) to be greater for G48 + TAI72 (32.4%) than for G48 + TAI48 (22.8%), but not for G72 + TAI 72 (25.2%).

Table 1. Fertility Results

	G48 + TAI48	G48 + TAI72	G72 + TAI72
TAI conception rate ¹ , %	22.8 (226)	28.3 (232)	23.2 (234)
Pregnancy rate ² , %	22.0 (226)	21.8 (232)	16.7 (234)

¹Excludes 98 females inseminated early before TAI. ²Assumes early inseminated females would not have conceive if TAI.

Key Words: Ovsynch, Ovulation, Conception rate

588 Cis-9, trans-11 and trans-10, cis-12 conjugated linoleic acids reduce prostaglandin F2A production by bovine endometrial cells. N. R. Kendall¹, A. L. Lock², D. E. Bauman², B. K. Campbell³, and G. E. Mann*¹, ¹University of Nottingham, Sutton Bonington, Loughborough, UK, ²Cornell University, Ithaca, NY, ³University of Nottingham, Queens Medical Centre, UK.

In cows, the establishment of pregnancy results from the embryo inhibiting the release of prostaglandin F2 α (PGF2 α) responsible for the demise of the corpus luteum. Failure of this inhibition contributes to high levels of early embryo loss. Any treatment that can reduce endogenous PGF2 α secretion has the potential to increase pregnancy rates. Appropriate dietary modification can increase incorporation of conjugated linoleic acid (CLA) isomers into uterine tissues, though the effects of these CLA isomers on PGF2 α secretion remain to be determined in the cow. The objective of this study was to examine the effects of cis-9, trans-11 and trans-10, cis-12 CLA on PGF2 α production from cultured bovine uterine endometrial cells. Uterine endometrium was collected from cattle at a local slaughter house and endometrial cells collected by enzymatic dispersion and cultured (6

replicates) for 192h with or without addition of 50µM or 100µM of trans-10, cis-12 CLA or cis-9, trans-11 CLA. PGF2α was measured by radioimmunoassay in culture medium collected at 48 h intervals during culture. Culture with both isomers resulted in significant (P < 0.001) dose dependant (P < 0.05) inhibition of PGF2α secretion compared to control cultures. Treatment with trans-10, cis-12 CLA resulted in PGF2α concentrations at 48, 96, 144 and 192 h of culture of 78%, 55%, 38% and 23% of control values following treatment at 50µM and 43%, 28%, 21% and 19% of control values following treatment at 100µM. Treatment with cis-9, trans-11 CLA resulted in

PGF2α concentration at 48, 96, 144 and 192 h of culture of 53%, 36%, 28% and 15% of control values following treatment at 50 µM and 21%, 12%, 7% and 8% of control values following treatment at 100 µM. The cis-9, trans-11 isomer consistently caused greater inhibition than the trans-10, cis-12 isomer. These results demonstrate that both CLA isomers significantly inhibited PGF2α secretion by uterine endometrial cells, and may have potential to improve the establishment of pregnancy in cows. Further work is required to determine whether these effects occur in vivo and to establish optimum doses.

Key Words: CLA, PGF2α, Endometrium

Ruminant Nutrition: Calves & Heifers – Dairy

589 Effects of dietary fish oil on immunocompetence of neonatal Jersey calves. M. A. Ballou* and E. J. DePeters, *University of California, Davis.*

Fifty-one Jersey, bull calves (4±1 day old) were completely randomized to one of three treatments to evaluate the effects of dietary fish oil on immunocompetence. Treatments differed only in the fatty acid (FA) composition of the milk replacer, which was altered by supplementing 2% of the DM with FA from various lipids. Treatments included a control with a 3:1 blend of corn and canola oils, a 1:1 mix of fish oil and the control blend, and fish oil only. Body weight, height at withers, and length between withers and pins were measured weekly. Fecal and respiratory scores were recorded multiple times daily. Peripheral blood samples were collected on d 0, 7, 14, 21, and 42; the FA composition of plasma and peripheral blood mononuclear cell (PBMC) phospholipids was measured. Immunocompetence of calves was evaluated by the ability of neutrophils and monocytes to phagocytose *E. coli* and produce an oxidative burst, the change in ear thickness following an intradermal injection of phytohemagglutinin-P (PHA-P), and the primary and secondary humoral responses to ovalbumin (OVA). Adding fish oil to milk replacer significantly altered the omega-3, omega-6, and their FA ratios in both plasma and PBMC phospholipids and the response was dose and time dependent. Production and health parameters were unaffected by treatments. There were no significant treatment or treatment*time effects on phagocytosis; however there was a significant bell-shaped response on the percent of neutrophils producing an oxidative burst (49.9, 62.8, and 50.8 %; P=0.05). Fish oil did not affect the change in ear thickness in response to PHA-P. There was also no treatment effect on the primary IgG humoral response to OVA, but there was a significant bell-shaped treatment effect on the secondary IgG response (1.06, 0.79, and 1.03 OD; P=0.01). There was no significant IgM response in any treatment following either the primary or secondary OVA vaccination. Adding fish oil to milk replacer altered various functional immune responses and the effect was bell-shaped. However, no differences in the production or health of these calves were evident.

Key Words: Calves, Fish oil, Health

590 Modifying the acute phase response of neonatal Jersey calves by supplementing milk replacer with fish oil. M. A. Ballou* and E. J. DePeters, *University of California, Davis.*

Fifty-one Jersey, bull calves (4±1 day old) were completely randomized to one of three treatments to evaluate the effects of dietary fish oil on the acute phase response. Treatments differed only in the fatty acid composition of the milk replacer, which was altered by supplementing

2% of the dry matter (DM) with fatty acids from various lipids. Treatments included a control with a 3:1 blend of corn and canola oils, a 1:1 mix of fish oil and the control blend, and fish oil only. On d 23 each calf was injected subcutaneously with 4 µg/kg BW of *Salmonella typhimurium* endotoxin. Clinical, hematological, and biochemical parameters were measured at 0, 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 18, 24, and 72 h. Endotoxin caused a dramatic rise in respiratory rate; feeding fish oil significantly attenuated the increase (41.4, 35.1, 34.5 breaths/min; P=0.01). Heart rate and rectal temperature were not affected by treatment. Feeding fish oil attenuated the change in serum iron concentration over time (P=0.02). There was no effect of treatment on serum glucose concentration. Endotoxin also caused acute increases in blood urea nitrogen (BUN) and non-esterified fatty acids (NEFA); there were significant linear effects of fish oil on both BUN (8.34, 8.16, and 7.70 mg/dl; P=.02) and NEFA (0.689, 0.608, 0.524 mEq/L; P=0.02). Serum triglycerides (TG) were elevated beginning at 12 h after the endotoxin challenge and returned to baseline values within 72 h. Fish oil suppressed the rise in TG during this period, and the effect was linear (52.7, 42.8, and 33.4 mg/dl; P=0.01). There was no treatment effect on serum aspartamine aminotransferase activity, but there was a tendency (P=0.10) for fish oil to increase serum lactate dehydrogenase activity. Adding fish oil to milk replacer attenuates many aspects of the acute phase response, and the effect is linear in the range of 1 to 2% of the DM as fatty acids from fish oil. Adding fish oil might provide a better balance between a necessary versus an excessive acute phase response.

Key Words: Calves, Fish oil, Inflammation

591 Sodium zeolite A supplementation to dairy calves. K. Turner*¹, B. Nielsen², C. O'Connor², D. Rosenstein², H. Schott², C. Womack², F. Nielsen³, and M. Orth², ¹The University of Georgia, Athens, ²Michigan State University, East Lansing, ³Grand Forks Human Nutrition Research Center, Grand Forks, ND.

Sodium zeolite A (SZA), an aluminosilicate, has been used in animal studies, but alterations in mineral metabolism and tissue composition have not been fully investigated. The objective of this study was to determine the effects of SZA on mineral metabolism and tissue mineral composition in bull calves. At three days of age, twenty calves were placed according to birth order into one of two groups: SS, receiving 0.05% BW SZA daily in milk replacer and CO, receiving only milk replacer. Blood samples were collected on d 0, 30, and 60 for mineral analysis (Si, Al, Ca, Cu, Fe, Mg, P, Zn). Total collections of feces and urine were performed on d 30 for mineral metabolism. Calves were euthanized on d 60 and multiple tissues were harvested for mineral

analyses. Supplementation with SZA resulted in greater intakes of Si and Al ($P < 0.0001$). There was no difference in Si absorption or retention between groups. Plasma Si concentration in both groups increased from d 0 to d 15 but decreased to below starting values on d 30 ($P < 0.05$) and plasma Si concentration was higher in SS calves on d 15 ($P < 0.05$). Silicon content was greater in aorta, spleen, lung, muscle, and kidney of SS calves ($P \leq 0.05$). Retention of Al was greater in SS calves ($P = 0.001$). Despite a lack of change in plasma Al concentration in SS calves, all SS tissues analyzed had greater Al content ($P \leq 0.05$). Although there was no difference in Mg absorption or retention, plasma Mg concentration was lower and heart, kidney, liver and pancreas Mg contents were greater in SS calves ($P < 0.05$). Phosphorus absorption tended to be lower in SS calves ($P = 0.09$), and plasma P concentration was lower ($P < 0.05$). However, there was no difference in P tissue mineral content. Iron was the only mineral found to be lower in SS tissues ($P \leq 0.05$), suggesting possible antagonism with Al absorption. In conclusion, SZA alters mineral metabolism and tissue mineral composition of dairy calves, presumably through interactions with Al.

592 Ruminal development in Holstein dairy calves fed distillers grains. M. Thomas*, A. R. Hippen, K. F. Kalscheur, and D. J. Schingoethe, *South Dakota State University, Brookings.*

To evaluate the effect of calf starters containing dried distillers grains (DDG) on rumen development, 12 Holstein bull calves (3.4 days of age, SD 2.6) were blocked by birth weight and randomly assigned to one of three dietary treatments. Diets were formulated to contain 22% CP. The control diet (Ctrl) consisted of cracked dry corn, molasses, rolled oats, 44% CP soybean meal, and vitamin and mineral supplements to meet NRC 2001 suggested requirements. The experimental diets contained 28% DDG (T1) and 56% DDG (T2) (DM-basis) respectively, with DDG partially substituting for corn, oats, and soybean meal. Calves were housed individually and fed experimental diets once daily for ad libitum consumption for 12 wk. All the calves received commercial milk replacer (CP 22%) until weaning at 7 wk of age. Calves were sacrificed at 12 wk of age at which time, rumen tissues were collected for rumen epithelial growth measurements, and ruminal fluid was collected for measuring pH and volatile fatty acids. Weight of empty rumens and intestines were recorded. The average papillae densities per cm^2 of the rumen tissue were 75.4, 117.1 and 98.7 for calves fed Ctrl, T1 and T2, respectively, with Ctrl differing from T1 ($P < 0.02$). Papillae length (0.29, 0.22 and 0.22 cm) was greater for Ctrl than T1 and T2 ($P < 0.05$). Papillae width (0.07, 0.06 and 0.06 cm) was greater for Ctrl than T1 ($P < 0.06$) and T2 ($P < 0.07$). Hence, the average surface area for papillae was greater for calves fed Ctrl ($P < 0.03$) than for those fed diets containing DDG. There was no difference in the total surface area of papillae per cm^2 of rumen tissue. The pH of the ruminal fluid (5.38, 5.28 and 5.14) was higher for Ctrl than T2 ($P < 0.03$). Empty weight of rumen were 4.6, 3.2 and 3.7 Kg with Ctrl differing from T1 ($P < 0.02$) and T2 ($P < 0.07$). There were no significant differences in rumen volatile fatty acid concentrations and weight of intestines across treatments. This study indicated that the inclusion of DDG in calf starters increased the number of rumen papillae per unit area; however the positive influence of this is diminished by decreased size and surface area of individual papillae.

Key Words: Distillers grains, Dairy calves, Rumen development

593 Effect of altering theoretical rumen degraded and metabolizable protein in a calf starter. T. Hill*, J. Aldrich, H. Bateman, and R. Schlotterbeck, *Akey, Lewisburg, OH.*

The objective of the trial was to compare feeding three calf starters with different concentrations of rumen degraded (RDP), metabolizable protein (MP), metabolizable lysine (Mlys), and metabolizable methionine (MMET). Most published trials that compare starters with different concentrations of MP have increased MP while reducing RDP. Additionally, RDP and MP values of feeds are based on trials in older animals. Calves were fed starters and water free choice from d 1-56. Starters were complete pellets. Starter A contained 53.9% corn, 24.25% soybean meal, 14.0% wheat midds, 2.5% molasses, and other non-protein ingredients and was 18% CP as-fed. Starter B (over 10% more MP, Mlys, MMET, but less RDP than Starter A) contained 60.9% corn, 8.45% soybean meal, 14.0% wheat midds, 4.6% blood meal, 2.5% molasses, 2.2% fish meal, 2.2% corn gluten meal, and other non-protein ingredients and was 18% CP as-fed. Starter C (equal RDP to Starter A; equal MP, Mlys, MMET to Starter B) contained 52.46% corn, 17.89% soybean meal, 14.0% wheat midds, 3.4% blood meal, 2.5% molasses, 2.4% fish meal, 2.4% corn gluten meal, and other non-protein ingredients and was 21% CP as-fed. All 48 Holstein calves from one dairy (initially 2-3 d old, 43 ± 1 kg, 5.0 ± 0.2 mg serum protein/dl) were fed 0.681 kg daily of a 26% CP, 17% fat milk replacer and weaned at 28 days. Calves were housed in a naturally ventilated nursery with no heat in individual pens bedded with straw. Data were analyzed as a completely randomized block design. Treatment means did not differ ($P > 0.1$) for gain (0.56 ± 0.02 kg), starter intake (2.11 ± 0.09 kg), gain to feed efficiency (0.40 ± 0.02), hip width change (4.0 ± 0.2 cm), body condition score, fecal score, or medical days from 0-56 d. Increasing the theoretical MP, Mlys, and MMET concentration of the starter did not change calf performance during the first two months of life, suggesting that these theoretical values for the feeds are not appropriate for young calves and/or protein fractions were not limiting gain.

Key Words: Calves, Rumen undegraded protein, Metabolizable protein

594 Effect of altering theoretical rumen undegraded soybean protein in a calf starter. T. Hill*, J. Aldrich, H. Bateman, and R. Schlotterbeck, *Akey, Lewisburg, OH.*

The objective of the trial was to compare feeding two calf starters with similar CP, amino acid and energy concentrations but with different amounts of undegraded soybean CP. Most published trials that compared starters with different concentrations of undegraded protein have confounded amino acid composition or other nutrients. Additionally, theoretical undegraded protein values of feeds are based on trials in older animals. Calves were fed 18% CP as-fed starters (37% corn, 35% supplement pellets, 25% oats, 3% molasses) and water free choice from d 1-56. The low undegraded protein starter contained (as-fed basis) a supplement with 68.34% soybean meal, 18% wheat midds, and other non-protein ingredients. The high undegraded protein starter contained a supplement with 63.1% modified expeller extracted soy protein (Soyplus[®], Ralston, IA), 14.5% soybean meal, 9.4% wheat midds, and other non-protein ingredients resulting in over 30% more undegraded protein and over 10% more metabolizable protein compared to the low undegraded protein starter. All 48 Holstein calves from one dairy (initially 2-3 d old, 42 ± 2 kg, 5.2 ± 0.2 mg serum protein/dl) were fed 0.681 kg daily of a 26% CP, 17% fat milk replacer and weaned at 28 days. Calves were housed in a naturally ventilated

nursery with no heat in individual pens bedded with straw. Data were analyzed as a completely randomized block design. Treatment means did not differ ($P > 0.1$) for gain (0.55 ± 0.04 kg), starter intake (2.31 ± 0.14 kg), gain to feed efficiency (0.44 ± 0.02), hip width change (3.6 ± 0.4 cm), body condition score, fecal score, or medical days from 0-56 d. Increasing theoretical rumen undegraded protein and metabolizable protein while other nutrients in the starter were equal did not change performance during the first two months of life, suggesting that these theoretical values for the feeds are not appropriate for young calves and/or protein fractions were not limiting gain.

Key Words: Calves, Rumen undegraded protein, Starter

595 Enhanced-growth feeding program: Starter digestibility at weaning. M. Terré^{*1}, A. Bach^{2,1}, and M. Devant¹, ¹*Institut de Recerca i Tecnologia Agroalimentàries-Unitat de Remugants, Barcelona, Spain*, ²*Institució Catalana de Recerca i Estudis Avançats, Barcelona, Spain*.

Calves following an enhanced-growth feeding program usually show worse gain to feed ratio the weeks around weaning. To assess whether this decrease is due to a potentially lower capacity to digest starter after weaning of calves receiving an enhanced-growth feeding program, 19 Holstein male calves were used to determine starter apparent nutrient digestibility the week after weaning. Calves were divided in two groups: calves following a conventional feeding program (CF) and calves following an enhanced-growth feeding program (EF). After one week of adaptation to milk replacer (25% CP and 19% fat), the CF calves were fed 4 l/d of milk replacer (MR) at 12.5% DM from 1-27 d, and 2 l/d from 28-34 d, and the EF calves were offered MR at 18% DM: 4 l/d from 1-6 d, 6 l/d from 7-13 d, 7 l/d from 14-20 d, 6 l/d from 21-27 d, and 3 l/d from 28 d to weaning at 34 d of study. Calf starter (19.7% CP) was offered ad libitum from the beginning to the end of the study at 42 d, and starter consumption was recorded daily. Calves were weighed at 7, 24, 31, 38 and 42 d of study. Daily total feces collection was conducted the last 5 days of study. Final BW tended ($P = 0.08$) to be greater in EF than CF calves (87.9 vs 82.0 ± 1.93 kg, respectively). Starter DMI was greater ($P < 0.05$) in CF compared with EF calves (0.97 vs 0.64 ± 0.091 kg/d, respectively), but there were no differences in total DMI (1.46 and 1.52 ± 0.11 , kg/d in CF and EF, respectively). Calves in both treatments presented similar gain to feed ratios the weeks before and after weaning. However, apparent DM, OM, NDF, and CP digestibilities were greater ($P < 0.05$) in CF compared with EF calves (77.4 vs $71.8 \pm 1.23\%$, 78.6 vs $73.3 \pm 1.31\%$, 34.7 vs $20.3 \pm 3.79\%$, and 77.1 vs $71.6 \pm 1.29\%$, respectively) the week after weaning. Calves in the EF treatment presented lower nutrient digestibility compared with CF calves the week after weaning, but differences in gain to feed ratio were not found in the current study.

Key Words: Calves, Weaning, Digestibility

596 Effects of an intensified compared to a moderate feeding program during the preweaning phase on long-term growth, age at calving, and first lactation milk production. L. Davis Rincker^{*}, M. VandeHaar, C. Wolf, J. Liesman, L. Chapin, and M. Weber Nielsen, *Michigan State University, East Lansing*.

We previously found that increasing the energy and protein intake during the preweaning period resulted in larger and taller calves at weaning, decreased age at puberty and at conception, but also increased

preweaning feed cost per kg of gain. The experimental objective was to determine if increasing the energy and protein intake from 2 d to 6 wk of age would affect long-term body growth, age at first calving, and first lactation milk yield. Holstein heifers ($n = 80$) born throughout the year at the Michigan State University Dairy Teaching and Research Center were assigned randomly to 1 of 2 dietary treatments (moderate, M; high, H). The M diet consisted of a standard milk replacer (21.5% CP, 21.5% fat) fed at 1.2% of BW on a DM basis and a 19.9% CP starter grain fed to achieve 0.45 kg of average daily gain (ADG). The H diet consisted of a high-protein milk replacer (30.6% protein, 16.1% fat) fed at 2.1% of BW on a DM basis and a 24.3% CP starter grain fed to achieve 0.68 kg ADG. Calves were gradually weaned by 6 wk of age and were fed and housed similarly after 8 wk of age. Withers height, BW, and hip width measurements were taken every 4 wk after the treatment period. Heifers became eligible for breeding at 397 kg BW. Age at calving was 17 d earlier for heifers fed the H diet during the preweaning period ($P = 0.05$). Body weight taken after calving was not different and averaged 574 and 563 kg for M and H, respectively ($P = 0.13$, $SE = 5.2$). Daily gain during gestation, withers height at calving, BCS at calving, calving difficulty score, and calf BW were not different ($P > 0.4$). Average daily milk yield for the first 60 DIM was 30.5 kg for both treatments ($P > 0.9$). Intensified feeding programs during the preweaning phase is one way that producers can decrease age at first calving without causing detrimental effects on milk yield. Collection of milk production and health data through 150 DIM and economic analyses are ongoing.

Key Words: Calf, Nutrition, Milk replacer

597 The effects of restricted feeding high concentrate or high forage rations on rumen fermentation in dairy heifers. G. I. Zanton^{*} and A. J. Heinrichs, *The Pennsylvania State University, University Park*.

Feeding dairy heifers represents a balance between providing the precise nutrient requirements for maintenance and growth while minimizing the costs associated with meeting these nutrient requirements. Although a majority of the required nutrients are provided by forages in most dairy heifer rations, replacing the nutrients from forages with concentrates holds the potential to increase the efficiency of raising dairy heifers by lowering feed costs, improving metabolic efficiency, and reducing manure output. The objectives of this experiment were to evaluate rumen fermentation in dairy heifers fed a high concentrate (HC) or a high forage (HF) ration at two ages. The experiment was designed as a split plot design with Young (Y; 313 ± 4 d; 263 ± 6 kg) and Old (O; 666 ± 8 d; 583 ± 6 kg) heifer blocks given HC and HF twice daily to four rumen cannulated heifers per block for four, 28d periods. Rumen contents were sampled over d22-23 and removed on d14 and 28. Both the HC and the HF rations contained the same feeds, but in differing proportions, yielding two treatment rations containing 75 or 25 percent of the ration dry matter as forages (corn silage, grass, and alfalfa hay). The treatment rations were fed restrictedly to provide 0.22 Mcal ME and 1.9 g N per kg EBW^{0.75}. The heifers fed HF had increased total rumen content wet weight (37.84 HC vs. 42.18 HF ± 1.36 kg; $P < 0.01$). Total VFA concentrations were not altered by dietary treatment (110.80 HC vs. 112.87 HF ± 5.00 mM; $P > 0.14$). Similar concentrations of total VFA occurred due to higher acetate concentrations, lower butyrate concentrations (both $P < 0.01$), and a tendency for reduced propionate concentrations ($P > 0.07$) in HF. Mean rumen pH was lower for HC (6.24 HC vs. 6.51 HF ± 0.10 ; $P < 0.01$) and the amount of time that the pH was lower than 6.00 was greater in HC (7.12 HC vs. 3.15 HF \pm

1.84 hr.; $P < 0.01$). We conclude that feeding HC can produce changes in rumen fermentation in Y and O heifers, but the magnitude of these changes can be reduced by restricting intake.

Key Words: Dairy heifers, Forage:concentrate, Rumen fermentation

598 The effects of restricted feeding high concentrate or high forage rations on nutrient digestibility and nitrogen utilization in dairy heifers. G. I. Zanton*, A. J. Heinrichs, and E. F. Wheeler, *The Pennsylvania State University, University Park.*

The objective of this experiment was to evaluate nutrient digestibility and nitrogen utilization in dairy heifers fed a high concentrate (HC) or a high forage (HF) ration at two different ages. The experiment was designed as a split plot design with Young (Y; 313 ± 4d; 263 ± 6kg) and Old (O; 666 ± 8d; 583 ± 6kg) heifer blocks given HC and HF twice daily to four cannulated heifers per block for four, 28d periods with four days of total fecal and urine collection. Ammonia volatilization was analyzed once per period per heifer from a 200 g combination of urine and feces. The rations (25% HC vs. 75% HF forage; corn silage, alfalfa, and grass hay) were fed restrictedly to provide 0.22 Mcal ME and 1.9 g N per kg EBW^{0.75}. Organic matter intake was lower for heifers fed HC ($P < 0.01$), however due to improved OM digestibility (75.97 HC vs. 71.53 HF ± 0.70%; $P < 0.01$), intake of digestible OM was not different between treatments ($P > 0.20$). NDF digestibility was not significantly affected by dietary treatment (52.92 HC vs. 51.18 HF ± 1.46%; $P > 0.20$). Nitrogen intake was greater for the heifers fed HC (162 HC vs. 155 HF ± 2g/d; $P < 0.01$), however fecal N excretion tended to be greater for HF ($P < 0.06$) because of improved apparent N digestibility for HC ($P < 0.01$). Urinary N excretion was not affected by treatment ration ($P > 0.20$), leading to greater overall N retention for heifers fed HC ($P < 0.01$). The ammonia volatilization rate, when adjusted to reflect the greater production of urine and feces by HF, was greater for heifers fed HF (28.74 HC vs. 33.15 HF ± 1.00g/d; $P < 0.01$). Nitrogen retention was not different between Y and O heifers (34 Y vs. 38 O ± 2 g/d; $P > 0.20$). The proportion of absorbed N that was retained was therefore greatest in Y heifers and those fed HC ($P < 0.01$), however there were no significant interactions between age and ration. From these results we conclude that Y and O heifers fed HC will have improved efficiency of OM and N utilization when intake is controlled.

Key Words: Dairy heifers, Forage:concentrate, Digestibility

599 The effect of limit-feeding gravid Holstein heifers on first lactation milk production. P. Hoffman*, C. Simson, and M. Wattiaux, *University of Wisconsin, Madison.*

A study was conducted to evaluate the effect of limit-feeding gravid Holstein heifers on growth, feed efficiency, fecal excretion, behavior and first lactation milk production. Gravid Holstein heifers (n=54) weighing 464 kg were randomly assigned to one of nine pens containing six heifers/pen. Heifers were fed one of three experimental diets for 111 d. Control (C100) heifers were ad libitum fed a diet containing 11.3 percent CP and 2.46 Mcals/kg of metabolizable energy (ME). Two experimental diets of increased nutrient density were formulated to contain 12.7 and 14.2 percent CP and 2.55 and 2.68 Mcals/kg of ME respectively. Feed intake of these diets was limited to 90 (L90) and 80 (L80) percent of C100 intake. Nutrient intake, growth, fecal excretion, blood profiles, behavior and lactation performance of heifers were evaluated. Limit-fed heifers (L90, L80) consumed less ($P < 0.01$) DM (9.02, 8.30 vs 9.66 kg/d), but limit-feeding had no effect ($P > 0.10$) on any measure heifer growth. Feed efficiency was improved ($P < 0.09$) by 1.04 kg DM intake/kg gain by limit-feeding. Heifers fed L90 and L80 excreted 0.36 and 0.86 kg less ($P < 0.10$) DM but excreted similar amounts of N and P as compared to heifers fed C100. Limit-fed heifers spent less ($P < 0.05$) time eating, more ($P < 0.01$) time standing without eating and vocalized more ($P < 0.03$) than heifers fed C100. Milk production and parturition data from control and limit-fed heifers were collected between 0-150 DIM. Dystocia indexes, calf BW and postpartum BW of limit-fed heifers were not different ($P > 0.44$) between limit-fed heifers and heifers fed C100. Daily milk yield was similar ($P > 0.66$) at 30.6, 30.7 and 32.2 kg/d for heifers fed C100, L90 and L80 respectively. Likewise, milk fat and protein composition was not different ($P > 0.36$) between limit-fed and C100 fed heifers. Projected 305 first lactation milk yields were 8303, 8633, and 8948 kg/305 d for C100, L90 and L80, respectively. Data suggest limit feeding gravid Holstein heifers improved feed efficiency, decreased fecal excretion and had little effect on first lactation performance.

Key Words: Heifers, Limit feeding, Milk production

Ruminant Nutrition: Minerals & Vitamins

600 Effect of dietary vitamin A restriction on marbling in growing cattle. M. Gorocica-Buenfil*, F. Fluharty, C. Reynolds, and S. Loerch, *The Ohio State University, Wooster.*

To determine the effect of the duration of dietary vitamin A restriction on the site of fat deposition in growing cattle, 60 Holstein steers (BW = 219.1 kg) were fed a high-moisture corn-based diet with 2,200 IU supplemental vitamin A/kg DM (C) or no supplemental vitamin A for a long (243 d; LR) or short (131 d; SR) restriction before harvest at 243 d. The SR steers were fed the C diet for the first 112 d. Steers were penned individually and feed was offered ad libitum. Jugular vein blood samples for serum retinol analysis were taken on d 1, 112 and 243. Feedlot performance (ADG, DMI and G:F) was not affected ($P > 0.05$) by vitamin A restriction. At the end of the experiment, the intramuscular fat content of the longissimus muscle was 33% greater

($P < 0.05$) for LR vs. C steers (5.6 vs. 4.2% Ether extractable fat (EE), respectively), while EE of the longissimus muscle of SR steers was 3.9%. Depth of BF and KPH percentage were not affected ($P = 0.44$ and 0.80, respectively) by vitamin A restriction. Marbling scores were numerically greater for the LR steers (LR = 433.8, SR = 370.6, C = 401.7; $P = 0.36$). Carcass weight, composition of edible carcass and YG were similar among treatments ($P > 0.10$). Liver (LR = 6.1, SR = 6.5, and C = 44.7 µg/g; $P < 0.01$) but not subcutaneous fat retinol (LR = 0.5, SR = 0.7, and C = 0.6 µg/g; $P = 0.33$) was reduced in LR and SR steers. Vitamin A restriction reduced ($P < 0.01$) serum retinol by d 112 (LR = 2.8, SR = 4.2, and C = 3.8 µg/dL). On d 243, LR and SR steers had similar serum retinol levels and these were lower ($P < 0.01$) than those of C steers (LR = 2.1, SR = 2.5, and C = 3.7 µg/g). These results suggest that serum and liver retinol levels can be reduced

feeding a low vitamin A diet for 112 d. Restricting vitamin A intake for 243 d increased intramuscular fat percentage without affecting subcutaneous or visceral fat deposition, feedlot performance, or carcass weight. Restricting vitamin A intake for 131 d or less appears to be insufficient to affect the site of fat deposition in Holstein steers.

Key Words: Vitamin A, Steers, Marbling

601 Bioavailability of copper from copper glycinate when fed in the presence of high sulfur and molybdenum. S. L. Hansen^{*1}, P. Schlegel², K. E. Lloyd¹, L. R. Legleiter¹, and J. W. Spears¹, ¹North Carolina State University, Raleigh, ²Pancosma, S.A., Geneva, Switzerland.

Sixty Angus (n=29) and Angus-Simmental cross (n=31) steers, averaging 9 mo of age and 277 kg initial BW, were used in a 148-d study to determine the bioavailability of copper glycinate (CuGly) relative to feed grade copper sulfate (CuSO₄) when supplemented to diets high in sulfur (S) and molybdenum (Mo). Steers were blocked by weight within breed and assigned to one of five treatments: 1) control (no supplemental Cu), 2) 5 mg Cu/kg DM from CuSO₄, 3) 10 mg Cu/kg DM from CuSO₄, 4) 5 mg Cu/kg DM from CuGly, and 5) 10 mg Cu/kg DM from CuGly. Steers were individually fed a corn-silage based diet (analyzed 7.9 mg Cu/kg DM), and supplemented with 2 mg Mo/kg of diet DM and 0.15% S for 120 d (Phase 1). Steers were then supplemented with 6 mg Mo/kg of diet DM and 0.15% S for 28 d (Phase 2). Average daily gain and G:F were improved by Cu supplementation regardless of source (P = 0.01). Final ceruloplasmin (Cpl), plasma Cu and liver Cu values were greater (P < 0.05) in steers fed supplemental Cu compared with controls. Plasma Cu, liver Cu and Cpl values were higher (P < 0.05) in steers supplemented with 10 mg Cu/kg DM versus those supplemented with 5 mg Cu/kg DM. Based on multiple linear regression of final plasma Cu, liver Cu and Cpl values on dietary Cu intake in Phase 1 (2 mg Mo/kg DM), bioavailability of Cu from CuGly relative to CuSO₄ was 140 (P = 0.10), 131 (P = 0.12) and 140% (P = 0.09), respectively. Relative bioavailability of Cu from CuGly was greater (P = 0.01; 144, 150 and 156%, based on plasma Cu, liver Cu and Cpl, respectively) than from CuSO₄ following supplementation of 6 mg Mo/kg DM for 28 d. Results of this study suggest that Cu from CuGly is more available than CuSO₄ when supplemented to diets high in S and Mo.

Key Words: Bioavailability, Cattle, Copper

602 Plasma diamine oxidase as a biomarker of copper deficiency in the bovine. L. R. Legleiter^{*} and J. W. Spears, North Carolina State University, Raleigh.

Twenty-eight Angus steers (n = 11) and heifers (n = 17) were used to determine the efficacy of plasma diamine oxidase activity as a biomarker of copper (Cu) deficiency in the bovine. The steers and heifers were born to dams assigned to one of the following treatments: 1) control (10 mg Cu and 20 mg Mn/kg DM), 2) Cu deficient (-Cu; 2 mg molybdenum (Mo) and 20 mg Mn/kg DM), and 3) Cu deficient plus high Mn (-Cu+Mn; 2 mg Mo and 500 mg Mn/kg DM). Molybdenum was used to induce Cu deficiency. Following weaning at 7 mo of age calves were maintained on the above treatments through 15 mo of age and were individually fed via Calan gates. Plasma diamine oxidase (DAO), a Cu-dependent enzyme responsible for the degradation of cadaverine and putrescine, was measured on d 420. Using Mo to induce Cu deficiency was successful as indicated by indices of Cu status

(Table 1). Plasma Cu was significantly decreased (P < 0.01) in cattle receiving -Cu and -Cu+Mn treatments. High dietary Mn (-Cu+Mn) further depressed (P < 0.01) plasma Cu compared to the -Cu diet alone. Liver Cu stores and ceruloplasmin activity were significantly reduced (P < 0.01) in Cu deficient cattle compared to the controls. Plasma diamine oxidase activity was decreased (P < 0.01) in Cu deficient animals compared to controls and tended (P = 0.19) to be further depressed in animals receiving high Mn. These data demonstrate that plasma diamine oxidase activity can be used as a biomarker of Cu deficiency in the bovine.

Table 1. Copper indices of cattle fed control, Cu deficient, and Cu deficient plus high Mn diets.

	Control	-Cu	-Cu+Mn	SEM
Plasma Cu, mg/L ^{a,b}	1.32	0.37	0.10	0.04
Liver Cu, mg/kg DM ^a	178.1	4.6	2.3	8.0
Ceruloplasmin, mg/dL ^a	33.6	6.6	3.6	2.6
Diamine oxidase, U/L ^{a,c}	167.0	61.3	31.1	15.9

^aControl vs. -Cu & -Cu+Mn (P < 0.01); ^b-Cu vs. -Cu+Mn (P < 0.01); ^c-Cu vs. -Cu+Mn (P = 0.19)

Key Words: Cattle, Copper, Diamine oxidase

603 Effect of dietary potassium level and source on performance of finishing cattle fed varying dietary sulfur. R. S. Fry^{*}, K. E. Lloyd, and J. W. Spears, North Carolina State University, Raleigh.

An experiment was conducted to determine the effects of potassium (K) level and source on performance of finishing cattle fed diets low or high in sulfur (S). Sixty Angus and Angus-cross heifers (average initial BW 368 kg) were blocked by previous treatment and weight and randomly assigned to treatments. Treatments consisted of: 1) control (no supplemental S or K), 2) 0.30% supplemental K from KCl, 3) 0.30% supplemental K from K₂CO₃ (DCAD PlusTM), 4) 0.30% supplemental S from NH₄SO₄, 5) 0.30% supplemental S from NH₄SO₄ and 0.30% K from KCl and 6) 0.30% supplemental S from NH₄SO₄ and 0.30% K from K₂CO₃. The control diet analyzed 0.51% K and contained approximately 0.15% S. Heifers were housed in pens of 12 and individually fed using electronic Calan gates. Cattle were slaughtered after receiving a high corn finishing diet for either 101 or 121 d. Equal numbers of heifers per treatments were harvested on each day. Potassium addition to the control diet did not affect performance or carcass characteristics regardless of dietary S. Longissimus muscle area tended (P < 0.10) to be affected by a K source × S interaction. Heifers not receiving supplemental S had larger longissimus muscle areas (P < 0.01; 83.9 vs. 75.3 cm²) when fed K₂CO₃ compared with those supplemented with KCl. Potassium source did not affect longissimus muscle area of heifers fed high dietary S. Addition of 0.30% S to the diets reduced (P < 0.01) ADG (1.49 vs. 1.20 kg), and ADFI (8.73 vs. 7.19 kg) but did not affect G:F (0.172 vs. 0.167). Hot carcass weights (P < 0.01; 313.7 vs. 289.2 kg) and dressing percentage (P = 0.06; 59.1 vs. 58.1) were also lower in S supplemented than in non S-supplemented heifers. Results of this study indicate that increasing dietary K will not alleviate reduced ADG and ADFI observed in finishing cattle fed diets high in S.

Key Words: Cattle, Potassium, Sulfur

604 Effect of increasing dietary concentrations of dried distillers grains plus solubles on P balance in finishing steers. C. Benson, C. Wright*, J. McCarthick, and R. Pritchard, *South Dakota State University, Brookings*.

Eight crossbred steers (initial BW = 442 ± 15.2 kg) were used in a replicated Latin Square design to determine the effect of increasing dietary concentrations of dried distillers grains plus solubles (DDGS) on P balance. One steer had to be removed from the study due to health concerns. All data collected on this animal were removed and statistical analyses were performed as an unbalanced replicated Latin square with animal as the experimental unit. Regression analysis was also performed, regressing fecal P, urine P, total P excretion, and P retention on P intake. The control diet contained 79% dry rolled corn (DRC), 10% cottonseed hulls, 6% soybean meal (SBM), and 5% mineral supplement (total diet P concentration = 0.26%). In each of the remaining three diets, all of the SBM and a portion of the DRC were removed and replaced with DDGS at 12%, 24%, and 36% of the diet (total diet P concentrations = 0.28%, 0.33%, and 0.37%, respectively). Steers were housed in indoor, slatted-floor pens (1.7 x 2.6 m) during a 21-d diet acclimation period prior to a 5-d total fecal and urine collection period. All samples (feed ingredients, feed refusals, feces, and urine) were analyzed for P concentration. Phosphorus intake increased from 18.6 to 27.8 g/d (linear; $P = 0.007$) as the concentration of DDGS was increased in the diet. Fecal P was not affected by treatment. Urinary P (g/d; linear; $P = 0.001$), total P excretion (g/d; linear; $P = 0.025$), and P retention (g/d; linear; $P = 0.020$) increased as the level of DDGS in the diets increased. In regression analyses, fecal P (g/d; $P_{\text{fecal}} = 0.003 + 0.416P_{\text{intake}}$; $P = 0.003$; $r^2 = 0.29$), total P excretion (g/d; $P_{\text{total}} = 5.324 + 0.605P_{\text{intake}}$; $P = 0.001$; $r^2 = 0.47$), and P retention (g/d; $P_{\text{retained}} = -12.306 + 0.641P_{\text{intake}}$; $P = 0.001$; $r^2 = 0.50$) were influenced by P intake. Urinary P (g/d) tended to be influenced ($P_{\text{urinary}} = 0.537 + 0.189P_{\text{intake}}$; $P = 0.11$; $r^2 = 0.10$) by P intake. Results of the experiment demonstrate that as the levels of DDGS in the diets of finishing steers increases, P excretion increases.

Key Words: Distillers grains, Phosphorus, Steers

605 Phosphorus digestion in lactating cows fed diets containing beet pulp. T. H. Yang^{*1}, K. F. Knowlton¹, C. Shang¹, J. A. Voelker Linton², and M. S. Allen², ¹*Virginia Polytechnic Institute and State University, Blacksburg*, ²*Michigan State University, East Lansing*.

The objective of the study was to evaluate the effect of increasing dietary beet pulp (BP) content on duodenal and fecal flow of total phosphorus (P) and phytic-acid (PA) P. Eight multiparous Holstein cows fitted with ruminal and duodenal cannulae were fed diets containing 40% forage (corn silage and alfalfa silage) and 0, 6.1, 12.1 or 24.3% unmolassed, pelleted BP (replacing high moisture corn grain on a DM basis) in a replicated 4x4 Latin square design with 21-d periods. The nutrient content of BP averaged 39.9% NDF, 8.9% CP, 8.0% indigestible NDF, 3.9% starch, and 0.29% free glucose on a DM basis. Duodenal digesta and feces were collected every 9 h on d 12-14, and rumens were evacuated and subsampled 4 h after feeding on d 20 and 2 h before feeding on d 21. Samples were composited by cow within period and analyzed for P (nitric/perchloric digestion) and PA-P (anion-exchange method). Linear and quadratic effects of increasing BP content were analyzed using Proc Mixed of SAS. Dietary P and PA content were reduced linearly with increasing percent BP (0.59, 0.58, 0.57, 0.56 %P and 0.15, 0.14, 0.13, 0.11 %PA, respectively). With increasing BP content, P intake, ruminal P content, and rumen P pool size decreased. Digestion, duodenal flow and fecal excretion of P

were not affected. With increasing dietary BP content, PA intake was reduced, ruminal pool size was reduced, and rumen turnover time (h) was increased. Apparent ruminal digestibility of PA was decreased linearly with increasing BP (36.5, 31.8, 24.6, 13.6 %; $P < 0.02$), and apparent total tract PA digestibility was similarly affected (85.3, 82.7, 82.1, 79.1%; $P < 0.01$). As previously reported, increasing BP was associated with reduced ruminal starch digestion and increased post-ruminal starch digestion. Fecal excretion of PA-P averaged 5.2 g/d. Replacing starchy grains with BP reduced digestion of PA-P, and the majority of the disappearance of PA-P occurred post-ruminally.

Key Words: Phytic acid digestion, Dairy cattle

606 Modeling phosphorus utilization in dairy cows in Ontario. E. Kebreab*, J. France, N. E. Odongo, and B. W. McBride, *University of Guelph, Guelph, Ontario, Canada*.

Phosphorus (P) is a key mineral essential to nearly every aspect of metabolism in a dairy cow and needs to be supplied in sufficient quantity. However, dairy cows use less than 40% of dietary P; the rest is excreted mainly in feces, which can lead to environmental pollution. The objective of this study was to develop empirical models of P utilization and evaluate an extant mechanistic model. Data were collected from 12 lactating Holstein cows (678±17 kg body weight, 30 to 52 DIM) fed various amounts of P ranging from 63 to 101 g/d. Dry matter intake (DMI), P intake (total, tP, and digestible, dP), P excreted in feces and urine, P secreted in milk, and plasma P were recorded. An empirical model was developed using the REG procedure in SAS. Digestible P intake was highly related to fecal P, explaining 73.4% of the variation. Adding tP to the regression increased the r^2 to 99.6% (Fecal P, g/d = 34.2 + 0.59 tP - 0.85 dP). Urinary P excretion correlated best with plasma P but the relationship was not significant, probably because within the range of P fed, threshold plasma P (3 mmol/L) was not reached. Milk P secretion best related to DMI ($r^2=0.34$), with addition of tP to the model increasing the r^2 to 45.2% (Milk P, g/d = 0.00046 DMI + 0.08 tP). The data were also inputted to an extant mechanistic P model to generate predictions of fecal P values and the results evaluated using mean square prediction error (MSPE). The difference between overall observed (50.1 g/d) and predicted mean (54.2 g/d) fecal P output was 4.1 g/d. Root MSPE was 8.2 g/d, which was 16% of observed mean. Although most of the calculated error (75%) was due to random variation, 24% was due to central deviation from the mean due to overestimation of fecal P. This bias is most probably because the model was developed on cows fed grass silage-based diets while in the current experiment, the cows were fed corn silage/alfalfa haylage-based diets. Both analyses show that dietary manipulation of dP can reduce P excretion but under current conditions, urinary P excretion does not pose environmental problems. However, there is a need to calibrate the extant model to make it more relevant to cows in North America.

Key Words: Phosphorus, Modeling, Pollution

607 Calcium and phosphorus supplementation for transition cows. V. Moreira* and C. Coxé, *Louisiana State University, Franklinton*.

The objective of this study is to evaluate the performance of cows fed Ca and P either 15% below or 20% above NRC (2001) estimated absorbable requirement for 30 days post-partum. Nine of the 12 planned blocks (four cows per block) have completed the study. Multiparous cows were housed in a free-stall barn fit with electronic gates at least 20 days before expected calving date. Cows were blocked

according to calving date. Dry cows were fed a common TMR designed to contain Ca concentration (0.32% DM) slightly below NRC (2001) recommendation until two days after calving to minimize the risk of clinical hypocalcaemia. Dietary P was set slightly above recommendation (0.33% DM). Treatments were randomly distributed according to a 2x2 factorial arrangement (**HCa:HP** = 0.72%:0.48%; **HCa:LP** = 0.72%:0.36%; **LCa:HP** = 0.54%:0.48%; **LCa:LP** = 0.54%:0.36%; percents total mineral content in diet DM). Intake (**DMI**) and milk yield were recorded daily. Digestibilities (**DMD**) were determined during three days of total fecal collection for each block of cows averaging 20 DIM. Milk composition was determined when cows averaged 30 DIM. Data were analyzed as Randomized Block design with repeated measures using mixed procedures (SAS, version 9.1). Three cows were removed from the study because of unrelated problems. Milk production in the previous lactation and average DMI of the second week pre-partum were used as covariates for milk yield and DMI post-partum, respectively. Milk yield and DMI were similar for all treatments ($P \geq 0.10$). Cows averaged 44.3 kg/d of milk (SEM = 1.2 kg/d) and DMI was 21.6 kg/d (SEM = 0.75 kg/d) between 5 and 30 DIM. Cows fed diets containing higher Ca had lower ($P \leq 0.05$) DMD and tended to have higher peak of milk ($P \leq 0.08$). Milk contained 3.36% (SEM = 0.16%) fat and somatic cell scores averaged 2.90 (SEM = 0.51). Milk protein content was lower ($P = 0.001$) for cows fed HCa. Changes in body weight and body condition scores were not significantly affected by treatment. The partial results suggest cows fed P 15% below NRC estimated absorbable requirement supported high milk production in early lactation.

Key Words: Calcium, Phosphorus, Early lactation dairy cows

608 Development of methodologies to reduce the DCAD of hays for transition dairy cows. R. L. Horst*¹, K. T. Pecinovsky², K. J. Moore², D. R. Thoreson², J. R. Russell², E. C. Brummer², and J. P. Goff¹, ¹National Animal Disease Center, Ames, IA, ²Iowa State University, Ames.

Excessive potassium (K) content of forages can cause metabolic alkalosis in the cow and subsequently hypocalcemia and milk fever. Reducing K content of forages can be a means of reducing the incidence of milk fever and achieving a more favorable dietary cation anion difference (DCAD) for the transition cow. A reduction in forage K can be achieved by restricting K fertilization. In addition, increasing the chloride (Cl) content could also result in a more favorable DCAD for the periparturient cow. This study tests the hypothesis that Cl fertilization without K addition to hays will result in decreasing forage DCAD. Four forage species were seeded in four blocks of four 3 x 16 m plots. In the spring of 2004 each plot was divided into four subplots that were randomly treated with one of four treatments including 1) Control (C); 2) 100 lbs Cl as CaCl₂; 3) 200 lbs K₂O as K₂CO₃; and 4) Cl + K₂O as a combination of treatments 2 and 3. The four forage species to be evaluated were: Smooth Bromegrass (SB); Orchardgrass (OG); Reed Canarygrass (RC); and 4) Alfalfa (AF). In plots not receiving K₂O fertilization the K content of the plants was lower ($p < .01$) regardless of species and across all cuttings (Control, 1.92%; CaCl₂, 1.77%) relative to those receiving K₂O (K₂O, 2.15% and Cl+K₂O, 2.24%). Plots fertilized with Cl resulted in a 2-3 fold elevation in tissue Cl in all the hays tested ($p < .01$). This effect was observed for each of the three cuttings. Mean treatment Cl values across all cutting and species were control, 0.32%; CaCl₂, 0.90%; K₂O, 0.34%; Cl+K₂O, 0.84%. DCAD was also significantly ($p < 0.05$) reduced in plots treated with Cl alone relative to C; OG (365 vrs 600); RC (105 vrs 438); and OG (172 vrs 426). The combination of Cl + K₂O resulted in an

attenuation of this effect. Alfalfa DCAD appeared to be unaffected by Cl fertilization due to a compensatory Na accumulation. These data suggest that Cl fertilization without K addition may be an effective means of decreasing the DCAD content of hay. The effect of Cl fertilization on yield, hay quality and palatability is currently under investigation.

Key Words: Chloride fertilization, Forage, Milk fever

609 Effect of trace mineral source on lactation and reproductive performance of dairy cattle. F. Toni¹, L. Grigoletto¹, C. J. Rapp*², M. T. Socha³, and D. J. Tomlinson³, ¹Kriton Biological Services, Correggio, Italy, ²Zinpro Animal Nutrition, Boxmeer, Netherlands, ³Zinpro Corporation, Eden Prairie, MN.

One hundred eighty multiparous Holstein cows (90 cows/treatment) were blocked according to calving date and randomly assigned to a study to determine the effect of trace mineral source on performance. Treatments were 1) all trace minerals supplied by inorganic sources or 2) 360 mg of zinc, 200 mg of manganese and 125 mg of copper per day of inorganic minerals replaced with Availa[®]4 (Zinpro Corporation). Neither level nor source of cobalt supplementation differed between dietary treatments. Cobalt was supplemented as cobalt carbonate to supply 23 mg cobalt per day. Cows received their respective treatments from 60 d prior to calving through 200 days of lactation. Lactation diets were formulated to provide 79 mg/kg zinc, 57 mg/kg manganese, 15 mg/kg copper and 1 mg/kg cobalt (supplemental levels, DM basis). Cows were milked 2X/d and milk yield was recorded at each milking. Treatments were included in a supplement that was fed to individual animals via automatic feeders. Animal (cow) was the experimental unit. Lactation data and body condition scores were analyzed as repeated measures. Replacing inorganic trace minerals with Availa[®]4 tended to increase ($P=0.06$) protein yield (1.09 vs. 1.05 kg/d) while decreasing ($P=0.15$) somatic cell counts (linear score: 2.89 vs. 3.19). There was no effect of treatment on milk yield or milk composition. Feeding Availa[®]4 increased ($P < 0.01$) body condition score (2.97 vs. 2.86), and decreased ($P=0.02$) culling rate (13.3 vs. 25.6%). Feeding Availa[®]4 tended ($P=0.07$) to increase incidence of retained placentas (13.3 vs. 6.7%), while tending to decrease ($P=0.15$) incidence of metritis (14.4 vs. 16.7%) and increase ($P=0.15$) first service conception rate (21.9 vs. 19.1%). In conclusion, replacing inorganic trace minerals with Availa[®]4 tended to improve lactation and reproductive performance and decreased culling in dairy cattle.

Key Words: Trace minerals, Lactating dairy cow, Reproduction

610 Sodium zeolite A supplementation to lactating Holsteins. K. Turner*¹, B. Nielsen², and C. O'Connor², ¹The University of Georgia, Athens, ²Michigan State University, East Lansing.

Sodium zeolite A (SZA) has been shown to alter calcium and phosphorus metabolism in ruminants; however, clarification of the mechanisms by which this occurs is needed and alterations in milk mineral concentrations have not been fully investigated. Additionally, SZA has been suggested to alter bone metabolism in horses, as well as reduce skeletal injury rates. Therefore, twenty Holstein dairy cows in either their first or second parity were used to determine the effects of sodium zeolite A (SZA) on plasma and milk mineral concentrations as well as markers of bone metabolism. The cows were pair-matched by parity and milk production and placed into one of two groups – SZA supplemented (SS) or control (CO). Individual cow milk production and feed intake were recorded daily. All cows received their normal

total mixed ration, but SS cows also were supplemented with SZA at a dosage level of 2% of the diet. Milk, blood, and feed samples were taken on d 0, 15, and 30 for mineral analysis. Blood was also used for osteocalcin (OC) and deoxypyridinoline (DPD) determination. Treated cows decreased feed intake and milk production from d 15 to d 30 ($P < 0.007$) and had lower feed intakes and milk production than CO cows on both d 15 and d 30 ($P < 0.003$). On d 15, SS cows had higher plasma silicon concentrations than CO cows ($P = 0.01$) but there was no difference on d 30 ($P = 0.71$). Overall, plasma aluminum concentration was increased by SZA ($P = 0.002$). SS-cows had higher milk aluminum concentrations than CO cows ($P = 0.02$). Milk phosphorus concentration decreased from d 15 to d 30 in SS cows ($P = 0.007$). On d 15 and 30, milk phosphorus concentrations were lower in SS cows than CO cows ($P < 0.03$). Treated cows had higher plasma calcium concentrations, and lower plasma phosphorus concentrations than CO cows ($P < 0.0002$). There was no treatment*day effect on osteocalcin, DPD, or OC to DPD ratio ($P > 0.24$), suggesting bone metabolism was not affected. Sodium zeolite A decreased feed intake, milk production, and plasma phosphorus concentration, possibly via a phosphorus deficiency created by the aluminum intake. If SZA is added to the diet of a ruminant, additional phosphorus may be needed to prevent this induced deficiency.

611 The relationship between dry matter intake and acid-base status of lactating dairy cows as manipulated by dietary cation-anion difference. W. Hu^{*1}, L. Kung, Jr.¹, and M. R. Murphy², ¹University of Delaware, Newark, ²University of Illinois, Urbana.

Our objective was to examine, using mixed model statistical analysis, the potential relationship between dry matter intake (DMI) and acid-base status of lactating dairy cows as manipulated by dietary cation-anion difference [DCAD; defined as milliequivalents of Na + K - Cl per 100 grams of feed dry matter (DM)]. A database was developed from 16 studies of DCAD effects on DMI and productivity of lactating dairy cows in which 21 experiments, including 88 dietary treatments (DCAD ranging from -19.1 to 72.7) and 337 cows, occurred. Observed DMI values were adjusted for the study effects. Adjusted DMI increased quadratically with increasing DCAD ($P < 0.001$; $R^2 = 0.76$), peaking at 47 meq/100 g of DM. The adjusted DMI also increased as blood HCO_3^- concentrations (quadratic, $P < 0.001$; $R^2 = 0.83$), blood pH (linear, $P < 0.001$; $R^2 = 0.82$), and urinary pH (quadratic, $P = 0.009$; $R^2 = 0.66$) increased. The relationships between adjusted DMI and blood HCO_3^- , blood pH, and urinary pH suggested that DMI was closely associated with acid-base status of dairy cows. It appears that DCAD affects systemic acid-base physiology which, in turn, affects feed intake of dairy cows.

Key Words: Dry matter intake, Acid-base status, Dairy cows

612 Influence of altering dietary cation anion difference on milk yield and its composition by early lactating *Nili Ravi* buffaloes in summer. M. A. Shahzad^{*}, M. Sarwar, M. Nisa, and A. Khan, University of Agriculture, Faisalabad, Pakistan.

Influence of -110, +110, +220 and +330 mEq/kg dry matter (DM) of dietary cation anion difference (DCAD) on milk yield and its

composition by early lactating *Nili Ravi* buffaloes was examined in a randomized complete block design and data were analyzed by using analysis of variance technique while means were compared by using Duncan's Multiple Range test. Four DCAD levels were randomly allotted to four groups, three buffaloes in each group. A linear increase in nutrients (dry matter, crude protein, neutral detergent fiber, acid detergent fiber) and water intakes were recorded with increasing the DCAD level. Buffaloes fed +220 and +330 mEq/kg DM, DCAD diets showed better energy and nitrogen balance than those fed -110 and +110 mEq/kg DM, DCAD diets. A significant increase in blood pH and HCO_3^- was noticed with increasing DCAD level. Serum (Na + K) - (Cl + S) increased linearly with increasing the DCAD level, while serum chloride was higher in buffaloes fed -110 DCAD diet. Serum calcium increased significantly with decreasing the DCAD level while serum magnesium and phosphorus remained unaffected. Urine pH was increased significantly with increasing DCAD level. A linear increase in milk yield was also noticed with increasing the DCAD level. Milk fat% increased significantly with increasing the DCAD while all other milk constituents remained unaltered. In conclusion, high DCAD (+220 and +330) diets not only increased the dry matter and water intake but also improved milk yield and milk fat% in early lactating buffaloes during summer.

Key Words: Early lactating buffaloes, Dietary cation anion difference (DCAD), Nitrogen and energy balance

613 Influence of altering dietary cation anion difference on growth performance of growing buffalo calves. M. Sarwar^{*}, M. A. Shahzad, and M. Nisa, University of Agriculture, Faisalabad, Pakistan.

Influence of -110, +110, +220 and +330 mEq/kg of dry matter (DM) dietary cation anion difference (DCAD) on growth performance of growing buffalo male calves was examined in a randomized complete block design. The DCAD was calculated by using equation (Na + K - Cl + S) mEq/kg DM. Four DCAD diets were randomly allotted to four groups, five calves in each group. A linear increase ($P < 0.05$) in nutrients (dry matter, crude protein, neutral detergent fiber, acid detergent fiber) intake was recorded with increasing the DCAD level. The digestibilities of nutrients were higher ($P < 0.05$) in calves fed -110 DCAD diet than those fed +110, +220 and +330 DCAD diets. Calves fed +330 DCAD diet had higher nitrogen balance than those fed -110 and +110 DCAD diets. Blood pH and serum HCO_3^- increased ($P < 0.05$) with increasing the DCAD level. Serum (Na + K) - (Cl + S) increased linearly ($P < 0.05$) with increasing the DCAD level while serum chloride was higher ($P < 0.05$) in calves fed -110 DCAD diet. Serum calcium increased ($P < 0.05$) with decreasing the DCAD level while serum magnesium and phosphorus remained unaffected. Calves fed -110 DCAD diet had higher ($P < 0.05$) Ca balance than those fed +110, +220 and +330 DCAD diets. Urine pH increased ($P < 0.05$) with increasing the DCAD level. Calves fed +220 and +330 DCAD diets gained more weight ($P < 0.05$) than those fed -110 and +110 DCAD diets. In conclusion, increased DCAD level not only increased the dry matter intake but also improved the weight gain in growing buffalo male calves.

Key Words: Buffalo calves, DCAD, Nitrogen and calcium balance

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SYMPOSIA AND ORAL SESSIONS

Beef Species: Enterprise Integration for Sustainable Beef Production

614 Applications of grazingland simulation models. J. D. Hanson*, *USDA/ARS, Mandan, ND.*

The demand for goods and services produced from grazinglands has continued to accelerate over the past twenty. Complex interactions of environment, nutrients, plants, and animals within regions containing grazingland reduce the probability of consistently producing enough high quality crops and forages to maintain a stable and productive livestock enterprise. Simulation modeling has been used to examine the effects of agricultural management practices on environmental quality and to develop improved management practices, which are environmentally sound and profitable to the producer. These models are designed to represent the complex interaction of many factors. Models have been developed for the entire management system and for individual components of the system. The purpose of this paper is to examine various applications of simulation models to beef cattle production, forage production, carbon sequestration and storage, and other problems associated with grazingland management. The objectives of each modeling effort will be presented along with any lessons learned and gaps in our existing knowledge and abilities. An overall evaluation of the current ability to use simulation models to address natural resource problems will be addressed.

Key Words: Grazingland, Forage production, Beef cattle

615 Whole farm integration: Silvopastoral systems. J. P. S. Neel* and D. P. Belesky, *USDA-ARS Appalachian Farming Systems Research Center, Beaver, WV.*

Silvopasture integrates tree and forage production, creating unique microclimates. These microclimates significantly impact forage physiology, growth and development, and thus nutritive value. Integration of silvopasture into the farm system will influence nutrient availability, balance and cycling throughout the year. It also impacts overall farm productivity and income by increasing the production and value of saleable product. This is accomplished (dependent on geographic location) either by increased management of existing woodlots, thinning lower value trees and decreasing tree canopy to the point where herbage plants can be sustained, or introduction of trees to open pasture. We have found silvopasture herbage generally contains higher levels of nitrogen relative to energy when compared

to that growing in open pasture. This energy:nitrogen relationship provides unique opportunities from both an animal nutrition and farm systems standpoint. Nutritionally, silvopasture can be a source of nitrogen rich herbage to be utilized as a supplement to forage that is nitrogen deficient. From a systems standpoint, these areas may provide a means of capturing excess or waste nitrogen due to the inherent plant need for increased nitrogen levels because of microclimate conditions. Sustainable beef production is dependent on the reduction of off-farm inputs and the efficient utilization and integration of on-farm resources. For many beef enterprises, the incorporation of silvopasture or improved management of existing silvopasture, will enhance resource management and increase the chances for sustainability. We present experiences in the establishment and management of silvopasture as well as knowledge on nutritive value and pasture productivity.

Key Words: Silvopasture, Sustainable, Nutritive value

616 Sustainable beef production systems: An international perspective. G. R. Hagevoort*, *New Mexico State University Agricultural Science Center, Clovis.*

Animal production internationally is in the midst of a 'Livestock Revolution', which unlike the 'Green Revolution' is driven by demand. Income levels, population and urban growth in developing countries are drivers for this revolution, which is predicted to generate growth in meat and milk production till the year 2020 at rates of 2.8% and 3.3% annually in developing countries vs. 0.6% and 0.2%, respectively for developed countries. These rates of growth imply intensification of production systems, which historically have been associated with unsustainable practices. To achieve this growth, a shift from roughage-based systems to cereal-based systems is predicted, which would require annual feed consumption of cereals to rise by 292 million metric tons between 1993 and 2020. Production systems are predicted to emphasize land-divorced industrial production systems with large nutrient outflows. Sustainability can be achieved in most of the world's production systems by implementing a systems approach at a higher level, thereby restoring the balance between land and livestock, and closing nutrient cycles. Biodiversity appears to be key in all approaches. Consensus is that available technologies will only be adopted if the appropriate policy framework is established. Financial incentives,

regulatory instruments such as zonation, institutional ownership changes, empowerment, awareness and education are mentioned as instruments of change. In general it is accepted that the rural poor and landless, especially women, could benefit from an intensification of animal agriculture, and the 'Livestock Revolution' could contribute to the alleviation of poverty. However, rapid industrialization supported

by widespread subsidies for large-scale credit and land use could harm this mechanism of income and asset generation by the poor. The goal of this presentation is to address some technologies available for the different production systems throughout the world's climate zones.

Key Words: Sustainable animal agriculture, World trade, Farm policy

Breeding and Genetics: Beef, Sheep & Swine Breeding

617 Connectedness in Targhee and Suffolk flocks participating in the U.S. National Sheep Improvement Program. L. A. Kuehn*, R. M. Lewis, and D. R. Notter, *Virginia Polytechnic Institute and State University, Blacksburg.*

Connectedness among animals in separate flocks reduces risks associated with the across-flock comparison of EBV. The objective in this study was to assess levels of connectedness in the genetic evaluation of weaning weight among Targhee and Suffolk flocks participating in the U.S. National Sheep Improvement Program (NSIP). Among flocks currently participating in NSIP, a total of 25,404 weaning weight and 35,794 pedigree records were available for 16 Targhee flocks, and 14,017 weaning weight and 18,311 pedigree records were available for 24 Suffolk flocks. Connectedness was measured using two different methods. First, numbers of progeny with recorded weaning weights from linking sires (defined as sires with progeny in multiple flocks or sires born in one flock with progeny in another flock) were counted. Second, connectedness was measured by calculating the average prediction error correlation of mean flock EBV (flock r_{ij}). Benchmarks for flock r_{ij} were established with 0.10 and 0.05 representing low and moderate risk of comparing EBV among flocks, respectively. From 1995 through 2004, 44% of Targhee lambs but only 23% of Suffolk lambs with weaning weights were born to linking sires. Average flock r_{ij} were 0.10, 0.19, and 0.28 and 0.02, 0.02, and 0.04 in 1990, 1995, and 2005 among Targhee and Suffolk flocks that participated in NSIP in all 3 yr. Among all active flocks in 2005, flock r_{ij} averaged 0.13 in Targhee and 0.03 in Suffolk. Hierarchical clustering of flocks based on flock r_{ij} revealed that all active Targhee flocks connect at a level near or above 0.10. In Suffolk flocks, two distinct clusters had formed in which connectedness was relatively high within each cluster (flock r_{ij} near 0.10) but near zero between clusters. Risk in comparing EBV among flocks in Targhee is low; however, caution should be exercised when comparing EBV between Suffolk flocks from different clusters.

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Key Words: Connectedness, Prediction error, Sheep

618 Role of sire referencing schemes in terminal sire sheep to improve carcass quality in crossbred lambs. R. M. Lewis^{1,2}, A. M. van Heelsum², W. Haresign³, M. H. Davies⁴, R. Roehe², L. Bünger², and G. Simm², ¹*Virginia Polytechnic Institute and State University, Blacksburg*, ²*Scottish Agricultural College, Edinburgh, Scotland, UK*, ³*University of Wales, Aberystwyth, Wales, UK*, ⁴*ADAS Rosemaund, Preston Wynn, England, UK*.

In sire referencing schemes (SRS) genetic links are created among flocks by sharing rams. These links allow for across-flock genetic

evaluations creating a larger pool of candidates for selection and quicker genetic progress. In the early 1990s, SRS were introduced in the Charollais, Suffolk and Texel breeds in the UK resulting in gains near 2% per annum in a Lean Growth Index (LGI). In this study, the consequence of that gain on carcass traits of terminal sire cross lambs was tested. Thirty rams from SRS in each breed, half high and half low in LGI, were mated to 4,800 crossbred ewes between 1999 and 2002. Mean LGI differed by 5 s.d. between index groups. At target finish of 11% subcutaneous fat (SCF), the 6,584 lambs were weighed and slaughtered. Cold carcass weights were recorded. The right side of 978 carcasses was processed into retail cuts including leg steaks, cutlets and chops. A linear mixed-model was fitted using REML with year, sire index category and breed, sex, birth-rearing rank, dam age and, as a covariate, estimated SCF as fixed effects. Rearing dam and residual were random effects. A sire index category by breed interaction was found ($P < 0.05$) but did not cause re-ranking. Offspring of high as compared to low index sires weighed 1.1 ± 0.10 kg more at finish yet were no older, with 0.56 ± 0.047 kg heavier cold carcass weights. High index lambs yielded 0.47 ± 0.090 kg more saleable meat with increased weights of leg steaks, cutlets and chops ($P < 0.001$). In 2004, the average value per kg carcass was £2.62 (US\$4.60) in the UK. If over its lifetime, a ram sires 240 reared lambs and each lamb produces 0.56 kg extra carcass weight, a high index ram would earn an extra £353 (US\$620). In the UK, where roughly 10.1 million terminal sire cross lambs are marketed annually, this could generate £15 million (US\$26.2 million) more income. Clearly, within-SRS selection on LGI results in crossbred lambs yielding more saleable lean meat allowing substantially higher market returns.

Acknowledgements: We thank the Meat and Livestock Commission and the Department for Environment, Food and Rural Affairs for funding.

Key Words: Sire referencing, Carcass quality, Crossbred lamb

619 Genetic factors influencing different body weights of Thalli sheep in Pakistan. P. Akhtar*, A. Hussain, S. Ali, and M. Younas, *University of Agriculture, Faisalabad, Punjab, Pakistan.*

Thalli is the native sheep breed of Thalli area of the Punjab, Pakistan. Data on 17030 birth records of 5421 Thalli sheep maintained at Livestock Experiment Station, Rakh Ghulaman, district Bhakkar during 1975-2004 were utilized in the present study with the objective to evaluate the performance of Thalli sheep in Pakistan. The data were analyzed using GLM procedure of SAS to study the influence of environmental sources of variation on various performance traits. The genetic parameter estimation was done using DFREML 1997 procedure fitting an Individual Animal Model. The average birth weight was 4.11 ± 0.82 kg, which was significantly affected by year, type of

birth, sex and age of the dam and season of birth had non-significant effect on birth weight. The average 60- and 90-day weights were 11.58 ± 3.57 and 14.92 ± 4.56 kg, respectively, which were affected by year, season of birth, birth weight, type of birth (60 days weight) and sex (60 days weight) and age of the dam had non-significant effect on 60 days weight. Age of the dam significantly affected 90-day weight. Sex and type of birth had non-significant effect on 90 days weight. The weaning weight averaged 18.95 ± 4.12 kg and was affected by year and season of birth, sex of lamb born. The effect of type of birth, birth weight and age of dam on weaning weight were non significant. The direct heritability estimate of birth weight was 0.067 ± 0.01 . The heritability estimates for 60- and 90-day weight were 0.116 ± 0.01 and 0.18 ± 0.01 , respectively. The heritability estimate for weaning weight was 0.03 ± 0.11 . Genetic correlation between birth weight and weaning weight was -0.045 ± 0.003 which is negatively low. The low estimates of heritability for various performance traits indicated the presence of less additive genetic variance and large environmental variances. Hence improvement in the traits through selection may be limited.

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Key Words: Genetic parameters, Body weights, Thalli Sheep

620 Estimation of breeding values of different body weights of Thalli sheep in Pakistan. A. Hussain, P. Akhtar*, S. Ali, and M. Younas, *University of Agriculture, Faisalabad, Punjab, Pakistan.*

Data on 17030 records of 5421 Thalli ewes maintained at LES, Rakh Ghulaman, Pakistan during 1975-2004 were utilized to estimate the breeding values of different economically important traits by GLM procedure of SAS to see the influence of environmental sources of variation and the genetic parameter estimation was done using REML procedure. Breeding values for various performance traits were estimated using BLUP procedure by DFREML 1997. The direct heritability estimates of birth, weaning weight, 180-day, 270-day weights and yearling weight were 0.067 ± 0.01 and 0.03 ± 0.11 , 0.07 ± 0.01 , 0.083 ± 0.01 and 0.072 ± 0.01 , respectively. The direct heritability estimates of pre- and post-weaning gains were $0.07 \pm .01$ and 0.06 ± 0.01 , respectively. These estimates are low as reported by other workers. The estimated breeding values for rams ranged from -0.447 to 0.216 for birth weight; -1.512 to 2.859 for weaning weight; -1.357 to 2.404 for 180 days weight; -1.752 to 2.621 for 270 days weight; -1.686 to 2.089 for yearling weight; -0.0144 to 0.0255 for pre-weaning gain and -0.0045 to 0.0062 for post-weaning gain. Breeding values for ewes ranged from -0.368 to 0.0302 for birth weight; -2.618 to 1.677 for 60 days weight; -5.227 to 3.209 for 90 days weight; -1.799 to 2.421 for weaning weight; -1.656 to 2.069 for 180 days weight; -1.662 to 2.407 for 270 days weight; -1.144 to 2.261 for yearling weight; -0.0142 to 0.0211 for pre-weaning gain and -0.0031 to 0.0061 for post-weaning gain. No specific genetic trend was observed for growth traits during this period. There were wide fluctuations among the least squares means for estimated breeding values. The genetic trend remained oscillating around the x-axis indicating no net genetic change for growth traits. The genetic trend for growth traits was close to zero indicating that the breeding program in the past was ineffective and almost similar trend will be expected in the presence of random mating.

Acknowledgement: to Livestock and Dairy Development Department for data and Higher Education Commission, Govt. of Pakistan for expected travel grant.

Key Words: Estimated breeding values, Body weights, Thalli Sheep

621 Performance traits of 1980 vs. 2005 pigs when fed 1980 or 2005 feeding programs. J. S. Fix*, D. J. Hanson, E. van Heugten, J. P. Cassidy, and M. T. See, *North Carolina State University, Raleigh.*

The objective of this study was to assess changes over 25 years in pig performance traits. Pigs (n=162) representative of the current commercial industry were compared to pigs representative of the commercial industry 25 years ago. The 1980 genetic line was produced from dams selected to minimize genetic improvement and frozen semen from boars available in 1980. Pigs within sex, farrowing group, and genetic line were randomly assigned to a feeding program and placed 3 per pen (n=54) at an initial wt of 7 ± 0.4 kg. The 2005 feeding program included a 7 phase feeding program (Lysine from 1.51 to 0.73% and ME from 3428 to 3651 Kcal/kg), pelleted diets, and current diet formulation. The 1980 feeding program consisted of 4 meal diets (Lysine from 1.05 to 0.62% and ME from 3262 to 3317 Kcal/kg) based on formulations from the 1978 Pork Industry Handbook. Individual weights and pen feed consumption were measured every 2 wk. Pigs were slaughtered on a weekly basis when average pen weight exceeded 116 kg. Pigs from the 2005 genetic line were slaughtered 11 days sooner (162 vs. 173 d; $P < 0.05$). Pigs fed the 2005 feeding program reached final BW 12 days sooner (162 vs. 174 d; $P < 0.01$). A genetic line by feeding program interaction ($P < 0.05$) was observed for ADG where 2005 pigs and 1980 pigs showed 12% and 6% increases in ADG, respectively, when comparing 1980 to 2005 feeding programs. Pigs from 2005 genetics fed the 2005 program had the greatest ADG (885 g/d), while pigs from 1980 genetics fed the 1980 program gained the least per day (753 g/d). Pigs from 2005 genetic line fed the 1980 program (789 g/d) did not differ in ADG from 1980 pigs fed the 2005 program (799 g/d). Pigs fed the 2005 program showed 10% ($P < 0.01$) less ADFI than those fed the 1980 program, resulting in a 21% improvement ($P < 0.01$) in G:F. 2005 pigs were more efficient than pigs from the 1980 genetic line (0.41 vs. 0.37; $P < 0.01$). These results demonstrate that substantial improvements have been made in growth and efficiency over the past 25 years due to advances in both genetics and feeding programs.

Key Words: Pigs, Genetics, Nutrition

622 Some hybrid beef performances (B.taurus x B. indicus) in tropical Malaysia. A. Aman*¹, O. Ahmad², and S. Othman², ¹*International Islamic University Malaysia, Jalan Gombak, Kuala Lumpur, Malaysia,* ²*MARDI, Kuala Lumpur, Malaysia.*

Malaysian indigenous cattle (Kedah-Kelantan- KK) were bred by artificial insemination with semen from Limousin, Simmental and Charolais. The Kedah Kelantan breed is small, prolific, slow growing (ADG) and resistant to heat. By crossing KK with temperate cattle, growth (on grass and feedlot) and reproduction increased. The Charolais-Kedah Kelantan (CK) crossbred was heaviest, followed by Simmental-Kedah Kelantan (SK), and Limousin-Kedah Kelantan (LK). The CK crossbred was superior to KK by 41% at birth, 48% at weaning, 55% at yearling and 72% at 20 months. In feedlot CK was grew most rapidly (815 g/day), followed by SK (773 g/day) and

LK (750 g/day) and KK (528g/day). CK and LK crossbred calves were more efficient in converting feed to meat (6 kg. feed/kg meat). Crossbred heifers conceived earlier than KK. The crossbred calves had greater gains and better carcass quality than KK.

Key Words: Crossbred, B.indicus X B.taurus, Beef cattle

623 Use of a mathematical computer model to predict feed intake: Genetic parameters between observed and predicted values, and relationships with other traits. D. P. Kirschten^{*1}, E. J. Pollak¹, L. O. Tedeschi², D. G. Fox¹, B. Bourg², and G. E. Carstens², ¹Cornell University, Ithaca, NY, ²Texas A&M University, College Station.

The objectives of this study were to investigate the suitability of using DM required (DMR) as predicted by the Cornell Value Discovery System (CVDS) in genetic evaluations and to determine relationships between model predicted and individual DMI and other traits. Observed feed intake (FIO) records during the finishing phase were available from 115 individually fed Santa Gertrudis steers sired by 20 bulls. The data also contained records of ADG and mean BW (MW), carcass measurements (ribeye area, fat thickness, and marbling) and real-time ultrasound estimates (ribeye area, fat thickness, and marbling). These inputs were used in the CVDS model to predict DMR. For the purposes of parameter estimation, CVDS predictions of DMR using ultrasound (DMRus) and carcass traits (DMRca) were considered surrogates for FIO. Genetic parameters were estimated with REML, using a sire model with fixed effects of WW contemporary group and feedlot pen. Phenotypic correlations between FIO and DMRus, FIO and DMRca and DMRus and DMRca were 0.78, 0.79, and 0.99, respectively. Heritabilities for FIO, DMRus and DMRca were 0.09, 0.32 and 0.35, respectively. Genetic correlations between FIO and DMRus, FIO and DMRca, and DMRus and DMRca were 0.98, 0.98, and 0.99, respectively. Sire BV rank correlations were calculated for FIO, DMRus and DMRca. BV rank correlations among FIO, DMRus and DMRca were all 0.99. Residual feed intake (RFI) was calculated using FIO, metabolic MW and ADG. Phenotypic correlations between RFI and FIO, MW, and ADG were 0.21, 0.09, and 0.01, respectively. Heritability for RFI was 0.18. Genetic correlations between RFI and FIO, MW, and ADG were -0.88, -0.48, and 0.00, respectively. The strong genetic relationships between FIO, DMRus and DMRca and minimal re-ranking of sires suggested that predicted DMRus and DMRca may be used in place of FIO in genetic evaluations.

Key Words: Feed intake, Mathematical models, Beef cattle

624 Examination of feed efficiency traits with post-weaning growth and carcass traits in central test bulls. G. S. Hecht^{*} and L. A. Kriese-Anderson, Auburn University, Auburn, AL.

Twenty-seven years of performance test data from the Auburn University bull test was examined to determine heritabilities and genetic correlations among measures of feed efficiency, growth rate and ultrasound carcass attributes. Beginning in 1977, individual feed intake was measured on a maximum of 96 bulls per year using a Calan™ gate feeding system. Data on 2,180 bulls was collected from 1977 to 2004, among nine different breeds: Angus (n = 857); Brangus (n = 41); Charolais (n = 380); Gelbvieh (n = 103); Hereford (n = 12); Limousin (n = 106); Polled Hereford (n = 180); Santa Gertrudis (n = 106); and Simmental (n = 395). A sire-maternal grandsire model and MTDFREML was used to analyze the data. Fixed effects included test length (84, 96 and 140 days), breed and year. Covariates of age or weight were also included in the model. A⁻¹ included 3,739 animals.

Two-trait MTDFREML analyses were performed with results averaged over each trait. Traits included average daily gain (ADG) (n = 2,005; mean = 1.72 kg/d; h² = 0.58), weight per day of age (WDA) (n = 2,005; mean = 1.46 kg; h² = 0.25), feed efficiency (FE = gain to feed (G:F)) (n = 2,007; mean = 3.42 kg; h² = 0.53), fat thickness (FT) (n = 1,836; mean = 0.80 cm; h² = 0.54), intramuscular fat (IMF) (n = 391; mean = 3.20%; h² = 0.35), ribeye area (REA) (n = 927; mean = 100.00 sq cm; h² = 0.21), total gain (n = 2,005; mean = 204.74 kg; h² = 0.54), total feed intake (n = 2,007; mean = 1,534.8 kg), and residual feed intake (RFI) (n = 2,015; mean = 1.04 kg/d; h² = 0.36). Heritability estimates fall within published estimates and suggest genetic selection would be successful. Genetic correlations between FE and total gain, ADG, WDA, IMF, and REA were -0.62, -0.66, -0.16, 0.40, and -0.58, respectively with age as covariate. Genetic correlations between RFI and FT, IMF, REA, WDA, and ADG were 0.09, 0.50, -0.47, 0.06, and 0.04, respectively with age as covariate. RFI continues to show little correlation with ADG indicating cattle can be selected for improved feed efficiency without affecting growth rates or mature size.

Key Words: Feed efficiency, Performance testing, Post-weaning growth and carcass

625 Significance of cytoplasmic origin on body composition in Limousin cattle. M. M. Rolf¹, D. W. Moser^{*1}, and L. R. Hyde², ¹Kansas State University, Manhattan, ²North American Limousin Foundation, Englewood, CO.

Ultrasound carcass measurements were obtained on 7,031 yearling Limousin bulls and heifers and merged with a pedigree file containing 24,684 animals traced back to the original foundation dam of record. Approximately 25% of the measured animals traced back to a Limousin founder dam, and were categorized as being from a Limousin cytoplasmic line (LCL). The remaining records traced back to non-Limousin founder dam, and were categorized as being from a non-Limousin cytoplasmic line (NCL). The LCL versus NCL effects were evaluated using an animal model with contemporary group as a fixed effect and cytoplasmic line and animal as random effects on scan weight, rib fat, percent intramuscular fat and ribeye area. Results from MTDFREML showed that cytoplasmic line had virtually no effect on scan weight. The proportion of phenotypic variance explained by cytoplasmic line for ribeye area and percent intramuscular fat were 0.51% and 0.77%, respectively. LCL calves had .8949 sq cm larger ribeyes and .0649 percent less IMF than did NCL calves. Cytoplasmic line explained 2.2% of phenotypic variance for rib fat, and LCL calves had .0351 cm less rib fat than did the NCL calves. The magnitude of cytoplasmic line effects is small enough as to not bias current BLUP EPD predictions when such effects are ignored.

Key Words: Beef cattle, Carcass traits, Cytoplasmic origin

626 Association of microsatellite markers on bovine chromosomes 5 and 6 with carcass traits. A. M. Sanborn^{*1}, E. Casas², and A. J. M. Rosa¹, ¹South Dakota State University, Brookings, ²U.S. Meat Animal Research Center, Clay Center, NE.

The objective was to identify chromosomal regions associated with phenotypic variation in carcass traits in three crossbred families. Three half-sib families were developed from crossbred sires. Families 1, 2, and 3 comprised 29, 25, and 77 offspring, respectively (N=131). The genetic background of the sires, dams, and offspring was 1/3 Angus, 1/3 Hereford, 1/3 Simmental. Animals were housed at the South Dakota State University Beef Breeding Unit, Brookings, SD.

Calves were born between 2001 and 2004. Carcass traits collected were finished weight, hot carcass weight, marbling score, and longissimus muscle area. Microsatellite markers on chromosomes 5 and 6 were selected based on their relative position. Markers used on chromosome 5 were BM6026, RM103, BM321, RM084, BMS1216, BM315, and BM597. Markers used on chromosome 6 were ILSTS093, ILSTS090, BM1329, BMS518, ILSTS035, BM8124, and BMC4203. Individual marker analysis was conducted because homozygosity of the bulls for some markers hindered interval mapping. Family 1 exhibited allelic effects for finished weight, hot carcass weight, and marbling score on chromosome 5. Markers RM103 and BM321 were associated with finished ($P < 0.01$) and carcass ($P < 0.05$) weights. An association with marbling score was identified with BM6026 ($P < 0.05$), RM103 ($P < 0.01$), and BM321 ($P < 0.01$). On chromosome 6, BMC4203 was associated with longissimus muscle area in family 1 ($P < 0.05$) and family 2 ($P < 0.001$). No association was detected ($P > 0.05$) on family 3. Association of these markers with carcass traits on chromosomes 5 and 6 are consistent with findings from independent studies.

Key Words: Markers, Bovine, Carcass

627 Associations between single nucleotide polymorphism in the Dgat2 gene and several economic traits in commercial feedlot steers.

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DGAT2 was found to be a new diacylglycerol acyltransferase gene family in 2001. It plays more important role in mammalian triglyceride metabolism than DGAT1 does, but associations between DGAT2 and beef cattle economic merits have not been reported. The objective of this study was to try to find single nucleotide polymorphisms (SNP) with PCR-SSCP method in bovine DGAT2 gene and evaluate the

association of that with carcass and meat quality traits from 157 commercial feedlot steers distributing to 3 Chinese local breeds and 4 cross breeds. In this study, 15 SNP have been discovered in the Dgat2 Intron3 (GenBank Accession No. AY589091) at positions 65, 128, 178, 210, 241, 255, 270, 312, 328, 334, 365, 366, 371, 415 and 437 (Named as their position in PCR amplified fragments). Only 7 of them were analyzed (128, 178, 241, 270, 312, 328 and 371), because three groups (65-128-255, 178-210-365 and 241-334-366) were in complete linkage disequilibrium within group, SNP at position 415bp is a mutation of deletion and that at position 437bp is a null mutation. These data were analyzed using two different models, 1) genotype, and 2) allele substitution. Contemporary groups were fit as a fixed effect and formed from feed group in feedlot plus breed type. Significant statistics are listed in table 1. An initial conclusion was that associations exist between DGAT2 gene and several beef cattle economic traits that concern with carcass fat. For the small sample size of this study, proposal is further effort should be required to validate these findings in larger populations.

Table 1. List of significant statistics

Model	Trait ¹	SNP	LSM or regression coefficient estimates	F	Pr>F		
Genotype	REA	128	AA: 62.9 ± 6.7 ^a	GG: 77.9 ± 0.9 ^b	5.4	0.028	
Genotype	KPH	270	CC: 40.1 ± 3.2 ^a	CT: 42.5 ± 2.2 ^a	TT: 47.8 ± 1.0 ^b	4.0	0.019
Allele substitution	NMP	270	270-C	0.81 ± 0.40	4.0	0.046	
Allele substitution	REA	128	128-A	-7.48 ± 3.37	4.9	0.028	
Allele substitution	KPH	270	270-C	-4.27 ± 1.53	7.8	0.006	
Allele substitution	KPH	312	312-A	3.36 ± 2.43	4.9	0.029	

¹IMF: intramuscular fat percentage (%); REA: rib eye area (cm²); KPH: kidney, pelvic and heart fat weight (kg); NMP: net meat percentage (Retail cuts weight / Live body weight, %). ^{a,b}Within a row, least square means with different superscript letter differ, P<0.05.

Key Words: DGAT2 Gene, SNP, Carcass traits

FASS Environment, Waste Management and Ecosystems: Transforming Forages to Improve Nitrogen Use by Dairy Cows and Decrease Nitrogen Emissions

628 Source, amount and fate of nitrogen on US dairy farms. R. A. Kohn^{*1} and M. Wattiaux², ¹University of Maryland, College Park, ²University of Wisconsin, Madison.

The purpose of this review is to identify factors related to forage crop production that affect the efficiency of nitrogen (N) utilization on dairy farms, and may decrease N losses to the environment. Nitrogen enters most dairy farms in the form of fertilizer, N fixed by leguminous crops, atmospheric deposition, and imported feeds or manures. Typically less than half of the N entering the farm can be accounted for in milk, crop, cattle, or manure outputs, indicating considerable leakage of various chemical forms of N to the environment. Typically, less than 25% of the manure N produced by a dairy herd is recycled into home-grown feed N. Considering the entire agricultural system in support of milk production, all N in milk protein ultimately derives from atmospheric N. Atmospheric N becomes biologically active in one of two ways:

chemically by the Haber-Bosch process or biologically by the rhizobial bacteria associated with the roots of legumes. Total N inputs to agriculture for milk production are 3 to 10 times greater than the outputs as N in milk and meat. Most N is lost to ground and surface water through leaching and runoff, or lost to air via volatilization as ammonia, nitric oxide or nitrous oxide. These losses are harmful to the environment and human health in various ways. Some N is also denitrified back to the atmosphere as harmless N₂ gas. Whereas chemical fixation of N is highly dependent on non-renewable energy sources, legume crops fix N near crop roots for efficient utilization. However, high concentrations of legumes in rations oversupply ruminally-degraded protein, which increases N excretion, in particular in urinary N, which is highly vulnerable to volatilization. Although minimizing N losses to the environment requires that crops use N efficiently, it is equally important for animals to utilize feed N efficiently. Thus, the ideal cropping system would fix its own N,

or recycle manure N very efficiently, but at the same time, produce adequate carbohydrate and a protein source with ruminally undegraded protein and the ideal amino acid profile for milk production.

Key Words: Nitrogen emissions and runoff, Protein requirements, Forage crop improvement

629 Importance of forages on dairy farms, beyond their use as feed. M. P. Russelle*¹, N. P. Martin², and D. H. Putnam³, ¹*USDA-Agricultural Research Service, St. Paul, MN*, ²*USDA-ARS-US Dairy Forage Research Center, Madison, WI*, ³*University of California, Davis*.

The decline in use of perennial forages in US dairy herd rations is due in part to higher yield, greater energy content, and more uniform forage quality of corn silage. Although conversion of land from rotations of perennial with annual crops to continuous annual cropping has logistical advantages, it increases the need for fertilizer nitrogen (N), pest control, and energy, and raises the risk of soil erosion, nutrient runoff, nitrate leaching, and impaired soil, water, and air quality. Perennial forages help replace soil organic matter, which improves soil aeration, water holding capacity, and nutrient supply. Thus, these forages help offset organic matter declines due to increased soybean production and replacement of solid manure with manure slurry. Additional benefits to wildlife and aesthetics may play roles on some farms, such as those near suburban development. Alfalfa offers a combination of advantages available in no other perennial forage crop. It has the capacity for high N fixation, which provides a source of free N to the farm. Fixation of new N decreases when soil N supply is high, however, alfalfa helps buffer swings in N supply. Recent research results on a regional scale and at a feedlot remediation site demonstrate the importance of this buffering. Alfalfa's deep roots and large N requirement help reduce nitrate leaching far better than shallow rooted legumes, and some grass forages offer the same benefit. Expanding the acreage planted to perennial forages likely will require new markets or external support. The Conservation Security Program has offered funding in targeted watersheds for practices that reduce degradation of public resources. Examples of new markets include the potential for biomass energy from alfalfa stems, with leaves as a valuable by-product, and a new facility in southern Minnesota that will be extracting four products from alfalfa and returning the residue to dairies as feed. Several improvements in perennial forages would enhance their benefits, including increased yield potential, reduced winterkill, adaptation to less frequent harvests, greater utilizable protein, greater phosphorus uptake, and reduced potassium accumulation.

Key Words: Alfalfa, Nitrogen, Environment

630 Preservation of protein during harvest and storage. L. Kung, Jr.*¹ and R. E. Muck², ¹*University of Delaware, Newark*, ²*USDA-ARS, Madison, WI*.

Prior to harvest, 80 to 95% of the crude protein (CP) in perennial grass and legume forages is true protein. The remainder is primarily peptides, free amino acids, nitrate and ammonia. The integrity of plant cells is gradually lost through physical damage from the mower-conditioner or reduction in turgor from drying in the field. This loss of cell integrity releases plant endopeptidases and exopeptidases that cleave proteins to peptides and free amino acids. Dependent upon temperature and the rate and length of drying, the soluble nonprotein nitrogen (NPN) in a forage when baled or chopped for silage may be 15 to 40% of total CP. Further reductions in true protein during storage are generally small in hay. However during ensiling, more proteolysis occurs that may result

in upwards of 60 to 70% of the total CP being NPN. Microbial activity during ensiling may change the composition of the NPN. Clostridia, enterobacteria and some lactic acid bacteria may use amino acids as substrates producing primarily ammonia. Proteolysis during harvest and storage is affected by forage species. Generally more proteolysis is expected in legumes than grasses, but perennial ryegrass species are as susceptible to proteolysis during ensiling as alfalfa. Within legume species, proteolysis is negatively correlated with tannin content. However, tannin content in some species may be high enough to adversely affect nitrogen utilization by the cow. Red clover has a polyphenol oxidase that reduces proteolysis. Currently, producers have few options to reduce proteolysis. Silage inoculants have little effect on the loss of true protein but do reduce adverse microbial activity, minimizing ammonia and preserving more free amino acids and peptides. Acid additives, such as formic acid, are common in northern Europe and can reduce proteolysis. Cost and safety issues have kept these products from adoption in North America. Ideally, modifying forages to contain either polyphenol oxidase and its substrates or low levels of tannins would be beneficial for preserving forage protein during harvest and storage.

Key Words: Protein, Proteolysis, Hay

631 Challenges in utilization of high protein forages by lactating dairy cows. P. Huhtanen*¹, G. A. Broderick², and J. B. Russel³, ¹*MTT Agrifood Finland, Jokioinen, Finland*, ²*USDA-ARS, Madison, WI*, ³*USDA-ARS, Ithaca, NY*.

Forages are good for the environment and cow health. However, forages of sufficient quality often have elevated levels of rumen-degraded protein (RDP), much of which is converted to ammonia by ruminal microorganisms and excreted as urea. As a result, efficiency of N utilization by lactating cows fed high-forage rations can be low, leading to an increased risk of N leaving the farm through ammonia volatilization from manure or via nitrate losses in water. Despite high CP concentration in high quality grass and legume silages, protein supplementation has resulted in economical milk protein yield responses. The rumen operates as a continuous culture system and microbial growth is dependent on appropriate sources of both N and energy; this has led to suggestions that lack of synchronization of N and energy release is one reason for the low efficiency of the capture of N by ruminal microbes. However, there is little experimental evidence to support improved N utilization in response to timing energy and N release. For grass silage based diets, the incremental N from earlier harvest is better utilized than that from increased N fertilization due to improved fermentable energy supply. Feeding red clover silages has improved N utilization compared with alfalfa silages but, compared with grass silages, N utilization has been lower. Red clover has decreased proteolysis in the silo compared with both alfalfa and grass silages. This may account for the greater ruminal out-flow of non-ammonia N, mainly as feed N. However, this has not translated into improved milk protein yield in cows fed red clover silages. Certain bacteria isolated from the rumen have very high activity for producing ammonia from free amino acids. Suppressing these organisms in the rumen may aid in improving the supply of metabolizable amino acids in dairy cows fed these hay-crop silages. Strategies for improving N utilization in cows fed diets based on high quality forages, such as supplementary feeding of energy, protein and amino acids, will be addressed. Different aspects of modification of forage plants in relation to the potential to improve N utilization also will be discussed.

Key Words: N utilisation, Forage, Dairy cow

632 Manure nitrogen transformations in air, soil and crops on dairy farms. J. M. Powell^{*1}, K. F. Knowlton², M. P. Russelle³, and M. D. Hanigan², ¹USDA-ARS Dairy Forage Resh. Center, Madison, WI, ²Virginia Tech University, Blacksburg, ³USDA-ARS Dairy Forage Resh. Center, St. Paul, MN.

Only 25 to 35 % of the crude protein (CP) consumed by dairy cows is converted into milk. Such poor use of dietary CP may be due to inefficiencies associated with forage nitrogen (N) capture and metabolism. Manure N excreted in feces and urine, and the transformation of manure N in air, soil and crops are highly influenced by what dairy cows consume. For example, reducing dietary CP resulted in less total manure N, especially urine N excretion. Ammonia loss from manure from a low CP diet (13.6%) was lower than from a high CP diet (19.4%), representing 9 and 25% of applied manure N, respectively. Increasing condensed tannin content of dietary forage legumes also reduced urine N excretion. Ammonia emissions from barn floors were greater from manure derived from alfalfa silage (AS)-based diets than either birdsfoot trefoil with low or high tannin levels. After application to soil, feces from cows AS-based diets generally lead to higher soil inorganic N (IN) levels than soils amended with feces from corn silage-based diets; feces from AS-based diets increased plant yield and N uptake; feces from high CP diets resulted in greater soil IN levels than feces from low CP diets; and feces from low CP diets did not increase soil IN but decreased plant yield and N uptake. Only a small increase in N efficiency is necessary to make substantial reductions in the dairy industry's contribution to the environmental N load. There appears to be a range of dietary options that satisfy the nutritional requirements of high-producing dairy cows, yet produce manure that has differential effects on post-excretion transformations and environmental losses. Dairy production efficiencies may be gained and manure N losses reduced by incorporating moderate levels of tannins or other protein protection compounds into forages to enhance CP use and reduce dietary CP concentrations, and by developing perennial forages that tolerate manure applications, have improved ammonia absorption and assimilation potential, and are able to assimilate excess soil nitrates.

Key Words: Forages, Manure, Nitrogen cycling

633 Transforming forage plants to increase nitrogen utilization in dairy systems: What are the possibilities? R. Hatfield^{*1}, J. Grabber¹, M. Sullivan¹, G. Waghorn², and M. McCaslin³, ¹USDA-ARS, Madison, WI, ²Dexcel Limited, New Zealand, ³Forage Genetics, St. Paul, MN.

Forages can supply adequate protein to meet the nutritional needs of high producing dairy cows, at least as the crop stands in the field. However proteins are one of the most labile nutritional components in most forages, often being excessively degraded during ensiling and ruminal digestion, leading to depressed amino acid absorption and excessive urea excretion by cattle. Even when forages are grazed, protein-use efficiencies are often low due to rapid plant cytoplasmic protein degradation in the rumen. To maintain high production, dairy diets are frequently supplemented with a protein source to compensate for poor forage protein use. Traditional breeding and molecular approaches can be used to modify forages for improved protein-use by cattle. For example, redesigning alfalfa to produce polyphenol oxidase and *o*-diphenols or condensed tannins would lead to decreased protein degradation during ensiling and ruminal digestion with a likely increase in amino acid absorption by cattle. Production and feeding of such a forage would reduce urea excretion and possibly slow nitrogen release from feces and crop residues, thereby reducing nitrogen losses from farms. Altering specific gene expression in the lignin pathway may allow decreased lignification and increased fiber digestion for improved nitrogen utilization. Genetic selection or molecular alteration of forages to produce greater quantities of rapidly fermented carbohydrates should enhance conversion of non-protein nitrogen to ruminal protein for utilization by cattle. Increasing total biomass production that has good quality remains a challenge for forage production. Exploiting the genetic potential for total biomass production in forages is just now being explored. Redesigning forages to function more efficiently as effective nitrogen sources for dairy cows is not impossible; it could decrease the need for protein supplements, and ultimately decrease nitrogen losses to the environment.

Key Words: Protein, Plant-modification, Nitrogen waste

Physiology and Endocrinology: Endocrinology

634 An erythropoietin receptor (EPOR) gene polymorphism (SNP) alters EPOR mRNA in fetal liver of swine during early gestation. J. L. Vallet^{*} and B. A. Freking, USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.

We previously reported that an EPOR gene C/T SNP was associated with litter size. The T allele created a putative GATA-1 site, which was predicted to increase EPOR gene expression. This experiment determined whether the SNP was associated with: (1) EPOR gene expression by the fetal liver or (2) maturation of the fetal blood supply during early gestation. CC and CT gilts were unilaterally hysterectomized-ovariectomized at 160 d of age, mated to boars of like genotype and slaughtered on d 25 (n = 13 CC, 13 CT), 30 (19, 25) and 40 (14, 15) of gestation. Numbers of corpora lutea (CL) and live fetuses were recorded. For CT gilts only, a blood smear was prepared for each fetus, the fetus was weighed and fetal liver and other tissues were collected. Percentage of nucleated blood cells was assessed on d 30 and 40 (all blood cells were nucleated on d 25). DNA was prepared from fetal tissues to determine EPOR genotype. Total RNA

was prepared from fetal liver of one fetus of each genotype for each litter (d 25 and 30), and EPOR mRNA was measured using real time RT-PCR. Number of fetuses decreased ($P < 0.01$) between d 30 (11.7 ± 0.4) and 40 (8.5 ± 0.5) but did not differ between gilt genotypes. Percent nucleated cells decreased significantly between d 30 and 40 but were not affected by fetal genotype. Fetal liver EPOR gene expression was greater ($P < 0.01$) on d 30 compared to d 25 of gestation and a significant additive effect of genotype ($P < 0.01$) was observed (d 25, 3.8 ± 0.7 , 4.6 ± 0.7 , 5.4 ± 0.7 ; d 30, 9.8 ± 0.5 , 10.3 ± 0.5 , 11.3 ± 0.5 relative units; CC, CT, and TT, respectively). Although these results do not indicate an effect of the SNP on litter size, uterine capacity affects litter size on d 40 or later, and the number of gilts on d 40 were likely inadequate. The SNP also did not affect maturation of the fetal blood supply. However, the T allele was associated with increased EPOR gene expression during early pregnancy as predicted and, thus, could influence erythropoiesis and fetal survival.

Key Words: Blood, Erythropoiesis, Fetus

635 Serum constituents and thyroid hormones in sheep fed halophyte forages. A. Riasi*¹, M. Danesh Mesgaran², M. J. Zamiri³, and M. D. Stern⁴, ¹University of Birjand, Birjand, Khorasan, Iran, ²Ferdowsi University of Mashad, Mashad, Khorasan, Iran, ³University of Shyras, Shyras, Fars, Iran, ⁴University of Minnesota, St. Paul.

Halophyte forages originating from central Iranian deserts (*Kochia scoparia*, *Atriplex dimorphostegia*) were harvested at early bloom stage. The potential value of these forages occasionally is constrained by alteration of serum constituents and metabolic hormones of some ruminants. Nine Balouchi ewes (48±2 kg BW) were transferred to metabolism cages and randomly allocated to three dietary treatments [T 1: kochia + alfalfa (1:1), T 2: atriplex + alfalfa (1:1), T 3: alfalfa] in a Latin Square experiment with three periods (28 days periods). During the last 3 days of each period, samples of blood serum and urine were collected. There was no differences between treatments as serum levels of Mg and Na ($P > 0.05$). Whereas, Serum Ca levels for T 1 (8.04 mg/dl) and T 2 (8.29 mg/dl) was lower ($P < 0.01$) than that T 3 (9.19 mg/dl). Halophyte forages elevated serum cholesterol ($P < 0.01$), thyroxine ($P < 0.001$), and bilirubin ($P < 0.01$). Ewes fed T 1 had the highest ($P < 0.01$) blood serum activity of alanine aminotransferase (ALT) (34.8 U/l). The activity of Aspartate aminotransferase (AST) was increased in blood serum of ewes fed halophyte forages ($P < 0.05$). The effect of treatments on blood serum glucose levels were different ($P < 0.05$) and the linear relationship for the sampling time tend to be significant ($P < 0.08$). The effect of treatments on blood serum urea N were completely different ($P < 0.0001$), however there was no linear and quadratic relationship for the time of sampling.

Key Words: Serum constituents, Sheep, Halophyte forages

636 Food deprivation-induced decrease in blood insulin-like growth factor-I is associated with decreased liver growth hormone receptor mRNA and protein in steers. M. Wu¹, R. Akers¹, R. Torres-Diaz¹, S. Frank², J. Hall¹, W. Beal¹, and J. Jiang*¹, ¹Virginia Tech, Blacksburg, ²University of Alabama, Birmingham.

The insulin-like growth factor-I (IGF-I) is essential for animal growth and development. Most of the IGF-I in the blood comes from growth hormone (GH)-stimulated IGF-I gene expression in the liver. In a variety of animals including cattle, the IGF-I concentration in the blood is reduced during food deprivation or food restriction. This study was conducted to determine whether the decrease in blood IGF-I was associated with decreased expression of IGF-I mRNA, growth hormone receptor (GHR) mRNA and (or) GHR protein in the liver during food deprivation, to understand the role of liver GHR in the effect of food deprivation on blood IGF-I. Five steers were deprived of food for 60 h while another five steers (control steers) were allowed their usual access to food. A blood sample and subsequently a liver biopsy sample were taken from each steer at the end of the 60-h period. Serum IGF-I concentrations were 46.75% lower ($P < 0.01$) in food-deprived steers than in control steers. Liver IGF-I mRNA, GHR mRNA, GHR1A mRNA (a major GHR mRNA variant in the bovine liver) and liver GHR protein were less abundant ($P < 0.01$) in food-deprived steers than in control steers. Liver expression of non-1A GHR mRNA variants (i.e., the combination of GHR1B, 1C and other minor GHR mRNA forms) was, however, not different ($P > 0.05$) between food-deprived and control steers. Given the relative positions of GHR1A mRNA and GHR protein in the process of IGF-I mRNA production in the liver, that they were all reduced during food deprivation suggests that decreased expression of GHR1A mRNA

contributes to decreased IGF-I mRNA expression and hence decreased blood IGF-I during food deprivation.

Key Words: Growth hormone receptor, IGF-I, Cattle

637 Effects of standing estrus and concentrations of estradiol on uterine pH. J. R. Nelson*, B. L. Perry, and G. A. Perry, South Dakota State University, Brookings.

Research has shown cows in estrus within 24 h of fixed-time AI had elevated concentrations of estradiol and greater pregnancy rates compared to cows not in estrus. Our objective was to determine if estradiol and/or estrus had an effect on uterine pH during a fixed-time AI protocol. Non-lactating beef cows ($n = 19$) were treated with the CO-Synch protocol (100µg GnRH on d -9; 25 mg PG on d -2; and 100µg GnRH on d 0). Half ($n = 10$) the cows received an injection of estradiol cypionate (ECP; 1mg) 12 h following PG. Cows detected in standing estrus within 24 h of the second GnRH injection were considered to be in estrus. Cows treated with ECP had greater ($P < 0.01$) concentrations of estradiol compared to control cows (8.3 ± 0.7 and 5.2 ± 0.7 pg/mL, respectively). A treatment by time interaction ($P < 0.01$) influenced concentrations of estradiol. All cows had similar ($P > 0.15$) concentrations of estradiol at time of ECP, but ECP treated cows had elevated ($P < 0.02$) concentrations of estradiol following the second GnRH injection compared to control cows. Treatment ($P = 0.01$), time ($P < 0.01$), and treatment by estrus by time ($P = 0.065$) influenced uterine pH. Control cows that did not exhibit estrus had a higher uterine pH compared to ECP cows that did not exhibit estrus ($P = 0.03$) at time of ECP. All cows had a similar uterine pH ($P > 0.19$) 12 h after ECP. Control cows that did not exhibit estrus had a higher uterine pH compared to control cows that did exhibit estrus ($P < 0.01$) and ECP cows that exhibited estrus ($P = 0.05$) at time of the second GnRH injection (time insemination would occur; 7.0 ± 0.1 , 6.7 ± 0.1 , 6.8 ± 0.1 , respectively). ECP cows not exhibiting estrus were intermediate (6.8 ± 0.1). All cows had similar uterine pH 24 h after GnRH through ovulation ($P > 0.06$). Concentrations of estradiol had no linear ($P > 0.21$) or quadratic ($P > 0.21$) relationship with uterine pH. In summary, ECP treatment elevated concentrations of estradiol and lowered uterine pH to a level similar to the uterine pH of control cows that exhibited estrus within 24 h of when insemination would occur.

Key Words: Estradiol, Estrus, Uterine pH

638 Species-specific differences in constitutive androstane receptor (CAR) coding region predicts altered constitutive activity in ruminants. D. L. Greger*¹, C. Morel², C. R. Baumrucker¹, and J. W. Blum², ¹Pennsylvania State University, University Park, ²University of Bern, Bern, Switzerland.

Constitutive androstane receptor (CAR) is a nuclear receptor that regulates genes involved in detoxification and elimination of potentially toxic foreign and endogenous compounds (xenobiotics and endobiotics). In addition, CAR also regulates genes involved in energy homeostasis, affecting such processes as thyroid hormone metabolism and gluconeogenesis. The constitutive activity and specificity of ligand binding are dependent upon highly conserved amino acids involved in hydrogen bonding that maintain the activated conformation of the CAR molecule. Specifically, computer modeling has shown that a central tyrosine (Y326) is required for maintenance of the activated conformation, likely through the formation of a hydrogen bond with an

asparagine (N165) on the opposite side of the ligand binding domain. Site directed mutagenesis studies have confirmed this prediction. While these residues are highly conserved across mammalian species, we have discovered that ruminant species possess hydrophobic amino acids in these locations that would preclude hydrogen bond formation. In particular, CAR sequences obtained thus far from all ruminant species using multiple individual and pooled DNA samples from several breeds of cattle, as well as individual samples from sheep, red deer, wapiti, roe deer, goat and bison, all possess a phenylalanine substitution at the critical tyrosine residue (Y326F). Interestingly, the Bovidae (*Bos taurus*, *Bos indicus*, *Bison bison*) also have a substitution in the partner amino acid residue asparagine, N165, that is replaced by the hydrophobic residue isoleucine. These changes are not observed in non-ruminant herbivores. Given the importance of CAR as a repressor of hepatic genes encoding gluconeogenic enzymes, and the critical requirement in ruminant species for very high rates of glucose production, the ruminant CAR variants may play a vital role in the regulation of gluconeogenesis.

Key Words: Constitutive androstane receptor, Comparative genomics, Gluconeogenesis

639 Cortisol enhances N-acetylglutamate synthase activity and arginine synthesis in enterocytes of suckling piglets. G. Y. Wu^{*1,2}, Y. L. Yin¹, and N. E. Flynn^{2,3}, ¹The Chinese Academy of Sciences, Changsha, Hunan, P.R. China, ²Texas A&M University, College Station, ³Angelo State University, San Angelo, TX.

There are marked decreases in both plasma cortisol concentrations and intestinal activity of N-acetylglutamate synthase (NAGS; a key enzyme in arginine synthesis) in piglets during the suckling period. This study was designed to test the hypothesis that cortisol may play an important role in regulating intestinal NAGS expression in sow-reared piglets. Thirty-two 7-day-old suckling pigs were randomly assigned to one of four groups with seven animals each, and received intramuscular injections of vehicle solution (sesame oil) (control group), hydrocortisone-21-acetate (HYD) (25 mg/kg body wt), RU486 (10 mg/kg body wt) (a potent blocker of glucocorticoid receptors), or HYD plus RU486. During the entire experimental period, pigs were nursed by sows. At 14 days of age, pigs were sacrificed for preparation of jejunal enterocytes for measurements of synthesis of citrulline and arginine from glutamine and proline, mitochondrial activity of NAGS, and mitochondrial concentration of N-acetylglutamate (NAG), using established methodologies (Wu, *Am J Physiol* 272: G1382, 1997; Bush et al. *J Nutr* 132: 59, 2002). Cortisol administration had no effect ($P > 0.05$) on body weight but increased ($P < 0.05$) jejunal weight and villus height, compared with the control group. The cortisol treatment enhanced 1) NAGS activity and prevented the postnatal decline in NAGS activity during the suckling period; 2) increased NAG concentration as well as citrulline and arginine synthesis from glutamine and proline in enterocytes ($P < 0.01$), in comparison with the control group. The stimulatory effects of cortisol on intestinal NAGS activity and arginine synthesis were abolished ($P < 0.01$) by co-administration of RU486. Our results indicate that cortisol treatment provides a novel and effective means to prevent the marked declines in intestinal NAGS expression and arginine synthesis in suckling piglets via a glucocorticoid receptor-mediated mechanism. Supported by funds from the Chinese Academy of Sciences, China NSF, and USDA.

Key Words: Cortisol, N-Acetylglutamate, Suckling piglets

640 Adrenal involvement in the biostimulatory effect of bulls. S. A. Tauck*, J. R. Olsen, and J. G. Berardinelli, *Montana State University, Bozeman.*

The objective was to evaluate if cortisol concentrations are associated with the biostimulatory effect of bulls in postpartum, primiparous cows. The hypotheses were that interval from start of exposure to resumption of luteal activity; proportions of cows that resumed luteal function during the exposure period; and cortisol concentrations do not differ among cows exposed or not exposed to bulls (Exp. 1), and cows continuously exposed to bull or steer urine (Exp. 2). In Exp. 1, 28 anovular cows were exposed (BE; n=13) or not exposed (NE; n=15) to bulls for 35 d at 58 d after calving. In Exp. 2, 30 anovular cows were fitted with a controlled urine delivery device at 45 d after calving and exposed continuously (24 h/d) to bull (BUE; n=15) or steer (SUE; n=15) urine. Length of exposure was ~64 d. Blood samples were collected from each cow on d 0, and every 3 d throughout exposure periods in both experiments and assayed for progesterone. Cortisol was assayed in samples collected on d 0, 9, 18, and 27 in Exp. 1; and, d 0, 19, 38, and 57 in Exp. 2. In Exp. 1, interval from the start of exposure to resumption of luteal activity was shorter ($P < 0.05$) for BE cows than NE cows, similarly, more ($P < 0.05$) BE cows than NE cows resumed luteal function during the exposure period. In Exp. 2, there was no difference in intervals from the start of exposure to resumption of luteal activity and proportions of cows that resumed luteal function during the exposure period between BUE and SUE cows. In Exp. 1, there was no difference in cortisol concentrations between BE and NE cows at the start of the experiment (d 0), however, cortisol concentrations were greater ($P < 0.05$) in BE cows than NE cows on d 9, 18, and 27. In Exp. 2, cortisol concentrations were higher for BUE than SUE cows on d 0 ($P < 0.05$) thereafter cortisol decreased ($P < 0.05$) but did not differ between BUE and SUE cows. We conclude that continuous physical presence of bulls stimulates resumption of luteal activity and is coincident with increased cortisol concentrations. We hypothesize a possible association between adrenal activation and the biostimulatory effect of bulls.

Key Words: Biostimulation, Cortisol, Postpartum anestrus

641 Localization of Period1 mRNA in the ruminant oocyte and investigations of its role in ovarian function. R. A. Cushman*, M. F. Allan¹, S. A. Jones¹, G. P. Rupp², and S. E. Echternkamp¹, ¹U.S. Meat Animal Research Center, Clay Center, NE, ²University of Nebraska, Clay Center.

The clock gene Period 1 (Per1) may be a prolificacy gene, because it localized to the mouse oocyte and Per1-null drosophila shed fewer eggs. Because Per1 mapped to a region of mouse chromosome 11 homologous to bovine chromosome 19 where a QTL for ovulation rate existed, we hypothesized that Per1 influenced folliculogenesis and ovulation rate in ruminants. Ovarian cortex was collected at slaughter on Days 5, 12, 15, 17, and 20 after estrus for real-time RT-PCR evaluation of Per1 mRNA expression in Dorset (n = 18); Romanov (n = 10); Romanov/Dorset (n = 21); and Composite (n = 22) ewes. Ovarian cortex was also collected from cows selected for increased ovulation rate (n = 37) or unselected controls (n = 28) on days 4, 5, and 6 of the estrous cycle for *in situ* hybridization and real-time RT-PCR. To examine the role of Per1 in early follicular development, ovarian cortex from neonatal calves (n = 5) was cultured for ten days and Per1 mRNA levels were measured on Day 0 and on Day 10 of culture. The primers generated a 483 bp amplicon with 100% homology to bovine RIGUI-like protein (Per1) which is 20 cM from the QTL. Per1

mRNA expression was unaffected by prolificacy, day of the cycle, or pregnancy status in ewes or cows. The riboprobe hybridized to oocytes of bovine preantral and antral follicles. In bovine ovarian cortical cultures on Day 0, the tissue contained mostly primordial follicles (5.6 ± 0.6 follicles/section); however, after 10 days in culture, the number of primordial follicles per section decreased (0.5 follicles/section) and the number of primary follicles increased as follicles activated (Day 0 = 0.5 ± 0.6 vs. Day 10 = 10.4 ± 0.6 primary follicles/ section; $P < 0.001$). Per1 mRNA did not change over time in culture. We conclude that Per1 mRNA is expressed by ruminant oocytes in preantral and antral follicles; however, its physiological role in mammalian ovarian function remains to be elucidated.

Key Words: Oocyte, Fertility, Gene expression

642 Trace element concentration of bovine ovarian and hepatic tissue. W. S. Swecker, Jr^{*1} and D. J. Tomlinson², ¹Virginia Tech, Blacksburg, ²Zinpro Corp, Eden Prairie, MN.

Adequate provision of nutrients is essential to bovine reproduction. Ovarian tissue in cycling beef and dairy cows must support follicular growth, corpus luteum (CL) formation and lysis. Antioxidant enzymes such as superoxide dismutase and glutathione peroxidase are essential to protect the ovary and may have regulatory functions in hormone synthesis. The objective of this study was to compare concentrations of trace element constituents (Mn, Cu, Zn, Se) of antioxidant enzymes and trace element antagonists (Fe, Mo) in ovarian stroma, luteal tissue, and liver. Liver and ovarian tissue was collected from cows

at a commercial abattoir. Trace element analysis of ovarian stroma, CL, and liver tissue was submitted on a subset of 18 cows that had a CL > 10 mm present. Mineral concentrations were determined by Inductively Coupled Plasma Mass Spectrometry. Manganese concentrations in the CL were similar to liver concentrations and both were 10-fold greater than ovarian Mn concentrations. Copper concentrations were similar between ovarian stroma and CL and were 60-fold lower than liver Cu. Zinc concentrations were similar between CL and ovarian stroma and were 4-fold lower than liver concentrations. Corpus luteum selenium was similar to ovarian concentrations and both were 75% of liver concentrations. For antagonistic trace elements, both Fe and Mo concentrations of the CL were intermediate to liver and ovarian concentrations. In summary, Mn, Fe, and Mo appear to be concentrated in the CL relative to ovarian stroma. Selenium concentrations of ovarian stroma and CL are most similar to liver concentrations as compared to the other elements.

Table 1. Mineral Content of Tissues

Element	Corpus Luteum	Ovarian Stroma	Liver	Pooled SEM
Cu	5.7 ^a	3.7 ^a	360.6 ^b	33.9
Se	1.1 ^a	0.9 ^a	1.3 ^b	0.1
Mn	9.5 ^a	0.7 ^b	8.1 ^a	0.7
Zn	58.1 ^a	68.7 ^a	262.6 ^b	17.6
Fe	182.3 ^a	75.0 ^b	328.3 ^c	23.8
Mo	0.7 ^a	0.2 ^b	2.8 ^c	0.1

Concentrations are ppm ^{a,b,c} values within row with different superscripts differ $P < 0.05$ DM basis

Key Words: Trace elements, Antioxidant enzymes, Ovary

Ruminant Nutrition: Grazing Nutrition

643 Effects of ruminal fill on bite and grazing dynamics. P. Gregorini^{*1,2}, S. Gunter¹, C. Masino², and P. Beck¹, ¹University of Arkansas, Hope, ²Universidad Nacional de La Plata, La Plata, Buenos Aires, Argentina.

Hunger affects intake rate. Ruminal fill (RF) has been related to such a state; thus, its level may operate in intake regulation, and grazing behavior. This experiment assessed the impact of manipulated ruminal fill on bite traits and grazing dynamics. During 15 d, 3 ruminally cannulated heifers individually grazed bermudagrass pastures. The first 11 d were adaptation to grazing management. New strips were allocated daily at 0800. At 1700 heifers grazed for a session (GS) of 30 min on a new strip. From d 12 to 15, the treatments, ruminal fill 100 (RF100), 66 (RF66) 33 (RF33), and 0% (RF0) of total ruminal contents, were randomly applied in a 3 x 4 Youden-square design. The rumen was emptied and contents weighed at 0700 and 1300, and after each GS to assess morning intake, set treatments (before GS), and estimate bite mass (BM), respectively. All GS were video recorded and analyzed for bite rate (BR), bites/feeding station (BFS), FS/min (FSR), intake/FS (IFS), and time/FS (TFS). Apparent bite depth (ABD), area (ABA), and area grazed/FS (AFS) were calculated. Dependent variables were analyzed by ANOVA. The linear, quadratic and cubic effects of RF were detected using orthogonal contrasts. As RF decreased, BM, BA, BFS, AFS, TFS and IFS increased ($P < 0.01$); while ABD and FSR decreased ($P < 0.01$). Heifers increased IR by changing bite

shape and increasing TFS instead of BR. These results support the connection of ingestive and digestive behaviors, and its use in new grazing strategies.

Table 1.

Variable	Treatment				se	Orthogonal contrast ^a		
	RF0	RF33	RF66	RF100		L	Q	C
BM, g	0.77	0.58	0.26	0.22	0.01	<0.01	0.10	0.05
ABA, cm ²	288.48	214.93	93.92	75.84	9.15	<0.010	0.37	0.29
ABD, %	46	48.37	50.62	53	<0.01	<0.01	0.91	0.86
BR, bites/min	49.7	52.1	53.5	51.6	1.27	0.69	0.6	0.89
BFS	9.17	9.04	7.64	5.35	0.25	0.01	0.23	0.92
FSR	4.86	5.91	7.14	9.67	0.17	<0.01	0.25	0.68
Intake/FS, g	6.86	5.20	2.21	0.91	0.13	<0.01	0.67	0.16
TFS, s	11.18	10.17	8.61	6.28	0.23	<0.01	0.41	0.94
AFS, %	96.53	69.01	29.07	10.66	2.54	<0.01	0.6	0.35

^aLinear (L), Quadratic (Q), and Cubic (C) effects.

Key Words: Ruminal fill, Bite features, Feeding stations

644 Strain of Holstein-Friesian and concentrate feeding level influence endogenous plasma ghrelin concentration. A. J. Sheahan¹, D. P. Berry², and J. R. Roche^{*1}, ¹*Dexcel, Hamilton, New Zealand*, ²*Moorepark Dairy Production Research Center, Fermoy, Co. Cork, Ireland*.

Ghrelin (G) is an endogenous ligand of the growth hormone (GH) secretagogue receptor and a potent orexigenic agent in monogastrics and ruminants. Although also known to increase GH in dairy cows, little is known about the effect of nutrition or genetics on plasma G concentration in grazing dairy cows. Our objective was to determine the effect of strain of Holstein-Friesian and/or concentrate supplementation on plasma G before and after feeding. Sixty cows of either New Zealand (NZ; n=30) or Northern hemisphere (NH; n=30) ancestry were randomly allocated at calving to 3 levels of concentrate supplementation (0, 3 or 6 kg DM/cow/d fed daily in two feeds at milking) on a pasture diet. Blood was sampled before the morning feed and following a 2 h grazing bout, on average 75 and 82 DIM. Extracted plasma was analyzed for G, GH, NEFA and glucose. Plasma ghrelin concentrations pre- (PreG) and post-feeding (PostG), and the change in ghrelin (Δ G) were correlated with plasma metabolites, milk production variables and estimated breeding values for production traits. Repeatability of ghrelin concentration using all data was 0.51. Plasma G concentration averaged 271 ng/ml at baseline (prefeeding) and declined ($P < 0.001$) to 154 ng/ml following a grazing event. There was a tendency ($P < 0.1$) for NH cows to have higher G concentrations than NZ cows (219 vs. 190 ng/ml), but strain did not affect Δ G. Concentrate supplementation did not affect PreG but linearly ($P < 0.05$) reduced PostG. There was no significant correlation between PreG and any milk production variable, but PostG and Δ G were negatively correlated ($P < 0.05$) with milk, fat, protein and lactose yield. PreG and PostG were negatively correlated with the estimated breeding value for milk fat ($P < 0.01$) and protein ($P < 0.1$) yield. PreG, PostG and Δ G were positively correlated ($P < 0.05$) with plasma glucose, and Δ G was positively correlated ($P < 0.001$) with the change in plasma NEFA. Results point to a possible role of ghrelin in strain and nutrition effects on DMI.

Key Words: Ghrelin, Pasture, Concentrates

645 Nutrient status of young postpartum range cows fed range supplements containing increased glucogenic precursors. R. L. Endecott*, C. M. Rubio, S. H. Cox, M. R. Rubio, R. B. Lueras, I. Cowboy, R. D. Speckmann, C. A. Löest, D. E. Hawkins, and M. K. Petersen, *New Mexico State University, Las Cruces*.

Consistent responses of young postpartum beef cows to protein supplementation could improve reproduction and cow sustainability. A 2-yr study conducted at the Corona Range and Livestock Research Center from February to July in 2003 (n = 51) and 2004 (n = 40) evaluated responses of 2- and 3-yr-old postpartum beef cows grazing dormant native range to three protein supplements with increasing glucogenic potential (GP). Supplements were fed at 1135 g•cow⁻¹•d⁻¹ twice weekly for approximately 70 d and provided 1) 341 g CP, 142 g ruminally undegradable protein (RUP), 57 g GP (RUP0), 2) 341 g CP, 151 g RUP + 80 g propionate salt (NutroCAL™, Kemin Industries, Inc.), 124 g GP (RUP80), or 3) 341 g CP, 159 g RUP + 160 g propionate salt, 192 g GP (RUP160). Weekly serum samples were composited and analyzed for glucose, non-esterified fatty acids (NEFA), and serum urea nitrogen (SUN). Supplement × yr interactions were observed for each metabolite ($P \leq 0.04$). Cows fed RUP0 had higher glucose concentrations in 2004 than in 2003. In 2003, cows fed RUP160 had higher serum SUN concentrations than RUP80-fed

cows; the opposite effect was observed in 2004. However, SUN concentrations for all cows were higher in 2004 than in 2003. Serum NEFA concentrations of RUP160-fed cows were higher in 2003 than in 2004. Cows fed RUP80 had the most consistent response, regardless of yr. Implications of this study suggest that cows fed the moderate level of GP were able to compensate for yr differences.

Table 1.

Response	Supplement	Year	
		2003	2004
Serum glucose (mg/dL) supp × yr $P < 0.01$	RUP0	47.3 (3)	57.4 (3)
	RUP80	48.6 (2)	54.0 (3)
	RUP160	52.9 (2)	49.4 (3)
Serum SUN (mg/dL) supp × yr $P = 0.03$	RUP0	9.2 (0.5)	15.6 (0.5)
	RUP80	8.7 (0.5)	15.9 (0.5)
	RUP160	10.2 (0.4)	14.5 (0.5)
Serum NEFA (mEq/L) supp × yr $P = 0.03$	RUP0	408 (25)	293 (23)
	RUP80	374 (22)	342 (23)
	RUP160	472 (20)	330 (22)

Mean (SE)

Key Words: Propionate, Protein supplements, Reproduction

646 Effect of daily herbage allowance and concentrate level on the milk production performance of spring calving dairy cows in early lactation. E. Kennedy^{*1,2}, M. O'Donovan¹, M. Rath², F. O'Mara², and L. Delaby³, ¹*Dairy Production Research Centre, Teagasc Moorepark, Fermoy, Co. Cork, Ireland*, ²*School of Agriculture, Food Science and Veterinary Medicine, NUI Dublin, Belfield, Dublin, Ireland*, ³*INRA, UMR Production du Lait, St. Gilles, France*.

The objective of this study was to establish the influence of daily herbage allowance and concentrate supplementation on the milk production performance of spring calving dairy cows in early lactation. Sixty-six (30 primiparous and 36 multiparous) Holstein Friesian dairy cows (mean calving date 7 Feb) were randomly assigned to a 6 treatment (n=11) grazing study. The treatment groups were comprised of 3 DHA's (13, 16 and 19 kg DM/cow/day >4 cm) and 2 concentrate supplementation levels (0 and 4 kg DM/day). Treatments were imposed from 21 February to 8 May (11 weeks). Milk yield was recorded daily; milk composition and liveweight were determined weekly. All animal parameters were analysed using covariate analysis within a completely randomised statistical design. Offering a low DHA in early lactation resulted in only a slight reduction in milk yield and liveweight. The inclusion of concentrate in the diet increased ($P < 0.001$) milk yield, milk composition and liveweight. These results indicate that as DHA increases, the rate of increase in milk production declined. Including concentrate in the diet resulted in increased milk production and liveweight.

Table 1. Effect of DHA and Conc on milk production

	Low DHA	Med DHA	High DHA	No Conc	Conc	SED	DHA	Conc	Linear
Milk yield (kg)	25.6 ^b	26.6 ^{ab}	27.1 ^a	24.3 ^b	28.6 ^a	0.87	0.08	***	*
Fat yield (g/day)	980	1009	998	925 ^b	1066 ^a	53.67	NS	***	NS
Protein yield (g/day)	840 ^b	877 ^{ab}	900 ^a	800 ^b	945 ^a	33.90	*	***	**
Lactose yield (g/day)	1234 ^b	1282 ^{ab}	1313 ^a	1157 ^b	1396 ^a	49.86	0.09	***	*
SCM yield (kg)	23.5 ^b	24.9 ^a	24.6 ^a	22.5 ^b	26.3 ^a	0.87	*	***	0.08
Liveweight (kg)	489 ^c	499 ^b	508 ^a	493 ^b	504 ^a	6.9	***	***	***

$P \leq 0.001$, $** = P \leq 0.01$, $* = P \leq 0.05$. ^{abc}values in the same row not sharing a common superscript differ significantly. DHA=Daily herbage allowance; Conc=concentrate level

Key Words: Daily herbage allowance, Concentrate, Milk production

647 Effects of offering different types of supplementation to spring calving dairy cows at grass in autumn. M. O'Donovan^{*1}, E. Kennedy¹, T. Guinee², and J. J. Murphy¹, ¹Teagasc, Dairy Production Research Centre, Teagasc Moorepark, Fermoy, Co. Cork, Ireland, ²Teagasc, Moorepark Food Research Centre, Teagasc Moorepark, Fermoy, Co. Cork, Ireland.

The objective of this experiment was to compare alternative forages and concentrate as buffer feeds offered to spring-calving dairy cows in the autumn. Ninety Holstein-Friesian cows were balanced on calving date and milk yield (19.9 ± 1.5 kg/cow/day) and randomly assigned to one of 6 treatments; (i) 17.5 kg of grass DM allowance (LG), (ii) 24 kg of grass DM allowance (HG), (iii) LG + 4 kg concentrate DM (C), (iv) LG + 4 kg maize silage DM (M), (v) LG + 4 kg urea-treated processed whole crop wheat DM (UPWCW) and (vi) LG + 4 kg fermented whole crop wheat DM (FWCW). Treatments were imposed from 13 September to 7 November 2004 (2 grazing rotations). Both LG and HG herds grazed separately while the 4 supplemented treatments grazed together, as a single herd. The supplementary forages were group fed from a diet feeder after morning milking. Concentrates were offered individually in the milking parlour during am milking. Herbage removal rate was 18.7, 15.0 and 14.4 kg/cow/day (s.d. 2.65 kg) for HG, LG and supplemented herds, respectively. Animals supplemented with concentrate (18.3kg/cow) had a significantly ($P < 0.001$) higher milk yield compared to the HG (15.5kg), M (15.0kg) and UPWCW (14.9) treatments, which in turn had a significantly greater milk yield than LG (13.2kg) and FWCW (14.2 kg). Solids corrected milk (SCM) yield was significantly ($P < 0.001$) greater for C (+2.3kg) than HG (14.9), which was greater than M (14.5), UPWCW (14.3) and FWCW (13.8kg /cow), the LG herd (12.6kg /cow) had the lowest SCM yield. Milk fat, protein and lactose concentrations, as well as body condition

score (BCS) and liveweight were not significantly different across treatments. The rennetability of milk tended to be higher in treatments M and FWCW while it was poorest in C. There is a large solids-corrected milk production benefit to supplementing grazing cows, on a restricted grass allowance in late lactation, with concentrate. Supplementing with other forages gave smaller responses, while extra herbage allocation proved superior.

Key Words: Supplementation, Herbage, Milk production

648 The effect of supplementing grazing cows with barley, corn or a mixture of both on milk yield, blood metabolites and rumen pH fluctuation. F. Dohme^{*}, A. Scharenberg, and A. Munger, *Agroscope Liebefeld-Posieux, Swiss Federal Research Station for Animal Production and Dairy Products (ALP), Posieux, Switzerland.*

A different degradability of starch sources may influence rumen fermentation and consequently milk production. In a 3×3 Latin square design experiment with 12 cows (6 rumen-cannulated) grazing ryegrass/clover pasture, the effect of three supplements, differing in their ruminal starch availability, on milk production, blood metabolites and rumen pH fluctuation was determined. From a milk production of 21 kg/d on, cows received the same amount of net energy for lactation (3.9 MJ NE_L) per kg additionally produced milk as ground barley (B), barley/corn (B/C) or corn (C). Each experimental period lasted for 28 d with data collection from d 21 to 28. Grass intake was quantified by the double alkane technique using controlled-release capsules. Milk yield and milk constituents were recorded for each milking. Rumen pH was measured continuously for 22 h/d with a pH electrode placed in the rumen through the cannula. For each cow pH data were summarized as mean, maximum and minimum pH and time period when pH was < 5.8 and < 6.2 . Venous blood was sampled on d 21 and 27 of each experimental period. Cows of treatment B (4.0 kg dry matter (DM)/d) were allocated more supplement ($P < 0.1$) than cows of treatment B/C (3.6 kg DM/d) and C (3.4 kg DM/d). However, total intake of DM and NE_L were not affected by treatments. Milk yield and milk fat content did not differ among treatment groups whereas the milk protein content was higher for group B compared to group C ($P < 0.05$). While the concentration of milk urea nitrogen was higher ($P < 0.05$) for cows fed B/C than for cows fed B or C, the plasma urea concentration was highest in groups B/C and B and lower ($P < 0.05$) in group C. The type of supplement had no influence on mean (6.17), maximum (6.56), and minimum (5.73) rumen pH and time when the pH was < 5.8 (88 min/d) or < 6.2 (676 min/d). In conclusion, the starch source provided by the supplement had an effect on nitrogen use efficiency in dairy cows whereas the influence on rumen pH was low. However regardless of treatment, the time when the pH was < 6.2 was quite long which might compromise rumen microbial activity.

Key Words: Grazing, Rumen pH, Supplement

Ruminant Nutrition: Nitrogen Metabolism - Beef

649 Balancing diets to meet the animal's requirement for absorbable amino acids. J. W. Golden^{*1}, M. S. Kerley¹, and N. A. Pyatt², ¹University of Missouri, Columbia, ²ADM Animal Nutrition Research, Decatur, IN.

A study was conducted to determine if growth rate and gain to feed ratio (GF) could be improved in feedlot steers by balancing the diet

for absorbable amino acid requirements. The ruminally degradable protein (RDP) in the diet met, but did not exceed predicted degradable nitrogen required to maximize microbial efficiency. Two protein sources, bloodmeal (BM) and fishmeal (FM) were contrasted to test the hypothesis that diets could be formulated, based on absorbable amino acid requirements. BM and FM diets were whole corn based. The control diet (14%CP; SBM) was whole corn based with soybean

meal and hay (10%). All diets contained a vitamin-mineral premix with Rumensin[®] and Tylan[®]. BM and FM diets were formulated to achieve an average daily gain (ADG) of 2.05 kg during phase one (P1; Day 0-84) and 1.70 kg for phase two (P2; Day 84-finish). Diets were optimized for RDP and microbial crude protein estimates were calculated using empirical equations. Amino acid requirements of feedlot steers were based upon the original CNCPS. ADG differed ($P < 0.10$) during P1 between BM, FM, and SBM groups (1.79, 1.63, and 1.61 kg) with cattle fed BM having a greater ADG than FM and SBM. GF differed ($P < 0.10$) during P1 between BM, FM, and SBM groups (0.26, 0.26, and 0.23) with BM and FM cattle having a greater GF ratio than SBM. Total pen manure was collected for one week during P1. Average pen wet manure weight (WMW) differed ($P < 0.10$) between BM, FM, and SBM (117, 112, and 271 kg) with BM, and FM cattle excreting less manure than SBM. There were no differences in manure dry matter (DM) for BM, FM, and SBM groups during P1 (35.9, 39.6, and 38.7%). There was no difference in ADG (1.60, 1.45, and 1.54 kg) or GF (0.20, 0.20, and 0.17) for BM, FM, and SBM groups during P2. Total pen manure was collected for one week during P2. Average pen WMW differed ($P < 0.10$) for BM, FM, and SBM (162, 151, and 268 kg) with BM, and FM cattle excreting less manure. There were no differences in manure DM between BM, FM, and SBM groups during P2 (42.7, 48.4, and 41.0%). We concluded from this research that animal performance can be improved when diets are formulated to meet the absorbable amino acid requirements.

650 Effects of energy supplementation on leucine utilization by growing steers. G. F. Schroeder*, E. C. Titgemeyer, and E. S. Moore, *Kansas State University, Manhattan.*

The effects of energy supplementation on leucine (Leu) utilization in growing steers were evaluated using 6 ruminally cannulated Holstein steers (initial BW = 150 ± 7 kg) in a 6×6 Latin square design. All steers were limit-fed (2.3 kg/d of DM) a diet based on soybean hulls and received a basal ruminal infusion of 100 g/d of acetate, 75 g/d of propionate, and 75 g/d of butyrate, as well as abomasal infusions of 200 g/d of glucose and a mixture (215 g/d) containing all essential AA except Leu. Treatments were arranged as a 3×2 factorial with three amounts of Leu infused abomasally (0, 4, and 8 g/d) and supplementation with two amounts of energy (0 and 1.9 Mcal/d of GE). The supplemental energy was supplied through ruminal infusion of 100 g/d of acetate, 75 g/d of propionate, and 75 g/d of butyrate, as well as abomasal infusion of 200 g/d of glucose to provide energy to the animal without affecting microbial protein supply. Total tract apparent DM digestibility (71%) and fecal N excretion (17 g/d) were not affected by the treatments. Nitrogen balance was increased linearly ($P < 0.01$) by abomasal supplementation of Leu as a result of linear ($P < 0.01$) decreases in urinary N excretion, which demonstrated that, as designed, Leu was the limiting AA. Energy supplementation increased N balance ($P < 0.01$) as a result of decreased urinary N excretion ($P < 0.01$), indicating that energy supplementation improved the efficiency of Leu utilization. When additional energy was supplied, N retention increased linearly in response to Leu (25.6, 28.5, and 31.6 g/d for 0, 4, and 8 g/d of Leu). However, when no energy was supplemented, increases in N retention were similar for 4 and 8 g/d of Leu (24.5, 27.0, and 27.3 g/d for 0, 4, and 8 g/d of Leu). The efficiency of supplemental Leu utilization was 0.31. Energy supplementation appeared to improve Leu utilization by modestly increasing N retention when Leu was limiting (0 or 4 g/d of supplemental Leu) and by increasing the ability of steers to respond to the highest amount of supplemental Leu (8 g/d).

Key Words: Leucine, Energy, Cattle

651 Influence of dietary protein concentration and source on ruminal metabolism, nutrient digestibility, and urinary purine derivative excretion in steers. G. I. Crawford*, M. K. Luebke, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln.*

A metabolism experiment utilizing six ruminally and duodenally fistulated steers (474 ± 37 kg) was conducted to determine effects of dietary protein concentration and source on ruminal metabolism, nutrient digestibility, and urinary purine derivative (PD; allantoin + uric acid) excretion. Influence of urine sample collection time on PD excretion was also evaluated. Steers were arranged into a replicated 3×3 Latin square with treatments consisting of: 1) 85% steam-flaked corn (SFC; 9.6% CP); 2) 85% SFC + 1.5% urea (UREA; 13.7% CP); or 3) 25% SFC, 30% wet corn gluten feed, and 30% corn bran (BYPROD; 14.9% CP). Steers were fed once daily at 0730 h, and ruminal pH and DMI were continuously monitored throughout each collection period. Treatment effects were considered significant at $P < 0.10$. Greater ($P < 0.05$) DMI occurred with BYPROD than with SFC, and tended ($P = 0.07$) to be greater with BYPROD than with UREA, averaging 8.0, 8.3, and 9.8 kg/d for SFC, UREA, and BYPROD, respectively. Ruminal pH measured 5.43, 5.58, and 5.94 for SFC, UREA, and BYPROD, respectively, and was greatest ($P < 0.05$) with BYPROD. Ruminal OM digestibility was not affected ($P > 0.10$) by treatment, averaging 62.8%. Total tract OM digestibility measured 85.3, 87.8, and 79.8% for SFC, UREA, and BYPROD, respectively, and was lowest ($P < 0.05$) with BYPROD. Urinary PD:creatinine ratio (PD:C) was greater with BYPROD than with SFC, and tended ($P = 0.09$) to be greater with UREA than with SFC, measuring 0.75, 0.92, and 1.06 $\mu\text{M PD}/\mu\text{M creatinine}$ for SFC, UREA, and BYPROD, respectively. Urinary PD:C measured 0.82, 0.86, 0.96, and 0.98 $\mu\text{M PD}/\mu\text{M creatinine}$ when urine spot samples were collected at 0700, 1200, 1700, and 2200 h, respectively (linear; $P < 0.05$). Differences in PD:C due to diet and collection time suggest that the BYPROD treatment produced greater microbial CP flows than SFC or UREA treatments, and that estimates are greatest when spot samples are collected later in the day.

Key Words: Purine derivative, Spot sample, Steers

652 The effect of degradable intake protein on urea kinetics in steers consuming low-quality forage. T. A. Wickersham*, E. C. Titgemeyer, R. C. Cochran, and E. E. Wickersham, *Kansas State University, Manhattan.*

We evaluated the effect of increasing amounts of degradable intake protein (DIP) on urea kinetics in steers consuming prairie hay. Five ruminally and duodenally fistulated Angus \times Hereford steers (278 kg BW) were used in a 4×4 Latin square and provided ad libitum access to low-quality prairie hay (4.7% CP). The DIP was casein dosed ruminally, once daily at 0, 57, 114, and 171 mg N/kg BW daily. Periods were 13 d long with 7 d for adaptation and 6 d for collection. Steers were in metabolism crates for total collection of urine and feces. Jugular infusion of $^{15}\text{N}^{15}\text{N}$ -urea followed by determination of urinary enrichment of $^{15}\text{N}^{15}\text{N}$ -urea and $^{15}\text{N}^{14}\text{N}$ -urea was used to determine urea kinetics. Forage and N intake increased (linear, $P < 0.01$) with increasing DIP. Retention of N was negative (-2.7 g/d) for steers receiving no DIP and increased linearly ($P < 0.01$; 12.3, 23.1, and 35.4 g/d for 57, 114, and 171 mg N/kg BW daily) with DIP. Urea synthesis was 27.5, 24.4, 43.4, and 59.2 g urea-N/d for 0, 57, 114, and 171 mg N/kg BW daily (linear, $P < 0.01$). Entry of urea into the gastrointestinal tract as a percentage of urea synthesis was 98.3% for steers receiving no DIP and decreased linearly ($P < 0.01$) to a low of 93.0% for steers receiving 171 mg N/kg BW daily. Correspondingly, urinary urea

excretion was 1.7, 2.5, 2.8, and 7.0% of urea synthesis for 0, 57, 114, and 171 mg N/kg BW daily (linear, $P < 0.01$). The amount of urea-N entering the gastrointestinal tract was greatest for 171 mg N/kg BW daily (54.9 g urea-N/d) and decreased (linear, $P < 0.01$) to 42.4, 23.8, and 27.2 g urea-N/d for 114, 57, and 0 mg N/kg BW daily. Provision of DIP produced the desired and previously observed increase in forage intake, while also increasing N retention. The large percentage of urea synthesis that was recycled to the gut (93.0% even when steers received the greatest amount of DIP) points to the remarkable ability of cattle to conserve urea-N when fed a low-protein diet.

Key Words: Cattle, Urea

653 Determining the proportion of urea recycled to the gut that is incorporated into ruminal microbial protein. T. A. Wickersham*, E. C. Titgemeyer, and R. C. Cochran, *Kansas State University, Manhattan.*

We developed a method to measure the amount of recycled urea-N incorporated into microbial CP (MCP). Five ruminally and duodenally fistulated steers (237 kg) were given ad libitum access to prairie hay (4.7% CP). Three received 1 kg/d of soybean meal (SBM; 53.8% CP) and two received no supplemental protein. The experiment was 15 d long. Steers were in metabolism crates for total collection of urine and feces and continuous jugular infusion of $^{15}\text{N}^{15}\text{N}$ -urea. Urine, feces, ruminal bacteria, ruminal fluid, and duodenal samples collected on d 9 were used to determine background enrichments of ^{15}N . Infusion of 0.12 g/d $^{15}\text{N}^{15}\text{N}$ -urea began on d 10. Daily samples of urine, feces, ruminal bacteria, and duodenal digesta from d 10 through 14 were used to determine when ^{15}N enrichment plateaus were reached. Duodenal and bacterial samples collected every 3 h on d 15 were used to measure duodenal and microbial N flows and incorporation of recycled urea-N into MCP. Duodenal N flow was based on ADIA as a marker. Bacterial N flow was calculated as duodenal N flow multiplied by the ratio of duodenal:bacterial ^{15}N enrichment. Bacterial N from recycled urea-N was calculated as bacterial N flow multiplied by the ratio of bacterial:urinary ^{15}N enrichment. Urinary enrichment of $^{15}\text{N}^{15}\text{N}$ -urea plateaued after 24 h, whereas $^{15}\text{N}^{14}\text{N}$ -urea plateaued after 48 h of $^{15}\text{N}^{15}\text{N}$ -urea infusion. Urinary enrichment of $^{15}\text{N}^{15}\text{N}$ -urea at plateau was 0.33 atom percent for control and 0.07 atom percent for SBM. Bacteria reached a ^{15}N enrichment plateau after 24 h and duodenal samples after 48 h. Urea production was 17.6 and 78.0 g urea-N/d for control and SBM. Gut entry represented 99 and 87% of urea production for control and SBM. Incorporation of recycled N into MCP was 9.0 and 23.0 g N/d for control and SBM, representing 53 and 34% of gut entry, respectively. Recycled urea-N represented 33 and 27% of the microbial N at the duodenum for control and SBM. In steers consuming prairie hay, these methods allowed us to measure the incorporation of recycled urea-N into MCP.

Key Words: Cattle, Urea

654 Net flux of A-amino N across splanchnic tissues of ewes during abomasal protein and glucose infusion. H. C. Freetly*, C. L. Ferrell, and S. L. Archibeque, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

Amino acids that enter enterocytes are used for protein synthesis, catabolized, or released into the blood. We hypothesized that providing glucose as an alternate energy source would increase the release of amino acids into the blood. Mature ewes ($n = 18$; 71.7 ± 0.7 kg) with permanent catheters in the portal vein, hepatic vein, and abdominal

aorta and a cannula in the abomasum were fed a diet of 95% brome hay and 5% soybean meal, as DM (52.2 g/BW $\text{kg}^{0.75}$). The design was a Youden rectangle with 9 ewes receiving abomasal infusions of either 0 or 3.84 g/h glucose and 1 of 5 abomasal protein infusions (0, 18.1, 36.4, 54.4, or 72.6 mmol amino acids/h, x) in each of 5 periods. The protein was a combination of an isolated soy protein (Ardex® F Dispersible) and cysteine (8.3% by weight). Blood samples were collected 4 through 6 h after infusions were initiated. Net PDV α -amino N release increased with protein infusions ($P < 0.001$; $f(x) = 0.346x + 28.2$ mmol/h), but the difference between controls and glucose infused ewes was not significant ($P = 0.11$). Net PDV glucose release was higher ($P < 0.001$) in ewes receiving the glucose infusion (1.57 ± 1.51 mmol/h) than control ewes (-12.9 ± 2.8 mmol/h) and glucose release increased quadratically ($P = 0.03$; $f(x) = -0.026x^2 + 0.1603x$ mmol/h) in response to protein infusion. Net hepatic α -amino N uptake did not differ with glucose infusion ($P = 0.21$) but increased with protein infusion ($P < 0.001$; $f(x) = 0.275x + 27.3$ mmol/h). Net hepatic glucose release decreased ($P = 0.005$) with glucose infusion (16.9 ± 2.0 mmol/h) compared to controls (22.5 ± 3.8 mmol/h) and increased quadratically ($P = 0.004$) with protein infusion ($f(x) = 0.0048x^2 - 0.2148x$, mmol/h). This study suggests abomasally infused amino acids were released into the portal blood with an efficiency of ~35%, and that the presence of luminal glucose did not spare amino acids. Reduced hepatic glucose release with glucose infusion indicates that hepatic gluconeogenesis was reduced with increased dietary glucose.

Key Words: Sheep, Intestine, Amino acids

655 Effects of methionine supplementation on selected serum constituents in steers following an endotoxin challenge. J. W. Waggoner*, C. A. Loest, T. M. Thelen, C. P. Mathis, D. M. Hallford, and M. K. Petersen, *New Mexico State University, Las Cruces.*

Exposure to toxins stimulates an immune response and potentially increases metabolic amino acid demand. This study evaluated effects of supplemental dietary Met on DM intake, rectal temperature, and serum concentrations of cortisol, triiodothyronine (T3), thyroxine (T4), and insulin-like growth factor one (IGF-1) in Angus-cross steers ($n = 20$; $\text{BW} = 262 \pm 6.3$ kg) exposed to an endotoxin (bacterial lipopolysaccharide; LPS) challenge. Treatments (2×2 factorial) were LPS infusion and Met addition (0 vs 14 g/d rumen-protected; Smartamine M, Adisseo). Steers were adapted to a corn silage-based diet (1.7% BW) and Met for 14 d, and were then infused (i.v. 1 mL/min) with LPS on d 1 (LPS1; 2 $\mu\text{g}/\text{kg}$ BW) and 3 (LPS2; 1 $\mu\text{g}/\text{kg}$ BW) of a 5-d collection period. Serum was obtained prior to LPS infusions and every 2 h for 12 h thereafter. No endotoxin \times Met interactions ($P > 0.24$) were observed. Infusion of LPS reduced ($P < 0.01$) DM intake. An endotoxin \times day \times time interaction ($P < 0.01$) was observed for rectal temperature, serum cortisol, T3, and T4. Rectal temperature was elevated ($P < 0.01$) at 2 and 6 h after LPS1 and at 2 and 4 h after LPS2. Serum cortisol peaked 4 h (76.2 vs 7.9 ng/mL in controls) following LPS1, and remained elevated ($P < 0.01$) for 12 h; cortisol peaked 2 h (71.5 vs 6.9 ng/mL in controls) after LPS2 and remained elevated ($P < 0.01$) for 6 h. Serum T3 declined ($P < 0.01$) in response to LPS, remaining depressed 4 to 12 h post LPS1 and were lower ($P < 0.01$) at all times following LPS2. Serum T4 was reduced ($P < 0.01$) at 4 and 12 h after LPS1, but were unaffected ($P > 0.06$) by LPS2. Serum IGF-1 was not affected ($P > 0.13$) by LPS. Supplementation of Met did not affect ($P > 0.06$) DM intake, rectal temperature, serum cortisol, T3, T4, or IGF-1. Therefore, methionine supplementation did not alter serum constituents of steers exposed to an endotoxin challenge.

Key Words: Methionine, Endotoxin, Steer

ADSA Centennial Posters

C1 California Dairy Research Foundation: Creating Opportunities, Adding Value to Dairy. J. O'Donnell*, *California Dairy Research Foundation, Davis, CA.*

While only 18-years-old, the California Dairy Research Foundation (CDRF), like the American Dairy Science Association (ADSA), is committed to the advancement and stimulation of dairy knowledge and discovery. Executive director, Joseph O'Donnell, has been a member of the ADSA since 1983 and served as vice president, president and past president of the board (2002-2005), as well as in several committee leadership positions. The CDRF was created in 1988 as a not-for-profit research corporation to promote research and development activities benefiting California's producers, processors and consumers. With its creation, the CDRF became the first and only regional, industry-operated organization managing dairy foods research activities. Since its inception, the CDRF has managed more than 500 dairy research projects at such institutions as University of California, Davis, California Polytechnic State University (San Luis Obispo), North Carolina State University and Fresno State University. Research highlights include product technology/development (edible films and coatings from WPC, Dairy Ingredients Applications Lab, flavor lexicon for milk powders, butter and whey); dairy product nutrition research (milkfat, probiotics and prebiotics, milk composition, milk genomics); dairy confidence (California Dairy Quality Assurance Program, Dairy Food Safety Lab, On-farm BTM, J-5 and Salmonella vaccines); and education (short courses, workshops, symposia, educational Web sites).

C2 California Polytechnic State University, San Luis Obispo "Tradition Never Graduates". N. Borges*, E. Jaster, and W. Gillis, *California Polytechnic State University, San Luis Obispo.*

The California Polytechnic State University, San Luis Obispo was founded in 1901 by journalist Myron Angel, the driving force behind California Governor Gage. By 1903 Cal Poly had five Ayrshire and one shorthorn, two hundred and eighty acres of land, a dorm and three faculty members. Dairy Science has been part of the curriculum since the school first opened. In 1903 the first Cal Poly dairy facility was built with concrete floors, milk room, feed room and a living quarter. The first creamery was completed in 1908. Today the current Dairy Products Technology Center, combined with the Dairy Cattle Instructional Center, is one of the most modern dairy facilities. Over the past century Cal Poly has been well represented by numerous students who have competed in various judging competitions and attending the annual ADSA conferences. The Los Lecheros Dairy Club is the largest campus club in the College of Agriculture, and members agree that 'Tradition Never Graduates.'

C3 Dairy Science at Cornell University -- A Century of Excellence. T. R. Overton* and A. W. Bell, *Cornell University, Ithaca, NY.*

Focused efforts in Dairy Science at Cornell University are almost as old as Cornell itself. Professor I. P. Roberts established the Holstein dairy herd at Cornell in the 1870s and began to conduct early experiments

on silage quality and the effects of diet on milk composition. Before the turn of the century, extension efforts to join art and science in dairy husbandry already were evident. The principle of research-driven extension that has been a core value of our department throughout its history derives from these early days. Professor H. H. Wing was named the first head of the Department of Animal Husbandry in 1903. Throughout the first part of the 20th century, research and extension efforts focused on fundamental aspects of milk synthesis and secretion, machine milking, and development of feeding standards. Of particular note was the role of Cornell scientists in the development and field application of artificial insemination in New York. During the second part of the 20th century, Cornell scientists had pivotal roles in the advancement of our knowledge of the physiology and biochemistry of milk secretion, application of statistical methods to dramatically hasten genetic improvement of dairy cattle, and development and application of detergent methods for forage analysis that resulted in changes in ration formulation systems worldwide. A focus of the latter part of the 20th century was fundamental aspects of metabolic regulation and nutrient utilization, including the leading role in the development and subsequent application of recombinantly-derived bovine somatotropin for use in the dairy industry. In addition, the development and application of the Cornell Net Carbohydrate and Protein system and derivative programs has influenced ration formulation for dairy cattle worldwide. The Dairy Herd Management Fellows program has been the leading dairy undergraduate program in the U.S. for the past 20 years. Cornell has hosted five ADSA annual meetings and has amassed 44 winners of major ADSA awards. In addition, three faculty members (G. W. Salisbury, C. R. Henderson, and D. E. Bauman) have been elected to the National Academy of Sciences based primarily upon their Cornell work.

C4 Agricultural Economists—A Century of Commitment to the Dairy Industry at Cornell University. M. W. Stephenson*, *Cornell University, Ithaca, NY.*

Agricultural economists at Cornell University have a long and proud history of work in the dairy industry. The building that houses the department is named for George Warren, a pioneer in area of farm management. 2006 marks the 50th consecutive year that the New York Dairy Farm Business Summary has been conducted. This summary provides participants with an individual farm report summarizing the production and financial progress of the firm. Cornell economists have also been instrumental in the formation and support of dairy cooperatives. The Dairymen's League (now Dairylea) was formed in 1907. Ten years later, the League had 13,000 members and held the first successful milk strike in the country. By 1922 Dairymen's League Cooperative Association had 62,000 members and was effectively bargaining with large milk dealers associations. Cornell economists were instrumental as the country struggled toward national policies that would help stabilize milk prices and mediate the terms of trade for milk. Leland Spencer was among the first agricultural economists specializing in dairy markets and policy. From that legacy, The Cornell Program on Dairy Markets and Policy was formed in 1988. This group hosts dairy economists from around the country and conducts applied research and outreach in the field. In more recent years, Cornell has had economists working in the area of commodity research and promotion. Milk check-off dollars to fund expansion of dairy demand is somewhat novel. These dollars do not promote any specific brand

of dairy product, but rather the global benefits of dairy product consumption. Understanding where producer dollars are best spent for effective advertising, new product research and health claims, is an important contribution to the dairy industry.

C5 Over 100 Years of Milk and Dairy Foods Research by the United States Department of Agriculture–Agricultural Research Service. D. L. Van Hekken*, *Dairy Processing and Products Research Unit, USDA, ARS, ERRC, Wyndmoor, PA.*

Over the past 100 years, the United States Department of Agriculture (USDA) has performed research to benefit the public good and the milk and dairy food industries. With the creation of the Dairy Division of the Bureau of Animal Industry in 1895, USDA began conducting research on understanding and improving the quality and production of milk, butter, and cheese. As the research programs grew in scope, the division became the Bureau of Dairy Industry in 1924. In 1940, milk research was moved to the newly opened Eastern Regional Research Center (ERRC), Wyndmoor, PA while the products research remained in Washington, DC. In 1955, all dairy research programs were transferred to the newly created Agricultural Research Service (ARS). Research was conducted at the Wyndmoor, PA and Washington, DC sites until 1974, when all milk and dairy products research was consolidated at ERRC. USDA chemists, engineers, food scientists, microbiologists, and molecular biologists have published over 1,800 scientific papers, proceedings, book chapters, and patents on all aspects of milk and dairy products. Their basic and applied research has pioneered the development of much of the scientific instrumentation, analytical methodologies, and processing technologies that are still used in dairy research and by the dairy industries today. USDA scientists were charter members of American Dairy Science Association (ADSA) and continue their involvement as members, symposia organizers, elected officers, and board members. They continue to publish extensively in the *Journal of Dairy Science* and have been the recipients of several ADSA awards. Today, the Dairy Processing & Products Research Unit (DPPRU), with its mission to apply knowledge of the chemistry, biochemistry, and microbiology of milk to the development of new uses to increase its utilization, nutritional value, markets and assure its safety and biosecurity, continues to conduct basic and applied research on milk and milk products. While the research emphasis has shifted from improving the quality and production of bulk milk products to the new frontier of understanding the molecular basis for their properties, the main goal of the DPPRU is to conduct research that benefits the public good as it was over 100 years ago.

C6 The products, the people and the services of Diamond V Mills make the dairy industry more productive. I. Yoon*, M. Scott, and B. Kimbro, *Diamond V Mills, Cedar Rapids, IA.*

Since our foundation in 1943, Diamond V Mills has been the world's leading manufacturer and marketer of yeast culture products. The all-natural yeast culture, produced from a proprietary fermentation technology and backed by years of research, supports the production and health of dairy animals. Diamond V has a long history of research and service that has benefited the dairy industry. Diamond V took leadership in pioneering research to investigate yeast culture effects on the rumen and whole body metabolism and its impact on dairy

production. Many studies have shown the importance of a stable ruminal fermentation on energy metabolism and productivity in dairy cattle. Others have shown that ruminal bacteria have unique nutritional requirements and their growth may be improved by oral administration of specific products, such as yeast culture, that stimulate microbial growth. Results of these studies have allowed the industry to embrace yeast culture as a standard management practice. In addition to in-house research, Diamond V recognizes the importance of collaborative research and has worked with more than two dozen dairy research institutions. Sponsoring graduate programs and university foundations, helping dairy producers recovering from natural disasters, and serving as board members of local governing industry organizations are all important parts of Diamond V's public service. Diamond V's technical staff has been instrumental in providing up-to-date information to dairy advisors and producers. Diamond V has been very active in supporting national and regional dairy science meetings, symposia, and conferences. Since 1990, Diamond V has maintained corporate sustaining membership with ADSA and sponsoring annual meetings as a platinum or gold sponsor. Quality products, people, and services and its business ethic make Diamond V a trusted name in dairy industry and the world's leading manufacturer and marketer of yeast culture products.

C7 100 Years of Dairy Science at Kansas State University. K. A. Schmidt*, M. J. Brouk, T. G. Rozell, J. E. Shirley, J. F. Smith, and J. S. Stevenson, *Kansas State University, Manhattan.*

Kansas State Agricultural College was established in 1863. As early as 1883 dairy products such as butter and cheese were produced at the college and sold to the community. In 1899, the Dairy School was established with departments in butter-making, cheese-making, and dairy farming. The 'new dairy barn' followed in 1903. In 1911, the dairy department offered educational opportunities, such as a 10-wk course in dairy manufacturing, short courses for testing dairy products, 2-yr short course on dairy farming, and a 4-yr degree in dairying. In 1913, the Dairy Commissioner authorized the College to inspect the state's 250 creameries, dairies, ice cream factories, and cream-buying stations. In the 1920's the Dairy department advised the 12 state institutional dairy herds, supervised the registry records for dairy cattle breeders as well as planned and conducted experiments on the 4 dairy breeds. In 1933, a new dairy barn was opened northwest of campus and in 1940, dairy manufacturing was added as a curriculum. In 1950's the Kansas Artificial Breeding Service Unit was established to facilitate the use of artificial insemination. The Dairy Husbandry Department was renamed the Dairy Science Department in 1961 and moved into a new building in 1964 to house the dairy science faculty and a dairy sales counter for retail purchase of dairy foods. In 1977, Dairy Science, Poultry Science, and Animal Husbandry merged into the one department– the Department of Animal Sciences and Industry. Over the years, faculty, staff, and students have addressed current issues and concerns of the state and beyond by researching a variety of topics such as development of 'Ambrosia' a buttermilk-ice cream mix, comparison of hand vs. machine-milking, diet formulations to maximize milk components and yields, milk off-flavor and odors control, silage processing and preservation, reproductive management, heat abatement, and cow comfort.

C8 The Dairy Science Club at Louisiana State University Celebrates the 100th Anniversary of ADSA. C. C. Williams, B. Lyons, M. Konzelman*, A. Greenbaum, K. McClelland, and P. McGrew, *Louisiana State University, Baton Rouge.*

The LSU Dairy Science Club was first known in 1923 as the “Cream and Cow Club”, and it was formed to provide recreation and to sponsor educational activities. It was ten years later that the formal charter was presented, and the members were part of the Louisiana State University Dairy Science Club. In 1956 the Club became affiliated with the American Dairy Science Association. It readily established its reputation as an outstanding club by winning third place in its first year of affiliation. Since 1947 the Dairy Science Club has chosen a Dairyman of the Year, and in 1956 it began awarding an individual Honorary Lifetime Membership in the Club. In 1999, the club changed its name to ‘The Dairy Science Club at LSU’ due to the trademark issues with the LSU logo. The leadership qualities of the Dairy Science Club at LSU are exemplified in their past and current achievements in the Student Affiliate Division of ADSA. Five students have been National ADSA-SAD Presidents, five have been First Vice-Presidents, two Second Vice-Presidents, five Third Vice-Presidents, five Secretary-Treasurers, and five Officers at Large. Six students from the club have been selected as the recipient of the Outstanding Student Award. The club was First Place Chapter in 1960, 1966, 1968, 1969, and 1976. Four club advisors have served as National ADSA-SAD advisors and received the Outstanding SAD advisor award. Over the years, the Dairy Science Club at LSU has continued to grow and prosper. They are active at the local, regional, and national levels of ADSA. Whether the activities are of a promotional, fund-raising, educational, or even a social nature, the Dairy Science Club at LSU has set many precedents which other clubs have followed. While dairying as a science and an industry will take part in the next 100 years of development, members of the Dairy Science Club at LSU will be looking ahead for many years of accomplishments.

C9 100 Years of service to the dairy industry. B. Jenny*, K. Aryana, G. Hay, and C. Williams, *Louisiana State University Agricultural Center, Baton Rouge.*

The Dairy Science Department has a long history of research, teaching and public service programs that have benefited the dairy industry of Louisiana and the nation. Dairy programs were first initiated on what was then the campus of Louisiana State University in 1904 when the state legislature appropriated \$5000 for the establishment of a dairy herd, dairy barns and creamery. The department expanded out of the Animal Industries Department. In 1921 the Department of Dairying was formed with responsibility for teaching and operation of the dairy farm and creamery. In 1929 the Dairy Research Department was formed as a part of the agricultural experiment station and had responsibility for research in dairying. These two departments were joined in 1948 as the Dairy Science Department. Dr. J. B. Frye, Jr. was employed as the head of the newly created department and served in that capacity until 1984. Some of the original faculty included Dr. L. L. Rusoff, Cecil Branton, A. J. Gelpi, and T. E. Patrick. Dr. L. L. Rusoff was recognized for his pioneering research in dairy cattle nutrition and was the 1965 recipient of the prestigious Borden Award. Funds to establish the Dairy Improvement Center in the department were made available in 1947. Louisiana Animal Breeders Cooperative, a founding cooperative of Genex Cooperative, Inc., began in this facility. Genex continues to cooperatively operate a custom collection facility at this location.

The Dairy Improvement Center also houses the DHIA laboratory which continues to serve member herds in Louisiana, Mississippi, and Alabama. Graduates of the Dairy Science Department have gone on to serve the dairy industry in both academic and related industry positions. The Dairy Science Department remained as an independent department with programs in dairy production and dairy foods technology until it was merged into the Department of Animal Sciences on July 1, 2006.

C10 100+ Years of Dairy Manufacturing at MAC / MSC / MSU. J. Partridge*, Z. Ustunol, and E. Ryser, *Michigan State University, East Lansing.*

The institution known today as Michigan State University has been in the business of education, research and extension in the field of dairy manufacturing for well over the one hundred years of the American Dairy Science Association. Beginning with a modest milk-processing laboratory in the basement of Agricultural Laboratory (Cook Hall), the program has grown through three building programs and the extensive renovation of the current facilities. One of the strengths of the dairy manufacturing programs at MSU has been the commitment of the faculty, administration and state government to maintain facilities that were representative of the dairy industry. Some of the great educators and researchers of the last century have used these facilities to advance dairy manufacturing and dairy foods. People like G. M. Trout and L. G. Harmon, who not only influenced students at MSU, but also the country and the world through ADSA service as Presidents in 1950 and 1976, respectively. Dr. Trout’s ground breaking research on the homogenization of milk and the subsequent publication of ‘Homogenized Milk’ helped lead to the almost ubiquitous adoption of the technology. J. Robert ‘Bob’ Brunner (ADSA Fellow) was one of the great examples of basic scientist combined with applied scientist. His work with milk proteins and their nomenclature provided a training ground for many of the top protein scientists over the last forty years. Transfer of knowledge and skills to the industry and general populace has been at the center of the land grant philosophy that founded the Agricultural College of Michigan in 1855. A. L. Rippen modeled these Extension ideals and was recognized with the DeLaval Dairy Extension Award in 1972. The faculties of MSU have also shared their wisdom through the publication of texts that have been recognized as classics in the field of dairy foods. The wide variety of ADSA awards for teaching, research, and extension excellence demonstrates the balance of disciplines at MSU that has and continues to be a hallmark of the institution.

C11 NADC: Supporting animal health for 45 years. J. Goff*, R. Horst, T. Sutton, B. Nonnecke, and M. Kehrli, *National Animal Disease Center, Ames, IA.*

Since its beginning in 1961, the National Animal Disease Center (NADC) has been a leader in providing animal health solutions to dairy, livestock, and poultry producers. The focus of the Center is to conduct basic and applied research on the diseases of livestock and poultry that are of major economic importance to U.S. agriculture, and to apply the results to animal disease prevention and control programs. The NADC has strong research programs and capabilities in dairy, beef, swine, sheep, and turkey health research, genomics, wildlife reservoirs

and gnotobiotics. Recent accomplishments include: developed a fecal contamination detector for rapid detection of manure contamination on carcasses; developed rapid assays to detect *E. coli* O157:H7, multidrug resistant *Salmonella typhimurium* and *Yersinia enterocolitica* in livestock; demonstrated that feeding vitamin E to turkeys reduces shedding of *Salmonella* and the chance for food borne illness; demonstrated that beef quality can be improved through feeding high levels of vitamin D; developed an oral vaccine for shipping fever; assisted in the development of the RB51 vaccine for Brucellosis; collaborated with the University of Minnesota to sequence the chromosomes of the microbes that cause Johne's disease and bovine brucellosis; discovered the endocrine connection between dietary potassium and milk fever which led to development of anion supplements to reduce low blood calcium and milk fever in dairy cattle by up to 50%; described immune suppression in cows around the time of calving and the role of metabolic diseases such as milk fever and ketosis on the immune system and demonstrating a role for immune suppression in mastitis and retained placenta of dairy cattle; discovered and developed a test for bovine leukocyte adhesion deficiency (BLAD); developed a 'next generation' vaccine against the porcine reproductive and respiratory syndrome virus (PRRS). The NADC is in the process of constructing new facilities in conjunction with USDA's chief diagnostic facility, the National Veterinary Services Laboratories, and their regulatory center, the Center for Veterinary Biologics. Collectively, these three entities make up the National Centers for Animal Health.

C12 North Carolina State University Dairy Science Club History. A. Nelkie*, *North Carolina State University, Raleigh.*

Organization for the first Dairy Science Club at North Carolina State University began in 2002. It was spear headed by Dr. Mitch Hockett and student, Abigail Nelkie. They saw a need for an active Dairy club to allow NC State to participate in the collegiate dairy activities, such as Dairy judging, SAD-ADSA, and NIADC. The club officially began in 2003, with Abigail Nelkie elected as the founding president and Drs. Mitch Hockett and Kas Ingawa as advisors. The club quickly found its spot at the school and in the North Carolina dairy industry, organizing county fair milk booths, working at the NC Youth State Fair Dairy show, and Agriculture Awareness Week. In its first year of existence the club began attending SAD-ADSA southern region events with the guidance of Dr. Kas Ingawa. Since the clubs inception membership has grown to 18 members. This year the club elected its fourth president, Jennifer Young and now has a third advisor, Dr. Steve Washburn. Jason Wright and Jesse Ledbetter were the second and third club presidents respectively. Even though NC State's Dairy Science Club is new, the University has had a long tradition of participation in dairy the dairy industry and collegiate competitions. Prior to 2003, students at NC State could join the Animal Science Club to participate in Dairy activities such as showing cattle at the NC State Fair, the milking booth, or Farm Animal Days. NC State has had Dairy Judging teams since 1951 with brief interludes between 1977 to 1987 and 1993 to 2005 when there was no judging team at NC State. The Dairy Judging team was highly successful at NC State under the guidance of Coach Dr. Ray Murley. In 1958, the team finished 6th nationally. Prior to being called the Animal Science Club, the club was called the Animal Industry club aka AI club. The AI club was the first club to serve ice cream at the NC State Fair. The Food Science Club at NC State now hosts this activity. The importance of the Dairy to the University was recently demonstrated by the former Dairy Judging participants whom started an endowment fund to ensure that NC State

would have money for a Dairy judging team to travel to competitions. Prior to the 1950's old pictures found in the department show that the college was active in educating the youth on fitting and showing cattle. NC State is the birthplace of the Dairy Records Management Systems, which was started by Dr. Marvin Senger. Polk hall was the original training spot for DHI technicians. DRMS has since moved off campus but they still call Raleigh home.

C13 Contributions to the Dairy Industry by the Food Science Department at North Carolina State University. H. E. Swaisgood and T. R. Klaenhammer*, *North Carolina State University, Raleigh.*

Faculty in the department, formed in 1961, have worked across a number of areas in dairy science and contributed both fundamental and practical knowledge in these fields. Research areas have included: the development of ultra-high temperature processing and aseptic packaging technology; characterization of the enzymes and proteins of milk; identification of flavor compounds; characterization of sub-lethal damage and repair of dairy microorganisms; discovery of natural bacteriophage defense mechanisms of starter cultures; enhancing whey protein functionality; development of a cheese flavor lexicon; development of a non-acid (Sweet) acidophilus milk; and elucidation of the *Lactobacillus acidophilus* genome. The faculty of N.C. State University has received numerous association awards for their research and teaching and has also served in many leadership positions within ADSA, including three as president, and four as Board members.

C14 100 Years of Dairy Science at The Ohio State University. D. L. Palmquist*, J. L. Firkins, M. L. Eastridge, and H. R. Conrad, *Ohio State University Department of Animal Sciences, Columbus.*

From 1892 until merged in 1982 teaching and extension activities of dairy science were located at The Ohio State University in Columbus, whereas research was at the Experiment Station (now OARDC) in Wooster. Oscar Erf, first dairy professor (1907) at OSU, used the Babcock test to relate OSU teaching to dairy farmers. Dairy research was initiated in 1910 (butter quality) by A.E. Perkins. Nutrition and milk quality have been strengths of the department; mineral and protein nutrition studies were begun by E.B. Forbes (1907) and Perkins (1913). These, with vitamin nutrition and rumen digestion, were continued (1926-present) by W.E. Krauss, T.S. Sutton, W.D. Pouden, J.W. Hibbs, H.R. Conrad, and W.P. Weiss. K.L. Smith, Conrad, Weiss and J.S. Hogan did landmark research relating vitamin E, selenium and environmental mastitis. Weiss, Conrad and N. St-Pierre made important contributions to forage evaluation by quantifying the surface effect of lignin on cell wall digestion, and developed equations to estimate energy value of feeds from laboratory analyses. Rumen kinetic studies of forages, 15N and role of protozoa in rumen metabolism were introduced by J.L. Firkins. D.L. Palmquist measured lipid metabolism and utilization of dietary fat, leading to development of calcium soaps as an energy supplement for dairy cows. M.L. Eastridge has led studies in application of feeding systems. W. Harvey, F. Allaire and St-Pierre contributed fundamental knowledge on statistical models for research and management decisions. Other leaders: N. Fehhheimer, chromosome aberrations, for which he was named a University scholar; N.L. VanDemark and R. Gomes, physiology of testes; J. L. Pate, expression of histocompatibility complex on corpus luteum; T.

Ludwick, artificial insemination; F.L. Schanbacher, lactoferrin and milk proteins; and L.B. Willett, environmental contaminants in milk. Dairy faculty are recipients of 20 ADSA awards and 3 have been recognized as Fellows. F. Ely was ADSA president (1947-48) and Sutton, G.H. Schmidt and Weiss were editors of *J. Dairy Science*. OSU hosted ADSA annual meetings in 1938, 1968 and 1992.

C15 100 Years of Dairy Science at Oklahoma State University. S. E. Gilliland*, *Oklahoma State University, Stillwater.*

The land grant university, presently known as Oklahoma State University, was founded more than 100 years ago in 1890 in Stillwater, Oklahoma Territory. Early in its existence dairying was included in the Agriculture Department. Through the dairy program the frontier farmers were encouraged to have a few extra milk cows. This allowed more milk to be produced than needed by the farmer and his family so cream could be collected for sale to local cream stations. This also provided another cash crop for the farmers, which provided enough extra income to avoid the need for loans to get them through the year. The first dairy building was constructed in 1904, and a separate Department of Dairying was formed in 1906. One of the main activities of the department in relation to people in the state was to promote the expansion of the use of separators and cream production much of which was churned into butter. Thus, butter making was an important component of the class work. The college creamery provided space for these practical laboratory courses, where separation and churning were taught. In 1905, there were only about 5 dairy processing plants in the Territory. By 1907 there were 50 such plants largely due to the efforts of the college. By 1951 there were close to 150 plants with at least one in every town of any size, especially the county seats. Today there are only 10 plants, but the total amount of milk processed is greater than in 1951. The number of dairy cattle, like in other states, has decreased since the 1950s, but the total amount of milk produced per cow has increased. Today, more milk is processed in the state than is produced. The dairy program, since 1968, is in the Department of Animal Science. There are fewer positions designated as being strictly dairy oriented since the Department has moved more toward a discipline orientation. There are four faculty members whose appointment has dairy activities. The needs of larger processing plants and larger dairy farms are much different than the small operations existing 100 years ago. The establishment of the Oklahoma Food & Agricultural Products Center provides processors and/or people interested in starting a processing business a place to obtain needed technical or business-related assistance.

C16 100 years of dairy science at Oregon State University. M. J. Gamroth* and L. Goddik, *Oregon State University, Corvallis.*

The present Oregon State University started in 1868 as a small private college near Corvallis. Its development parallels that of the American Dairy Science Association. The Dairy Husbandry department was formed one year after ADSA and has grown steadily. In 1907, the Departments of Agronomy, Animal Husbandry, Dairy Husbandry, and Poultry Husbandry were formed. Instruction tended to be a "hands-on" experience, and the 1908 college catalog noted, "The courses offered in this (Animal Husbandry) department embrace in a direct and practical way the teaching of specific subjects related to breeding, feeding,

and general management of livestock." Over the years, the dairy production and processing faculty have worked hard for the industry. Many are ADSA award winners and all have been active in the Association.

C17 The Penn State Dairy Science Club--celebrating decades of excellence. J. Bechtel*, D. Wilson, D. Olver, and R. Kensinger, *Pennsylvania State University, University Park.*

The Penn State Dairy Science Club has been an integral part of the educational experience for thousands of students interested in the dairy industry. The origin of the Club can be traced to 1923, the year of the first Penn State Dairy Exposition. This event is the Club's longest-running event, followed closely by the Spring Judging Contest established in 1925. The Penn State Dairy Science Club has been successful in honoring traditional activities such as the Dairy Expo while maintaining flexibility by sponsoring new events for dairy youth and Club members. The Club's current activities include a mixture of member education, youth involvement, industry and public service, and fundraising activities. The initiation of the holiday cheese sale in 1979 allowed the club to raise funds for trips and other educational initiatives. Since 1979, the Club has traveled to thirty-eight states and three countries for spring trips, ADSA Student Affiliate Division conventions, and Northeast ASAS/ADSA (NESA) student meetings. International trips have included travels to Ireland/Northern Ireland, Argentina, Canada, and a planned visit to New Zealand in 2007. The Club has enjoyed a long history with the ADSA Student Affiliate Division. Since 1984 the Club has placed first twelve times, second nine times, and third once in the Outstanding Chapter competition. Since 1977, six Penn State students have served as ADSA-SAD President, with the most recent, Emily Yeiser, completing her term at these Minneapolis meetings. Six Penn State students have been named Outstanding Student Affiliate Member. Ten Penn State students have earned first place in the Undergraduate Presentation Contest since 1990, and twenty-five members have served as ADSA-SAD national officers since 1961. Two faculty members, Lawrence Muller and Dale Olver, have been named Outstanding Advisor. Additionally, Penn State has won the first five ADSA Dairy Quiz Bowl contests. At the Northeastern Student Affiliate (NESA) meetings of ASAS/ADSA, Penn State has been named first-place institution thirteen times since 1990, and ten members have been named Outstanding Senior over the last sixteen years. Over the years the Penn State Dairy Science Club has partnered with various organizations in many industry-related activities. The Nittany Lion Fall Classic was established with the Pennsylvania Holstein Association in 1984, with over two million dollars of cattle marketed through this sale since its inception. In 1986 the Club assumed the responsibility of coordinating the Pennsylvania Holstein Quiz Bowl Contest at the Pennsylvania Junior Holstein Convention. This event typically attracts forty teams from around the state. In 2005 the Club held the first Penn State Dairy Days/Cow Camp, with industry groups providing excellent sponsorship for this activity. Over the last decade the Club has increased its public service events. In 1997, the Centre County Youth Services Bureau and Dairy Science Club partnered to offer the Spring Bargain Fling, a rummage sale that has earned over \$100,000 for Big Brothers/Big Sisters in the central Pennsylvania region. The first Osteochallenge Fun Run, a benefit for the National Osteoporosis Foundation, was held in October 2003. In the early years of the Club, most of the members were from dairy farms; currently a large portion of the Club's membership consists of students from a wide variety of majors, interests, and backgrounds.

Each generation of students and dairy youth benefits from the Club's activities, and the next decades should be equally exciting as the first eighty-three years.

C18 Penn State: The Second Land-Grant University. R. Pruyne, L. Muller, R. Kensinger*, and M. O'Connor, *Pennsylvania State University, University Park.*

Chartered in 1855 and designated as the second land-grant institution in the United States in 1863, Penn State has been noted for agricultural research and education for more than 150 years. Dairy research at Penn State gained recognition in 1887 with Henry Armsby's studies of energy metabolism using the Calorimeter. This work heralded the beginning of more than 100 years of dairy research and educational programs designed to assist the industry in the areas of animal breeding and reproduction, nutrition, health, growth, housing, milk synthesis, and dairy manufacturing. Penn State gained international attention with its dairy cattle nutrition studies, research in artificial insemination and dairy cattle fertility, and determination of the actions of bovine somatotropin. Penn State researchers were the first to use gas-liquid chromatography to characterize milk fatty acids and were among the first to identify lipids as a factor in heart disease. In the 1970s, they published research linking somatic cell counts with mastitis, and helped incorporate its use in testing programs. From the 1950s through the 1990s, studies of milk processing significantly extended the shelf life of dairy products. Penn State faculty established the first forage testing laboratory, and developing the current NIR technology used in forage-testing. Related research led to numerous publications, resources, and tools for evaluating pasture and forage and for monitoring calf and heifer growth. Penn State also was a pioneer in certificate programs, correspondence courses, and extension education. Statewide efforts in cattle breeding included the establishment of AI organizations, progeny testing, and Dairy Herd Improvement Associations. The Dairy Production Medicine Certificate Program was the first continuing educational program in the United States for bovine practitioners that emphasized management concepts. The University's Ice Cream Short Course, begun in 1894, is the oldest food technology and technical course in the world. Penn State also takes a keen interest in educating undergraduate students, as is evidenced by their many notable achievements. For more information about Penn State's Department of Dairy and Animal Science, see das.psu.edu.

C19 A Century of Dairy Science at Purdue University. J. Chambers*, *Purdue University, West Lafayette, IN.*

During the organizational year of the American Dairy Science Association (ADSA), Otto F. Hunziker led the dairy program at Purdue University. A charter member of ADSA and its third president, Dr. Hunziker's brilliant career as a scientist, teacher and author is recognized throughout the world. At Purdue he provided leadership in developing educational programs to better educate dairymen. His research programs established the accuracy of glassware and provided standard methods for the Babcock fat test of milk and cream. He planned Smith Hall, which was built in 1913 to provide facilities for teaching, research and extension work. Ollie E. Reed, ADSA's 1946 Borden Award recipient, established the Purdue dairy farm in 1919 for the purpose of instruction and research in milk production and dairy

herd management. From 1921-1960, Howard W. Gregory led Purdue's Dairy Department and served ADSA as president in 1937. He worked tirelessly on outreach programs, publications, training and educational services to the dairy community. Elliot H. Parfitt, whose research is well recorded in ADSA journals, served Purdue for 17 years as a dairy bacteriologist. His sanitizing protocol eventually became adopted by the Indiana State Board of Health. Another Purdue notable, Fredrick J. Babel, left a legacy of knowledge for researchers and management in the dairy food industry. His long list of teaching awards, including the 1973 ADSA Kraft Teaching Award, stands as a testimony to the excellence and popularity of this professor. The 1973 ADSA Borden Award recipient, Thomas W. Keenan, left his mark at Purdue as a biochemist with an emphasis on cell physiology. In 1983 faculties from Animal Sciences, Horticulture and Agronomy combined to form the Food Science Department, headed by Philip E. Nelson. Outreach programs, led by James V. Chambers, ADSA's 1992 DeLaval Dairy Extension Award recipient, focused on contemporary issues facing the dairy industry, such as antibiotic avoidance and municipal sewer use ordinances. During the final decade of Purdue's dairy science century, a new food science building was constructed. In 2004, S. Suzanne Nielsen became Department Head and continues to mentor the traditional successes of the Purdue University Food Science Department. Demand for Purdue food science students remains high within the dairy and food industries.

C20 Highlights of Dairy Production at Purdue University. M. M. Schutz*, B. R. Baumgardt, and J. L. Albright, *Purdue University, West Lafayette, IN.*

'Progress in a new field of science is always much easier and faster if someone has made a path', L.A. Rogers – ADSA Meetings 1938. At Purdue, W.C. Latta, 'The Grand Old Man of Purdue University and Indiana Agriculture', led the way for extension (1889-1923). C.S. Plumb began dairy production in 1890 as a Professor of Animal Industry and Dairying and later became Director of the Agricultural Experiment Station until 1902. He was the founder of the existing Indiana State Dairy Association in 1891 which furnished the main leadership for dairy farmers for the next 20 years. Plumb was a pioneer for humane treatment, dehorning and housing of dairy cows. The first Head of the Dairy Husbandry Department and a charter member of ADSA was O.F. Hunziker (1905-1917). He was followed by O.E. Reed (1917-1921), who developed the first Purdue University dairy farm in 1919, and H.W. Gregory (1921-1960). During Gregory's tenure there was heavy emphasis on dairy manufacturing. Smith Hall and the Purdue Creamery were completed in 1914 and housed dairy faculty and staff for over 60 years. F.W. Andrews succeeded him and soon became the first Head of the combined Animal Sciences Department (1960-1963) with a future plan for hiring dairy scientists. Faculty hired in the 1960's earned ADSA major awards such as Borden, Extension, Management, Physiology, Reproduction, and Teaching, and Fellows. Subsequent Heads of the Animal Sciences Department were J.L. Krider (1963-1971), W.R. Woods (1971-1986), B.G. Harmon (1986-1997), J.D. Armstrong (1997-2001), and A.L. Grant (2001-to present). The first three Department Heads were ADSA Presidents, as were dairy scientists R.E. Erb and B.R. Baumgardt later. Research prominence has been in nutrition, management, reproduction, endocrinology, genetics, behavior and well-being with teaching and extension efforts to complement these areas. Unique educational relationships exist between Purdue University and the many large dairies that recently have come to Indiana.

C21 A century of dairy research, teaching and extension. J. E. Wohlt*, H. D. Hafs, and M. L. Westendorf, *Rutgers, The State University of New Jersey, New Brunswick*.

The Rutgers farm was established in 1861, and George H. Cook issued the first dairy cattle feeding publications in 1881. Legislation in 1875 required inspection of dairy farms and plants, specified that the Experiment Station was responsible for official analyses of milk products, and stimulated investigations into factors that affected milk production and composition. Feeds and nutrition were one focus of early research by Edward Voorhees beginning in 1883. Clarence Lane, Rutgers' first Dairy Husbandman, pioneered (1896-1902) investigations of alfalfa for dairy cattle. Silage and silos have been a continuous focus of Rutgers research since 1881. The first silo was erected in 1883, and a round barn constructed in 1948 had a self-feeding central silo. In addition to the alfalfa trials, Carl Bender and his colleagues published (1921-1940) numerous articles on several grasses and grains for silage, some together with legumes. William Regan initiated pioneering inbreeding studies with the Rutgers Jersey herd, and transferred 33 with him when he joined the University of California in 1923. John Bartlett used inbreeding to improve both milk and butter production in the Rutgers Holsteins. Based upon his observations of the industry in Denmark in 1937, Enos Perry organized the first US artificial insemination cooperative near Clinton, NJ, on May 17, 1938. The first calf from AI in the US was born (February 15, 1939) on the Richard Schomp farm near Stanton, NJ. Joe Evans was one of the first to explore replacing ration protein with urea, Jim Wohlt demonstrated that yeast increased intake of corn silage rations, and Ralph Reece pioneered hormone research in dairy cattle. He also exemplified training at Rutgers; his student H. Allen Tucker published over 250 peer-reviewed papers, and in 2004 had over 70 of his own scientific successors. The Animal Science Image Gallery (www.anscigallery.nal.usda.gov) is led by Rutgers, and Rutgers' modern heifer facilities accommodate replacements for a single herd shared with the University of Delaware, as well as replacements for the University of Pennsylvania.

C22 More than 100 Years of Dairy Science at South Dakota State University. Dairy Science Faculty*, *South Dakota State University, Brookings*.

The first dairy courses were taught at the South Dakota Agricultural College in 1890, nine years after the territorial legislature established the College, one year after South Dakota became a state, and 16 years before the American Dairy Science Association was formed. The Dairy Husbandry Department was officially formed in 1907 with its name changed to the Dairy Science Department in 1964. The Department always had research and teaching programs in both dairy production and dairy foods, one of the few departments of that type in the nation today, and is the recognized leader in training students for careers in the dairy industry. SDSU students competed in the first undergraduate dairy cattle and dairy foods judging contest in 1916 and in virtually all of the contests since then, being national champions 15 times in the dairy foods division. Creamery short courses were prominent from 1900 until the 1950s. During the 1960s, major dairy processing in the state and region turned from butter to cheese. Today SDSU scientists are among the leading cheese researchers in the world and a part of the Minnesota – South Dakota Dairy Foods Research Center, one of the six national centers formed in the 1980s. In 1910, the department led the nation in research on mechanical milking machines. Two classic SDSU bacterial studies in the 1920s paved the way for later mastitis research. In the 1930s, scientists made important contributions about

vitamin A and D requirements of dairy cows. The first milking parlor in South Dakota was installed in the SDSU dairy barn in 1941. SDSU scientists were the first in the nation to house calves in individual outdoor hutches, a practice that greatly reduced calf losses. During the past 30 years, SDSU dairy scientists became acknowledged world leaders in whey utilization research, both in dairy foods and in livestock feeds. Today the department is a recognized leader in the use of distillers grains and other byproduct feeds for dairy cattle as well as in methods to modify the composition of milk for increased marketability and consumer health. Much of the SDSU research starts at the farm and continues with evaluations of dairy products in the department's processing plant, a true "cow to consumer" approach to dairy research.

C23 SDSU Dairy Club "Snapshots from the Past". A. Wirt*, *South Dakota State University Dairy Club, Brookings*.

The SDSU Dairy Club is well-known for their scholarship, leadership, and service. The club is comprised of dairy production, dairy manufacturing, and other students interested in the dairy industry. The SDSU dairy club was chartered in 1946. Since the charter many activities have been started including the following: dairy club formal, cheesebox sales, dairy camp, the all-breeds sale, dairy challenge, dairy digest, and showing at the SD State Fair. One of the most unique activities the SDSU Dairy Club does is cheesebox sales. Every fall, all SDSU Dairy club members gather together to manufacture cheese and sell the wholesome product to family, friends, and community members. Cheeseboxes are sent all over the U.S.A., from Hawaii to the New England States and Florida to Alaska. This fundraiser is extremely profitable and was started over 40 years ago. Dairy production and dairy manufacturing students are given the opportunity to experience both sides of the dairy industry through cheesebox sales and the all-breeds sale every year. The Dairy Club usually travels to the World Dairy Expo; Midwest and/or National ADSA conferences; the Central Plains Dairy Expo; the Canadian Royal; Mt. Rushmore; and various other clinics and places in any given year. SDSU Dairy Club members have enjoyed bonding together by having fun activities planned after each meeting including the following: paintball, ice skating, bowling, bonfires, dances, and creating a Hobo Day Float every year. Also, each member has the opportunity to build showmanship and fitting techniques by participating in the Little International Contest. Sometimes there are stubborn heifers which have even been ridden in past years. Dairy club members also enjoy putting on the SDSU Dairy Club Dairy Camp for younger students. It is a great time to strengthen the youth of the dairy industry and embolden the leadership abilities of dairy club members. Finally, the Dairy Club has had past South Dakota Dairy Princesses, Minnesota Princess Kay of the Milky Ways, and runner-ups for both as members of the dairy club. The SDSU Dairy Club is a thriving group and will continue to prosper and succeed in the future!

C24 100 Years of Dairy Science at Texas A&M University. M. A. Tomaszewski*, E. Jordan, and H. O. Kunkel, *Texas A&M University, College Station*.

Texas A&M University has a long history of research, teaching and public service programs that have benefited the dairy industry. Early courses in agriculture included feeding and care of the milking herd

and manufacture of butter and cheese. Robert E. Thweatt was hired as the first full time instructor in dairying and foreman of the creamery work in 1903. The Department of Dairy Husbandry was established in 1911 and in 1916 new facilities were built for a herd of registered Jerseys, Holsteins and Aryshires. Pioneering research on dairy cattle management, nutrition, microbiology, milk composition and nutrition has had a global impact on understanding the inheritance of production and other genetic traits, requirements and supply of nutrients, reproduction, genetic improvement, and new and innovative dairy products. Various educational methods from hands-on-teaching to the first use of computers in dairy management courses to the use of the internet have been used to train future leaders of the dairy industry. Former students now hold prestigious positions in universities and industry and are establishing excellent records of achievement in research, teaching, and service to the dairy industry. Texas A&M faculty members have been instrumental in establishing mechanisms to provide up-to-date information to dairy producers. Faculty members were leaders in establishing state breed association, the Southern Regional Dairy Records Processing Center, National Dairy Data Base, reproductive programs and decision support systems that have had a national impact on the dairy industry. Faculty have held various offices in the American Dairy Science Association, including Presidents Walter Rupel and Ron Richter. Because of their contributions faculty and students have been the recipients of numerous awards.

C25 100 years of Dairy Science at the University of Alberta.

M. Oba, C. Strawson*, P. Jelen, and J. Kennelly, *University of Alberta, Edmonton, Alberta, Canada.*

The University of Alberta has worked closely with stakeholders in dairy industry. Feeders' Day began in 1922 and grew with an attendance of 1,500 in 1960's. This is the effort that University made in early 1900's to disseminate the research outcomes to livestock producers. In 1982, Dr. John Kennelly organized the first Western Canadian Dairy Seminar, which is now one of the most prestigious conferences for the North American dairy industry with about 700 attending annually. The WCDS has significant impacts on the efficiency and sustainability of the dairy industry in Western Canada. The dairy processing program at the U of A was founded by Provincial Dairy Commissioner, Dr. Marker, who offered short-courses in dairying for WW I veterans. The University of Alberta played a lead role in Dairy Foods Science in the early 1900's, and Dr. deMan earned one of the first 20 PhDs awarded at the U of A in 1958 - the first Canadian PhD awarded for dairy research. The first U of A Dairy Judging team was formed in 1978 and trained by Dr. Jelen. Since then, only once in almost 30 years did the Alberta team fail to place ahead of any other Canadian team. The U of A serves as the home of the editorial office for the International Dairy Journal with Dr. Jelen as Editor-in-Chief. In 1988, the U of A hosted the 83rd annual ADSA meeting in Edmonton. The Dairy Foods and Production programs have worked together more closely since 1994 with creation of the Department of Agriculture, Food, and Nutritional Sciences. It is also noteworthy that a partnership was created among the U of A, Alberta Agriculture, Food and Rural Development (provincial government), and Alberta Milk (dairy producer organization) to establish the Dairy Research and Technology Centre (DRTC) in 1997. This union brought together the resources of all partners with the vision to be Canada's leading centre for excellence in dairy research, teaching, and technology transfer. The DRTC is a symbol of the U of A's efforts to work intimately with provincial government and stakeholders in the industry.

C26 Contributions by the University of Florida toward improving the efficiency of dairy cattle production. B. C. do Amaral*, L. A. de Castro e Paula, and F. D. Jousan, *University of Florida, Gainesville.*

In an effort to improve the efficiency of dairy cattle production, the University of Florida provides producers with information, support and leadership for the continued economic development and sustainability of the dairy industry. Dietary supplementation of lipids allowed for improved production and reproductive performance of dairy cows, especially during the summer. Other contributions in nutrition include use of citrus pulp as an energy source and DCAD diets for cows in the transition period and the realization of the importance of mineral nutrition in the summer. A greater understanding of the physiology and endocrinology of the estrous cycle and ovarian function has led to the development of reproductive management tools for synchronizing estrus for timed insemination. In addition, pioneering work led to the discovery of interferon-tau as the key protein involved in maternal recognition of pregnancy. Shortening of the dry period increased milk income and reduced the incidence of disorders associated with transition cows as they initiate a new lactation. Studies with bST in lactating cows helped with its promotion and utilization to increase milk yield and allowed for increased profit margins of dairy enterprises. Realization that heat stress reduced the establishment and maintenance of pregnancy and lowered milk production led to studies to improve the ability of lactating cows to regulate their body temperature. These efforts included improving housing conditions through the use of shade, fans, sprinklers, water application rates, and cooling ponds and identification of the "slick hair" gene involved in thermoregulation. Incorporation of timed artificial insemination to eliminate heat detection and utilization of timed embryo transfer to bypass the sensitivity of early embryos to elevated temperature are management strategies used by producers to increase pregnancy rates in the summer. The Dairy Science program continues to improve dairy cattle efficiency while maximizing milk production and developing solutions for the changing needs of the dairy industry.

C27 100+ Years of Dairy Foods Research, Teaching and Extension at the University of Guelph. H. D. Goff* and D. W. Stanley, *University of Guelph, Guelph, ON, Canada.*

The Ontario Agricultural College was founded in 1874. It was one of the founding colleges of the University of Guelph in 1964. The Dept. of Dairying was established in 1885. It sent across the province a 'dairy train' in 1891, equipped to demonstrate new techniques of manufacture of dairy products both in the factory and on the farm. Recognition of the demand for further training led to the establishment of a 3-month dairy school in 1893, which continued until 1969. Two-year diplomas and 4-year degrees were offered by the Dept. of Dairying beginning in 1886. Prof. H. Dean, Chair from 1891-1932, was a founding member of ADSA in 1906. One of the outstanding dairy foods research contributions from this Dept. was the development of rapid analytical compositional testing methods, leading to the first infrared milk analyzer-equipped central milk testing laboratory in the world, established at Guelph in 1967. Industry training courses in cheese technology have run continuously since 1891 (first as part of the dairy school, then as a stand-alone course since 1969) and in ice cream technology as a stand-alone course since 1914. Today, the Dept. of Food Science hosts two Industrial Research Chairs in dairy foods, carrying on the legacy of 100+ years of dairy science at Guelph.

C28 100 Years of Dairy Science at the University of Illinois. J. Clark* and J. Baltz, *University of Illinois, Urbana-Champaign.*

Faculty from the University of Illinois are noted for their service to the American Dairy Science Association (ADSA). The ADSA was organized July 17, 1906, at the University of Illinois. W.J. Frazer, Instructor of Dairying, who was later hailed as the "Father" of ADSA called the first meeting to order. Five faculty members (H.A. Ruehe, 1936; P.H. Tracy, 1948; J.R. Campbell, 1981; J.H. Clark, 1993; M.F. Hutjens, 2005) have served as President of ADSA. The University of Illinois has a long history of research, teaching, and public service programs that have benefitted the dairy industry. Research began on milk production and composition in 1870. W.J. Frazer was hired in 1896 as the first full-time Instructor of Dairying and the Department of Dairy Husbandry was established in 1902. Pioneering research on dairy cattle biochemistry, genetics, management, microbiology, nutrition, and physiology has had a global impact on understanding synthesis and secretion of milk, inheritance of production and other genetic traits, ruminal fermentation, requirements and supply of nutrients, reproduction and artificial insemination, and automation of dairy farms. Everything from hands-on-teaching to the first dairy science class ever taught over the internet has been used to train future leaders of the dairy industry and ADSA. Former students now hold prestigious positions in universities and industry and are establishing excellent records of achievement in research, teaching, and service to the dairy industry. University of Illinois faculty members have been instrumental in establishing mechanisms to provide up-to-date information to dairy producers. Faculty members were leaders in establishing the Dairy Herd Improvement Association, the Weight-A-Day-A-Month Plan, and the National Dairy Data Base that have had a national impact on the dairy industry. Because of their contributions faculty and students have been recipients of 46 National ADSA Awards, numerous awards from other organizations, and four faculty members (G.W. Salisbury, C.R. Henderson, M.P. Bryant, D.E. Bauman) have been elected to membership in the National Academy of Sciences.

C29 100 Years of ADSA-SAD at the University of Illinois Illini Dairy Club. G. McCoy*, *University of Illinois, Urbana-Champaign.*

The Illini Dairy Club was founded in approximately 1922. Members of the Illini Dairy Club have been active leaders to promote the dairy industry locally, regionally, and nationally. Since organization of the ADSA-SAD four Illini club members have been elected President of Midwest ADSA-SAD (Mark McGuire, 1982; Chris Embry, 1990; Albert Lenkaitis, 1994; Julie Drendel, 2005) and 12 club members have been elected to National ADSA-SAD offices including two members as President (Mark McGuire, 1983-84; Andrew Lenkaitis, 2004-05). Six former Illini club members have served as President of ADSA (H.A. Ruehe, 1936; P.H. Tracy, 1948; G.A. Muck, 1980; R.W. Hemken, 1995; L.D. Muller, 1999; D.J. Schingoethe, 2001). Ed Jaster (1991) and Gene McCoy (2003) have been selected as National ADSA-SAD Outstanding Advisors. The club hosted the organizational meeting of the Midwest ADSA-SAD in 1982 and two later meetings in 1995 and 2001. Sixty-five students from 11 clubs attended the first meeting and by 1995 attendance had increased to over 400 students from throughout the midwest. For the past 23 years, the club has had a Milk-A-Cow booth at the Illinois State Fair where over 7000 people each year milked a cow and learned about the dairy industry and the nutritional value of dairy products. Cheese sales, managing the Purebred Dairy Cattle Association calf sales for 57 years, and hosting alumni golf

outings are other activities that provide an opportunity to learn from purebred breeders, renew friendships, and raise funds for the club and the dairy cattle judging team. Friendly competition is enjoyed at collegiate dairy judging contests and quiz bowl contests. Illinois was the winner of the National Collegiate Dairy Judging Team Contest in 1936, 1970, 1991, and 1999 and the Quiz Bowl Team placed first at the Midwest contest for several years and placed second in the national contest from 2001 to 2005. Management techniques and new technologies used in the dairy industry have been observed while on trips to dairy farms and processing plants in the United States, Canada, Netherlands, New Zealand, and Argentina. Members are recognized for their achievements and families, friends, faculty, dairy producers, and others are thanked for their support at an annual awards banquet.

C30 Gopher Dairy Club. B. Hemmesch*, *University of Minnesota, St. Paul.*

Passion for the dairy industry has never been in short supply for dairy students at the University of Minnesota. The U of M St. Paul Campus has been home to dairy student organizations since the Dairy Club was organized in 1916 at the University Passion for the dairy industry has never been in short supply for dairy students at the University of Minnesota. The U of M St. Paul Campus has been home to dairy student organizations since the Dairy Club was organized in 1916 at the University's School of Agriculture for rural secondary school students. With the merger of the School of Agriculture in 1960, college students were members of the U of M St. Paul Dairy Science Club through the 50's and 60's. A 15 year hiatus without an organization for dairy students was too long for some. November 11, 1982 was the first meeting of 25 founding student members and faculty where a constitution and the name 'Gopher Dairy Club' were approved. Beginning advisors to the club were Dr. Bill Mudge and Dr. Les Hansen. Today, the club's highly successful sale of malts and ice cream cones by GDC members at the state fair funds several scholarships for incoming freshmen to the club, allowing members to attend regional and national ADSA meetings, in addition to a very unique travel scholarship opportunity for senior members to travel to California. Since 1992, GDC has organized the animals and reasons takers at both the MN State FFA and U of M FFA Invitational dairy judging contests. Also, for three days in June of 2003 club members took part in the inaugural Gopher Dairy Camp created to enlighten young show persons about fitting and showing dairy cattle. During the January break, GDC senior members have a unique opportunity to travel somewhere warm, explore the dairy industry in other parts of the country. Previous years' senior trip locales have included Washington, Florida and Hawaii. Current and future GDC seniors will tour dairy operations and sightsee in the California sunshine. The Gopher Dairy Club will continue to leave a legacy of positively influencing students with leadership development and building professional relationships for success in the dairy industry.

C31 100 Years of Dairy Science at the University of Minnesota. J. Linn*, *University of Minnesota, St. Paul.*

University of Minnesota faculty were pioneering presidents of the American Dairy Science Association (ADSA). In 1909, 2nd ADSA

President, Dr. C.H. Eckles began his term; he served a 2nd term in 1922. Dr. W.E. Petersen (1949) and S.T. Coulter (1964) were also ADSA Presidents. The dairy industry has seen positive outcomes from U of MN research, teaching and extension programs. Nutrition research began with T.L. Haecker, "Father of Minnesota Dairying" and inventor of the Haecker Feeding Standards (1913). Other discoveries were: importance of phosphorus in rations and intravenous calcium injection as milk fever cure. C.L. Cole inseminated a Holstein cow resulting in the 1st calf born from A.I. in N. America (1937). E.F. Graham was a pioneer in reproductive physiology research. His work in semen preservation, superovulation and egg transplantation was critical to A.I. industry success and herd improvement. Since 1964, a genetic unchanged line of Holsteins has been maintained for genetic and genomic research. Current research emphasizes: protein and forage nutrition of lactating cows, calf/heifer nutrition and management, low-input production systems and crossbreeding. A worldwide reputation for teaching excellence began with C.H. Eckles; in 1933 the entire USDA Bureau of Dairying and 16 university dairy dept. heads were former students. The tradition of educating dairy leaders continues today with former students holding high impact roles in industry and academia. Dairy judging teams have a national reputation for success. Faculty-led dairy extension programs historically have focused on DHIA records, cow and calf nutrition, stray voltage and genetics. More recent extension program expertise reside in nutrition, milk quality, youngstock and production management. For over 40 years, MN, WI, IA and IL have cooperatively developed extension education programs. Faculty serve professional dairy organizations nationally and regionally. Their contributions are frequently recognized with awards. ADSA awards have been conferred to 37 faculty and students.

C32 Advances in Dairy Manufacturing and Food Science at the University of Missouri-Columbia, 1902-2006. R. T. Marshall*, *University of Missouri, Columbia.*

The first Missouri Agricultural Experiment Station Bulletin about dairying was published in 1894. This bulletin explained how to care for milk and make butter. Beginning in the winter of 1895 the University offered a course in dairying, using the 1894 bulletin as one of its texts. An official department of dairy husbandry was approved in 1901, and C.H. Eckles was chosen as the first departmental head. Dairy manufacturing and processing were always an integral part of the department. Early classes included butter making, and Ice cream making with a dairy chemistry lab for milk analysis. Early research included the use of adsorption chromatography to show why butter color varies due to the carotene content of different forage sources. W.H.E. Reid and his students developed pioneer research on the texture of ice cream and W.S. Arbuckle later expanded on this research with his work on the microscopical and statistical analysis of texture and structure of ice cream due to composition, physical properties and processing methods. The 5th edition of the book 'Ice Cream' was written in 1996 by R.T. Marshall and W.S. Arbuckle. Later research on ice cream by Marshall and others investigated how fat and fat replacers affected the flavor and physical properties of ice cream. The department had a functional milk processing plant that sold milk, butter, cottage cheese and ice cream to the community from the early 1900s to 1972. This facility provided valuable hands-on learning and research opportunities for the University's students. From the late 1950s, research on bovine mastitis included studies on differences in milk quantity and composition due to mastitis and on the importance of routine milk tests to reduce the incidence of mammary gland infections.

In the 1970s and 80s, Marshall and his group studied the degradation of dairy foods by psychrotrophic bacteria. Today, student's can get a taste of the past at the University operated, Buck's Ice Cream Parlor, located in Eckles Hall.

C33 100 Years of Dairy Science at the University of Missouri-Columbia. F. Martz, J. R. Campbell, R. Ricketts, and J. N. Spain*, *University of Missouri, Columbia.*

In April, 1901, the Missouri Legislature approved the establishment of a department of dairy husbandry at the University of Missouri. C.H. Eckles, a founding member of ADSA, was chosen as the first department head. Eckles emphasized research, teaching, and extension education under his direction. In 1930, he was named one of 'The Ten Master Minds of Dairying'. Early research focused on high producing cows and increasing appetite as well as studies on butter composition. In 1927, C.W. Turner began research that focused on the endocrinology of milk secretion. His work was instrumental in understanding mammary gland anatomy and function. In 1928, Samuel Brody began his research on the growth and development of domestic animals. He authored the classic book, 'Bioenergetics and Growth'. In 1936, H.A. Herman began pioneer work with artificial insemination and the physical and biochemical characteristics of semen. From 1958-79, John Campbell initiated research focusing on the nutritional quality and potential of whey and waste paper. In 1975, Campbell and R.T. Marshall coauthored the book, 'The Science of Providing Milk for Man'. In the 60s and 70s F. Martz conducted research on forage quality. Nutritional studies continued with R. Belyea and his work on the nutritive quality of byproduct feeds. Using lower cost, byproduct feeds in dairy diets was an economical boost to the dairy industry. In the 1980s and 90s, A. Garverick explored the reproductive biology of cystic ovaries in dairy cattle. He later studied gene expression during the wave of follicular development. In 1990, J. Spain joined the faculty and developed the 100 day Contract management concept for cows during the transition period. In 1993, M.C. Lucy began his work at MU and has focused his research on the decline of fertility in dairy cattle, focusing on nutrient partitioning mechanisms and their interactions on the reproductive axis. Today, the Commercial Agriculture and Dairy Extension Programs continue to aid the local dairy industry with projects such as the Dairy Heifer Plan and a web site entitled, Missouri Dairymen's Resource Guide. Today, the University still follows Eckles' original vision to meet the needs of the industry through teaching, research and extension while emphasizing a sound scientific approach.

C34 The University of New Hampshire: 100 years of Teaching, Research, and Extension in Dairy Science. P. Erickson*, E. Shea, and T. Fairchild, *University of New Hampshire, Durham.*

The University of New Hampshire has a long history with the dairy industry. The New Hampshire College of Agriculture and Mechanic Arts got its start at Dartmouth College but moved to Durham in 1890 thanks to Ben Thompson who willed his farm to promote the cause of agriculture. In 1887 the New Hampshire Agricultural Experiment Station was established. Post World War 1, researchers E.G. Ritzman and N.F. Colovos studied energetics and metabolism of ruminants. By the 1930's, Ritzman and Colovos developed an apparatus for the collection of solid and liquid from cows in digestion studies. H.C.

Moore found that solids-not-fat can vary by feeds consumed by cows. K.S. Morrow was also involved in dairy cattle nutrition research, teaching and the improvement of the breeding herd. After WW II, H. A. Keener and G.P. Percival discovered Co deficiency in cattle. In the 1960's, J.B. Holter joined Colovos in the study of dairy cattle energetics. Beginning in the 1970's, C.G. Schwab, began studying the amino acid requirements of dairy cattle. In the 1970's, W.A. Condon began research on the function of the corpus luteum. Research investigating corpus luteum function continues with P.C.W. Tsang and D.H. Townson joining Condon. UNH has won the Holstein Progressive Breeder Award 46 times and placed several bulls in AI. In 1992, UNH developed a new Dairy Herd Management program and in 1997, it started a student -run teaching program known as CREAM. Research focus continues in the area of dairy nutrition. Cooperative extension continues to be an important source of information for dairy farmers. Future plans at UNH include the development of an organic dairy.

C35 100 Years of Dairy Science at the University of Tennessee (UT). G. W. Rogers*, M. J. Montgomery, and J. B. Cooper, *University of Tennessee, Knoxville*.

Tennessee dairying rebounded from the Civil War with the 1869 establishment of the Knoxville Experiment Station. By 1918 six courses in dairy farming were offered at UT and research focused on substituting different forages and grains in rations and on culling and controlling diseases, especially tuberculosis and milk fever. From 1921 to 1929 three additional experiment herds were established: West Tennessee, Middle Tennessee (two Jersey herds to compare Island Bred and native stock) and a U.S. Dairy Experiment Station (Jersey herd) in Marshall County (among 12,000 Jerseys in this county). Extension specialists helped import (1948-1949) train loads of Jerseys from Canada that were auctioned to 4-H members to improve herds; Holsteins were likewise purchased. Each year for 20 years starting in 1950, 50 to 60 Guernsey heifers were purchased with money borrowed from a Tennessee bank; these were auctioned on a 'cost-basis' to Tennessee 4-H members. Clyde Chappell (1965) was instrumental in assisting East Tennessee Artificial Breeders forming Select Sires Inc. In the 1960s seven pairs of identical twin Jerseys were used to compare fast fattening growth with leaner 'normal growth'; leaner heifers outmilked the fat ones. In 1972 the new Department of Animal Science was formed from Animal Husbandry and Dairying. In the 1970s and 1980s the Junior Dairy Project was one of the most outstanding in the nation. Leaders were L.O. Colebank, Clyde Chappell, William Miller, Ray Spann and Monty Montgomery. Since 1984 Dr. Stephen Oliver and his lab have achieved international recognition for research focused on milk quality and mastitis. With Dr. Lannett Edwards as the leader of the UT Cloning team, Millie became the first Jersey calf cloned from an adult somatic cell (2000) and in 2002 ten clones of a single adult Jersey cow were born. Research on dairy form/angularity (2005) by Drs. Gary Rogers and Chad Dechow has led to the selection of bulls that produce daughters that hold their body condition early in lactation.

C36 Celebrating a Century—1906 to 2006—of the University of Vermont Department of Animal Science. J. M. Smith*, *University of Vermont, Burlington*.

One hundred years ago, in June 1906, the University of Vermont set the cornerstone for Morrill Hall. Senator Justin Smith Morrill, memorialized by the Morrill Act of 1862, was from Strafford, Vermont. Without his efforts there may not have been a land grant college system and certainly not a Department of Animal Science at the University of Vermont. Initially Morrill Hall housed the Department of Agriculture, which achieved College status in 1911. The early development of what would become the Department of Animal Science was overseen by Howard B. Ellenberger. Dr. Ellenberger was also active on the national scene and was elected President of the American Dairy Science Association in 1931. He served as Department Chairman until 1949. Under Dean Carrigan, the College really began to grow and take a shape resembling what was present at the end of the 20th century. New buildings sprouted up including the Hills Agricultural Science Building, the Bertha Terrill Home Economics Building, and the Dairy Science Building, which was renamed the Carrigan Building in 1965, 8 years after Dean Carrigan retired. The Department of Animal Science called all of these home at one time or another, moving from Morrill to Hills to Carrigan and finally to its current home in Terrill. The Department has had many names, as well, originally being called the Department of Animal and Dairy Husbandry, later Animal and Dairy Science, then Animal Sciences, and recently took on the singular name, Animal Science. The dairy foods faculty members were an integral part of the department until 1998 when they joined the nutrition faculty in the newly formed Department of Nutrition and Food Sciences. Department notables include Henry V. Atherton, J. Woodrow Pankey, Jr., James G. Welch, Catherine W. Donnelly, Karen I. Plaut, and David E. Kerr. Along with its research accomplishments, the department is proud of its teaching and advising record. The first Joseph E. Carrigan Outstanding Teaching Award went to Animal Science Professor Lyndon E. Carew, Jr., in 1981. Dr. Carew has taught introductory nutrition since 1971, and created an internet-based nutrition course in the early 1980s. In the College of Agriculture and Life Sciences, Animal Science is the largest major, with 250 students.

C37 UW-Madison: A Century of Excellence in Education and Discovery. L. H. Schultz, D. A. Wieckert*, C. C. Olson, W. T. Howard, and D. P. Dickson, *University of Wisconsin, Madison*.

William A. Henry, the University of Wisconsin's first agriculture professor, provided scientific research to expand the state's dairy industry in the late 19th century. Using the university farm and the newly created experimental station, Henry promoted the use of round silos for storing feed during the winter. In 1887, Henry hired Stephen Babcock who developed the first test for butterfat. This test enabled cheese makers to give farmers a fair price for their milk. In 1886 the university offered its first winter agricultural "short course." Stephen Babcock established the nation's first "Dairy School" in 1890. Created with legislative support, these schools moved farmers from wheat production to dairying. In 1907, S.M. Babcock and E.B. Hart forged discovery of vitamins and essential trace minerals by feeding diets of single grains to dairy heifers. These experiments proved that nutrients other than fats, proteins, carbohydrates, and salts were necessary for

life and reproduction. In 1933 a farmer brought a bucket of blood to the UW from a cow that had died for no apparent reason. Professor K.P. Linn determined the cause of death was internal bleeding due to the presence of dicoumarol, in moldy sweet clover hay. Dicoumarol is still used as a rat poison and a blood thinner in humans. In the mid-1930's, Wisconsin's breed organizations petitioned Agriculture Dean C.L. Christensen to establish a Department of Dairy Husbandry. With full support of the state legislature, Christensen moved several extension faculty members specializing in dairy from Animal Husbandry to create the new department in 1938. Dr. E.E. Heizer, a Holstein specialist from Ohio became the first Chairman of Dairy Husbandry. The department changed names to Dairy Science in 1962. The National Dairy Cattle Congress in Waterloo, Iowa, experienced financial difficulties in the mid-1960's. Dr. J. W. Crowley and prominent dairy cattle breeders from Wisconsin established the World Dairy Expo in Madison. The first show, held in 1968, continues to be the premier dairy exposition in the world. With the recent discovery of 'Ovsynch' (timed AI) the Department of Dairy Science continues to be a leader in utilizing basic biology knowledge to solve practical problems of dairy producers.

C38 Dairying becomes a highlight of the Utah Rocky Mountains: Glimpses into a century of contributions in research, service and teaching at Utah State University. G. H. Richardson, R. Lamb, T. Dhiman, and D. J. McMahon*, *Utah State University, Logan.*

Founded as the Utah Agricultural College in 1888. John T. Caine, purchased purebred Jersey bulls to initiate dairy herd improvement. George B. Caine continued this dairy breeding providing a basis for Cache Valley Breeding Association, and in 1958 the Holstein bull Burkegov Inka Dekol was the nation's highest rated bull. Lyman Rich pioneered use of "business machines" for processing dairy herd improvement records and teamed with Bliss Crandall, College statistician, resulting in formation of the Dairy Herd Improvement (DHI) computing service. Ruebin Hill was a pioneer in measurement of cheese curd tension. From this beginning, evolved a long history of research and instrumentation on milk coagulation. A.J. Morris was head of the Dairy Manufacturing Department and was a master teacher. His students became leaders in industry, research and education. C. A. "Tony" Ernstrom was the driving force behind construction of the Nutrition and Food Sciences building at Utah State University. He was instrumental in organizing the National Dairy Board research program and he pioneered use of ultrafiltration of milk for manufacture of natural and process cheese. Utah State University evaluated one of the first infrared milk analyzers in the USA, and these are now the prime means for measuring milk composition. Gary Richardson helped develop a hand-held conductivity meter for rapid detection of mastitis that is in use throughout the world and invented external pH-controlled starter system. Based on Richardson's research, several Utah State students formed a company to provide cultures, media and external pH-controlled systems to the cheese industry. Apart from being the most economical starter system, it produced some of the best improvements in cheese quality in the past fifty years and is now used worldwide. In the 1970s, Rodney Brown and Tony Ernstrom spearheaded the development and use of milk component pricing, resulting in a dramatic improvement in the economics of cheese manufacture. Now today's dairy faculty at Utah State University are making their own contributions in the fields of enhanced fat composition of milk, lactic acid bacteria genomics, cheese chemistry and manufacture, and whey proteins.

C39 Virginia Dairy Foods Research Program. S. Duncan*, *Virginia Polytechnic Institute and State University, Blacksburg.*

The Virginia Tech Dairy Foods Research Program was started in 1986 by Dr. J. Russell Bishop. Funded by contributions from dairy food processors within the state, the program targeted extension, education and research programs that improved quality and safety of dairy foods. Early research activities focused on rapid detection methods for spoilage bacteria and translating that work to the benefit of the dairy food processors within the state. In the early 1990s, Dr. Bishop initiated research on the accuracy and efficiency of rapid analytical methods for drug residue detection in raw and processed milk products. Dr. Bishop also initiated the Virginia Dairy Quality Control Program, an annual meeting of processors and regulatory officials within Virginia, with a meeting objective of sharing the current research and education information needed for improving quality, processing and safety of dairy products. Leadership of the program changed with Dr. Bishop's transition to the Wisconsin Center for Dairy Research. The program is now led by Dr. Susan Duncan and Dr. Susan Sumner and includes faculty expertise in food safety, sensory evaluation, processing, packaging, and chemistry. The expertise has expanded to include aseptic and extended shelf-life processing, fermentations, product development, and packaging. The six faculty, three support staff, and seven graduate students invested in the program continue to meet program goals through extension activities and publications, applied research of critical importance within the Commonwealth and the nation, and education of the next generation of scientists and processors. Publication of the monthly Dairy Facts newsletter and other general education releases assists in reaching the targeted audience. Faculty, staff and students participate in the annual Capital Hill Ice Cream Party sponsored by IICA and IDFA, provide educational activities to K-12 children in 4-H, FFA and the Governor's School for Agriculture, directly deliver programs to processors on sanitation, HACCP, sensory and packaging, and support the Virginia Dairy Foundation and Virginia Dairymen activities at the state fair. Current research activities include inhibition of mold growth on cheese, improved packaging for preventing light-induced and autoxidation reactions in fluid milk and dairy products, preventing growth of pathogens in soft cheeses, and use of nanocrystalline cellulose complexed with whey proteins for food applications. These research activities are funded through external competitive grants complementing the base funding provided by the Virginia Dairy Foods Research Program and increasing the program value.

C40 Dairy Club of Virginia Tech: Capturing the Past, Defining the Future. J. L. Leech* and D. R. Winston, *Virginia Polytechnic Institute and State University, Blacksburg.*

The Dairy Club was organized at Virginia Polytechnic Institute in 1921, and was one of the three original curricular clubs on campus. The Dairy Club of Virginia Tech, as the organization is now known, has a past that is rich in history and achievement. In 1924 the Dairy Club published its first annual and sponsored Virginia Tech's first dairy judging team. The following year, 1925, the club held its first Little All-American Dairy Show. The Virginia Tech Dairy Club became a member of the American Dairy Science Association in 1938. In the years that followed the club has been recognized as the Outstanding Chapter of the ADSA - Student Affiliate Division more than any other chapter. Since 1960, six club members have served ADSA-SAD president and seven have been recognized as the ADSA-SAD

Outstanding Student. The club has enjoyed similar success in the Southern Branch, having been named the outstanding chapter 20 times since 1980. Today, the club is highly visible on campus through its milkshake sales at all home football and basketball games. The Dairy Club has made national news more than once. In 1971 the Little All American show was featured on NBC's Today Show and in 2005 a Virginia Tech Holstein calf named Shana made national headlines on ESPN and the Wall Street Journal for her ability to "predict" Hokie football game scores. The club is helping define the future by training dairy leaders through its activities that compliment the undergraduate curriculum in Dairy Science.

C41 The Past, Present, and Future of Dairy Science at Virginia Polytechnic Institute and State University. J. W. McFadden*, M. L. McGilliard, and C. E. Polan, *Virginia Polytechnic Institute and State University, Blacksburg.*

Virginia Polytechnic Institute and State University (Virginia Tech) is today taking steps to assure its scientific contributions to the dairy industry will continue well into the future. In 1895, William D. Saunders, a Virginia dairy industry pioneer, was the sole instructor of dairy science courses and was well-recognized for his contributions to cheese processing. Faculty member Charles W. Holdaway was a charter member and first president (1922 and 1923) of the Southern Branch of the American Dairy Science Association (ADSA). Since that era, five Virginia Tech faculty members have held the presidency of the Southern Branch of ADSA (Paul M. Reaves, W. Ray Murley, Carl E. Polan, J. Russell (Rusty) Bishop, and Robert E. James). The Department of Dairy Science has been home to a multitude of scientific innovators. The scholarly contributions of these scientists include body condition scoring, major advancements in protein supplementation for enhanced milk production, the improvement of reproductive efficiency through refinements in semen quality and artificial insemination and the development of a dairy feeding program based on forage testing, computerized ration balancing, and a total mixed ration approach. Virginia Tech was influential in the formation of several key industry organizations: the Virginia State Dairymen's Association (1907), the Virginia State Feed Association (1946), and the Professional Dairy Heifer Growers Association (1997). Since the late 1970's dairy

producers, through the Virginia Setaside program, have contributed more than \$5 million to departmental programs. A variety of dairy courses taught by a committed faculty has been the foundation of an enthusiastic Dairy Club that for many years has actively supported the Student Affiliate division of ADSA. The Department of Dairy Science recently completed the construction of modern dairy facilities and has hired three faculty members (Benjamin A. Corl, Mark D. Hanigan, and Isis K. Mullarky) to insure the continued growth and success of its research, teaching, and extension programs.

C42 West Central®: Practicing dairy-nutrition innovation for 50+ years!. P. W. Jardon*, *West Central, Ralston, IA.*

In 1933 West Central® was founded in Ralston, Iowa as Farmers Cooperative Association of Ralston. In the years since West Central has become known for dairy-nutrition innovation. In 1942 an expeller processor was installed in Ralston. In the 1980's computer modeling of dairy rations became more advanced and nutritionists started to become aware of the benefits of bypass protein. West central refined the expeller process to optimize bypass protein and in 1984 began marketing SoyPLUS® to the U.S. dairy industry. A patent was awarded in 1993 for the unique processing technology that included a new reaction and conditioning phase. SoyPLUS has become the 'Gold Standard' by which dairy products are compared. In 1997, SoyChlor®, a palatable chloride source for closeup dairy cattle, was developed using hydrochloric acid technology. West Central received a patent for the technology for producing SoyChlor in 2002. SoyChlor has become the industry standard of anionic DCAD products. In 1996 West Central began producing methyl esters and in 1997 began manufacturing and marketing SoyPOWER® premium biodiesel fuel. Today West Central is the nation's largest marketer of biodiesel. West Central is proud to be a Sustaining Member of ADSA. West Central consistently supports the dairy industry through funding of research and special projects. The science of amino acid nutrition, rumen protein dynamics, transition cow feeding & management, and young stock nutrition are just some of the areas that have been advanced by support from West Central. West Central would like to extend gratitude and thanks to everyone in the dairy and allied industries for making our success possible. Congratulations to ADSA for 100 great years!

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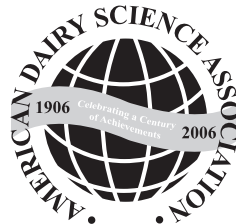
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