

ABSTRACTS
AMERICAN SOCIETY OF ANIMAL SCIENCE
AMERICAN DAIRY SCIENCE ASSOCIATION
July 20–25, 2002
Québec City, Québec, Canada

* Author Presenting Paper

6th Joint EAAP/ASAS Workshop on Biology of Lactation in Farm Animals
Alternative Strategies in Dairy Cow Management

1 Sensors and management support in high-tech milking. H. Hogeveen^{*1} and W. Ouweltjes^{2,1} *Farm Management Group, Wageningen University, the Netherlands, ²Research Institute for Animal Husbandry, Lelystad, the Netherlands.*

Two trends can be distinguished in the application of milking technologies on dairy farms: 1. High capacity (in terms of milkings per person per hour) milking parlors and 2. Automatic milking (AM) systems. In both types of systems the available labor must be directed to those cows that need it: management by exception. Therefore, sensors will be useful and necessary in AM systems. Since the 1980's, work has been carried out on the development and application of in-line sensors. Most work was concentrated on electrical conductivity, which is currently still the most applied technique for mastitis detection in AM systems. However, sensor development was technique-driven. A demand-driven approach will be better and the following questions need to be answered before further development of sensors: Which information is necessary to optimize the basic process of milking, and what information is necessary to support the decision making process around milking, e.g. detection of clinical mastitis. Because of the increased societal interest in animal health and welfare, these questions have to be answered within the constraints that milk must be a safe product, produced by healthy, well-managed animals in a hygienic and animal-friendly environment. Besides the need for more management information, application of high-tech milking changes milking procedures. In large capacity milking parlors, there is not more than 10 sec. time for udder preparation. Data show that in AM systems compared to conventional milking, the udder preparation process takes much more time and is very consistent. However, the time for teat cup attachment in AM systems is relatively long and very variable. Moreover, because of attachment failures, the milk let down is also influenced. Although available data to date provide some information, the full short and long term consequences of the indicated changes in milking procedures on milk production are not fully known.

Key Words: Milking systems, Milk production, Sensors

2 Effects of once-a-day vs twice-a-day milking throughout lactation in dairy goats. A.A.K. Salama, X. Such, G. Caja*, M. Rovai, R. Casals, E. Albanell, and A. Marti, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

The effects of once (1x) vs twice (2x) daily milking on milk yield, milk composition and udder health were studied in dairy goats throughout lactation. For two consecutive years, a total of 32 Murciano-Granadina dairy goats were assigned at wk 2 of lactation to two treatment groups, and were either milked 1x (0900; n= 17) or 2x (0900 and 1700; n= 15) daily until wk 28 of lactation. Goats were dried off at 300 DIM. Milk yield was recorded weekly, and milk composition, somatic cell count (SCC) and bacterial intramammary infections were evaluated for individual udder halves of each goat at each milking at wks 2 and 4 of lactation and then, monthly until the end of the experiment. Once-a-day milking resulted in 18% reduction in the yield of energy corrected milk at 4% fat (FCM-4%) compared to 2x (1.6 vs 2.0 L/d; P<0.001). This reduction was more marked from wk 2 to 12 (19%; P<0.05) than in late lactation (14%; P<0.08). Response to milking frequency varied according to goat's parity number (P<0.01): ≤2nd parity (1.5 vs 2.4 L/d; P<0.01), 3rd parity (1.4 vs 1.8 L/d; P<0.05) and ≥4th parity (1.7 vs 1.9 L/d; P= 0.284) for 1x vs 2x, respectively. Milk of 1x goats contained more (P<0.05) total solids (13.6 vs. 12.9%), fat (5.4 vs. 4.6%) and casein (2.6 vs. 2.4%) than milk of 2x goats. However, yields of total solids, fat, protein and casein tended (P<0.10) to be higher for 2x than 1x. Udder health was not modified by the experimental treatments but one goat from each treatment suffered mastitis and their data were excluded from the analysis. Geometric mean of milk SCC did not differ between treatments (979 vs 917×10³ cells/ml; P= 0.189) for 1x vs 2x, respectively. Total FCM-4% milk yield on 300 DIM was also lower for 1x vs 2x (504 vs 590 L; P<0.01) goats, respectively. We conclude that application of once-a-day milking in Murciano-Granadina dairy goats reduced moderately milk yield but did not have negative effects on milk composition and udder health. An increase in labor productivity is also expected.

Key Words: Once-daily Milking, Milk Composition, Somatic Cell Count

3 Management of photoperiod in the dairy herd for improved production and health. Geoffrey Dahl*¹ and Denis Petitclerc², ¹University of Illinois, ²AAFC-Dairy and Swine R&D Centre.

Environmental influences on lactation efficiency are frequently associated with reductions in milk output. Heat stress, for example, leads to depressed feed intake and subsequently losses in production. Conversely, cold stress may limit nutrients available for milk synthesis. Fortunately, one environmental factor, photoperiod, can exert a positive effect on dairy performance when managed properly. Long days have consistently been shown to improve milk yield during established lactation. In addition, photoperiod management can be used to improve heifer growth and maximize accretion of lean tissue including mammary parenchyma. There is, however, evidence of refractoriness to long day stimulation. Recent work has focused on the dry period as a time when photoperiod manipulation can influence subsequent milk production. In contrast to lactating cows, multiparous cows benefit from exposure to short days when the dry period is followed by long days or ambient photoperiod after calving. Similarly, primiparous animals also respond positively to short days late in pregnancy when subsequently exposed to long days during lactation. Emerging evidence suggests that short days positively influence immune function in cattle. Mechanistically, it appears that prolactin has a causal relationship with the observed dairy performance effects during the dry period and on immune function, via altered sensitivity to prolactin through differential expression of prolactin receptor in multiple tissues. The objectives of this paper include a review of fundamental aspects of photoperiod physiology, integration of applied and basic research findings, and development of management recommendations for the entire life cycle of the dairy cow to optimize performance.

Key Words: Photoperiod, management, immune function

4 Effects of chronic oxytocin administration on oxytocin release and milk ejection efficiency. J. Macuhova¹, V. Tancin^{1,2}, and R. M. Bruckmaier¹, ¹Institute of Physiology, Techn. Univ. Munich-Weihenstephan, Freising, Germany, ²Research Institute of Animal Production, Nitra, Slovakia.

The objective of this study was to test if reduced release of oxytocin (OT) from the pituitary or the sensitivity of OT receptors in the mammary gland are responsible for the reduced spontaneous milk ejection after long-term OT treatment. Fourteen healthy Brown Swiss dairy cows were used for the experiment. Cows were routinely milked twice daily at 5 a.m. and 4 p.m. in a 2x2 tandem milking parlour. They were randomly assigned to two treatment groups, seven animals in each group. During a period of 19 d they were i.m. injected with 5 ml NaCl solution (NaCl group) or 5 ml (50 IU) OT (OT group) 1 min before start of each milking. During evening milkings before and after chronic NaCl or OT treatment blood samples were collected at 1-min intervals for analysis of OT blood concentrations. At the end of these milkings OT (10 IU) was

i.v. injected to remove residual milk. To detect changes in mammary gland sensitivity to OT, intramammary pressure (IMP) in the udder cistern was recorded during OT infusion before and after the chronic NaCl and OT treatment period. OT was infused at 0.15 IU/min, which caused a steady increase of OT blood concentration. The occurrence of milk ejection was visualized by an IMP rise in the cistern. Chronic NaCl treatment did not influence milk removal, OT release or IMP pattern. Chronic OT treatment reduced spontaneous milk removal by 15±5 %. OT release during milking was not reduced after chronic OT treatment. During OT infusion and IMP recording, commencement of milk ejection was similar before and after chronic OT treatment. However, time to reach IMP maximum was prolonged after chronic OT treatment ($p<0.05$). In conclusion, chronic OT administration did not change OT release nor OT blood concentration required to commence myoepithelial contraction. However, the intensity of myoepithelial contraction was reduced thus causing incomplete udder emptying.

Key Words: Oxytocin Treatment, Milk Ejection, Cow

5 Lactation persistency: insights from mammary cell proliferation studies. A.V. Capuco*¹, S.E. Ellis², S.A. Hale³, E. Long¹, R.A. Erdman³, X. Zhao⁴, and M.J. Paape¹, ¹USDA-ARS, Beltsville, MD, ²Clemson University, Clemson, SC, ³University of Maryland, College Park, ⁴McGill University, Quebec, Canada.

Milk yield is a function of the secretory activity and number of mammary epithelial cells. A persistent lactation is dependent upon maintaining number and activity of milk secreting cells with advancing lactation. When dairy cows are milked twice daily, the increase in milk yield from parturition to peak lactation is due to increased secretory activity per cell, rather than to accretion of additional epithelial cells. After peak lactation, declining milk yield is due to loss of mammary epithelial cells by apoptosis. During lactation, only 0.3% of mammary cells proliferate in a 24-h period. Yet this proliferative rate is sufficient to replace most mammary epithelial cells by the end of lactation. Management practices can influence lactation persistency. Administration of bovine somatotropin may enhance persistency by increasing cell proliferation and turnover, or by reducing the rate of apoptosis. Increased milking frequency during the first weeks of lactation increases milk yield even after return to less frequent milking, with increases of ~10% over the entire lactation. A proliferative response to frequent milking during early lactation appears to be involved. Conversely, advanced pregnancy, infrequent milking, and mastitis increase death of epithelial cells by apoptosis. Regulation of mammary cell renewal provides a key to increasing persistency. Investigations to characterize epithelial cells that serve as the proliferative population in the bovine mammary gland have been initiated. Epithelial cells that stain lightly in histological sections are evident through all phases of mammary development and secretion, and account for nearly all proliferation in the prepubertal gland. Characterization of these cells may provide a means to regulate mammary cell proliferation and thus to enhance persistency, reduce the effects of mastitis, and decrease the necessity for a dry period.

**6th Joint EAAP/ASAS Workshop on Biology of Lactation in Farm Animals
Lactation Biology in the Post-Genomic Era**

6 Transgenic livestock: promise fulfilled. M.B. Wheeler*, University of Illinois at Urbana-Champaign.

Over the past two decades the ability to alter the genome of animals, by the introduction of DNA, has been a major technological advance in agriculture. Transgenic animals are produced by the introduction of a small, isolated, known fragment of DNA into pre-implantation embryos. This DNA is inserted into the chromosomes of the embryo and is expressed in all tissues of the resulting individual. The ability to move genes into organisms has been referred to as "gene transfer". This technique is of great importance to many aspects of biomedical science and agriculture. There are numerous potential applications of transgenic methodology to develop new or altered strains of agriculturally important livestock. Practical applications of transgenics in livestock production include improved milk production and composition, increased growth rate, improved feed utilization, improved carcass composition, increased disease resistance, enhanced reproductive performance, and increased prolificacy. The improvement of the nutrient or therapeutic value of milk may have a profound impact on survival and growth

of newborns in both humans and animals. Transgenic pigs containing gene constructs (for the bovine milk protein alpha-lactalbumin) designed to improve sow milk have been produced. Results of these studies have shown the concentration of bovine alpha-lactalbumin was directly correlated with the concentration of endogenous porcine milk proteins throughout the 21 days of lactation. Milk production was higher in transgenic sows on days 3, 6 and 9 of lactation as compared to control sows. At weaning (d 21), piglets suckling the transgenic sows weighed 0.5 kg more than piglets suckling control sows. The use of transgenics to improve lactation can enhance offspring growth and may enhance offspring health in economically valuable livestock. The ultimate utility and value of transgenic technology will be limited by our ability to identify genes and appropriate regulatory sequences for the production of traits we wish to improve. Future improvements in nuclear transfer (cloning) technology, automation of embryo handling techniques and improvements in gene and/or chromosome transfer technology will in-

crease the efficiency of transgenic livestock production and allow more precise changes in the livestock genome.

Key Words: Lactation, Transgenic Animals, Swine

7 Transgenic models for animal science research and application. D.E. Kerr^{*1}, O. Wellnitz¹, A. Mitra², and R.J. Wall², ¹University of Vermont, Burlington, ²USDA-ARS, Beltsville, MD.

Continual advances in the ability to produce transgenic animals make it likely that such animals will become important components of animal agriculture. Full benefit of the technology, and justification of its initial cost outlay, will be dependent on the establishment within these animals of new traits not easily achievable by other means. Potential applications include enhanced nutrient digestibility with reduced fecal losses, significantly altered milk composition, and enhanced disease resistance. Our goal is to enhance mastitis resistance of dairy cows by enabling the cells of the mammary gland to secrete additional antibacterial proteins. Proof of concept has been obtained through experimentation with a transgenic mouse model. Three lines of mice were developed that produce varying levels of lysostaphin in their milk. This protein has potent anti-staphylococcal activity and its secretion into milk confers substantial resistance to infection caused by intramammary challenge with *Staphylococcus aureus*, a major mastitis pathogen. Additional antibacterial proteins are being sought that will complement lysostaphin. A potential benefit of transgenic application of anti-bacterial proteins is the concomitant sparing in the agricultural use of anti-biotics currently used as human therapeutics. Anti-bacterial proteins are not typically used as injectable or oral therapeutics because of immune-mediated or digestive destruction of their activity. In contrast, the immune system of transgenic animals will not consider the transgenic protein as being foreign. In addition we are exploring the potential of involution or mastitis responsive promoter elements for use in subsequent transgenic experiments designed to restrict lysostaphin production to these important time points. It is anticipated that genomics will play a role in unveiling additional genes whose promoter elements will enable desired temporal expression patterns. The transgenic approach to insertion of new genetic material into agriculturally important animals is feasible but requires extensive prior evaluation of the transgene and transgene product in model systems.

Key Words: Mastitis

8 Regulation of apoptosis in mammary gland of cows at early lactation. M. Colitti^{*} and B. Stefanon, *Dipartimento di Scienze della Produzione Animale - Universita' di Udine, Italy.*

Apoptosis inducing factor (AIF) and bcl-2 proteins are involved in apoptosis control, but little is known about their interaction in lactation of cattle. In the present paper the onset of apoptosis and apoptosis-related signals in mammary gland at the beginning of lactation have been investigated. In addition a partial complementary DNA (cDNA) for bovine AIF has been identified and its expression evaluated. Mammary gland tissue was collected from 3 first-calving cows by biopsy at early lactation. The samples were processed for total RNA extraction and RT-PCR analysis were performed for bcl-2, bax, bcl-X and AIF genes. For AIF, ClustalX software was also utilised to align the coding sequences (cds) for rat (Genebank, accession AB04723), human (Genebank, accession XM010246) and mouse (Genebank, accession BC003292) AIF. Highly conserved regions of the AIF cds between the examined species were assessed with Genedoc software. Amplification and sequencing of AIF cDNA from bovine mammary tissue revealed a high degree of homology. In particular, the bovine AIF partial-cd was highly homologous (89%) between nucleotides 1584-1786 of the rat AIF sequence and nucleotides 1541-1743 that encode for the human PDCD8 (91%). The amino acid sequence of bovine AIF showed still higher similarity between species, with 96% homology for rat AIF (residues 496-562) and 93% with that of the human protein (residues 501-567). Within the time course of this experiment, we found a steady-state of bcl-2 and bcl-x expression and the up and down regulation of bax RNAs, which could indicate that in lactating cows these genes and related proteins are differently involved in apoptosis compare to mice. The *in situ* hybridisation data showed that the epithelial cells contained AIF expressed at an intracytoplasmic level, but not into the nucleus. It was demonstrated that no AIF translocation was detectable in bcl-2 overexpressing cells and this could suggest that in mammary tissue during early lactation the protein was confined

to the mitochondrial intermembrane space, in agreement with the low apoptotic index observed.

Key Words: Apoptosis Inducing Factor, Mammary gland, Dairy cows

9 Proliferation-associated gene expression in bovine mammary gland. T. B. McFadden^{*}, *University of Vermont.*

Mammary development is a crucial determinant of potential milk producing capacity in dairy cows. Fundamentally, milk production is a function of the number and synthetic activity of secretory cells in the udder. Optimal nutrition and management allow for full expression of lactational potential. Therefore, manipulation of mammary growth in developing heifers and dry cows offers an opportunity to increase the efficiency of milk production. However, realization of this opportunity will require substantial increases in understanding of the basic mechanisms that regulate mammary development. Currently, a wide variety of factors are known to influence mammary growth, including genetic merit, nutritional management, hormonal regulation, physiological state and photoperiod. Unfortunately, relatively little detail on underlying mechanisms is available. In recent years, rapid advances in genomic technology have made it possible to conduct high-throughput screening of tens of thousands of genes in an effort to determine relationships between levels of gene expression and physiological function. Such "functional genomics" experiments yield gene expression profiles that may confirm known roles of particular genes while illuminating associations with novel genes, or previously unsuspected involvement of known genes. Using such an approach, we recently identified 200 candidate genes whose levels of mRNA expression were strongly associated with proliferation of mammary cells. Ongoing studies with a subset of these genes are aimed at confirming their relevance and further characterizing the regulation of their expression and their roles in control of mammary development. The objectives of this paper are to provide an overview of the factors that influence mammary development, to discuss fundamental concepts underlying genomic approaches, and to illustrate application of these techniques to studying regulation of mammary development and potential applications.

Key Words: Proliferation, Gene Expression, Mammary Development

10 Molecular methods for probing signal transduction pathways in mammary tissue. L.G. Sheffield^{*}, *University of Wisconsin, Madison.*

Expression profiling studies indicate that expression of a large number of genes is altered during lactation. Among these are members of the amphiregulin family, including epidermal growth factor (EGF). Lactating mammary tissue expresses 5-10 times as much EGF as tissue from pregnant or otherwise nonlactating animals, with almost all of the expression localized to secretory epithelial cells. Although much of the EGF is processed for secretion, some appears to remain as a partly processed 40-45 kDa transmembrane protein that includes the EGF domain as well as several EGF-like repeats. One potential ligand for this transmembrane protein is a soluble form of the EGF receptor, consisting predominantly of the extracellular domain of the receptor. EGF receptor extracellular domain induces tyrosine phosphorylation of cytoskeletal proteins in cells that express EGF, but not in cells lacking EGF expression. Although the intracellular domain of EGF lacks any kinase activity, it appears to physically associate with at least one as yet unidentified protein kinase. Activity of the EGF-associated kinase is increased by treatment with the extracellular domain of EGF receptor, apparently independently of transmembrane EGF receptor. Our laboratory is currently using a variety of proteomics approaches to identify proteins that interact with the membrane bound forms of EGF. Recombinantly produced intracellular domain of EGF fused with a 5X histidine tag is used as a bait protein in co-precipitation assays. Similarly, co-immunoprecipitation of EGF is used to verify results. These methods, when combined with microsequencing and/or matrix-assisted laser desorption mass spectrometry (MALDI MS) can identify interactions with known proteins. Yeast two hybrid approaches are used to identify interactions with unidentified proteins. In addition, DNA array approaches are being used to explore the possible pathways by which transmembrane forms of EGF can modify cell physiology. Results to date suggest that transmembrane forms of EGF may have a role in limiting cell proliferation or activating tumor suppressor pathways. Similar techniques are applicable to a variety of other signaling systems.

Key Words: Genomics, Proteomics, Mammary Development

11 Modeling the interaction of milking frequency and nutrition in lactation. I. Vetharaniam and S. R. Davis, *AgResearch Limited, Hamilton, New Zealand.*

A model of lactation, parameterized for primiparous New Zealand cows grazing pasture was used to understand and quantify how milking frequency interacts with nutrition. In a simulation, cows were given one of two intakes over a lactation of 270 days: a low allowance (LA) reflecting actual pasture intake patterns, and a higher (on average 20%) allowance (HA) designed to counter deficit periods. Milking frequencies were varied from 1 to 4 times per day.

Once daily milking (1DM) compared with twice daily (2DM) resulted in a production losses of 29% on LA and 32% on HA. 3 and 4 milkings per day (3DM and 4DM) increased production compared with twice daily milking by 9% and 12% respectively on LA, and 11% and 17% on HA. At the end of the lactation, 1DM resulted in 44% less mammary tissue than with 2DM, while 3DM and 4DM respectively gave mammary tissue increases of 22% and 40% over 2DM. Increasing the solids' content of milk by 20% reduced the loss associated with 1DM by 4%. Increasing cistern capacity by 20% only reduced this loss by 1%.

Temporary 1DM for the first 3 weeks of lactation resulted in a production loss of 19%, compared with 2DM, on HA. With LA, this effect was only 9%. After 3 weeks, there was a long term loss in mammary tissue of 4%, and a loss in production of the same amount for either allowance. A 20% increase in cistern capacity of the udder reduced production loss in the first three weeks by 3% for HA.

The model shows that mammary gland size over time is modulated by milking frequency, and determined the production potential of the udder, but actual production is strongly influenced by nutrition affecting secretion rates of alveoli. The response to milking frequency varied considerably with nutrition. A significant portion of the loss associated with 1DM is due to udder fill effects inhibiting secretion as opposed to loss of mammary tissue. The model reflects the underlying biology and its behavior is in good agreement with experiment. It demonstrates that higher milking frequencies need to be coupled with higher nutrition to obtain the potential benefits, and thus would be a useful teaching or research tool.

Key Words: Milking frequency, Nutrition, Lactation

12 Changes in cisternal and alveolar milk throughout lactation in dairy sheep. M. Rovai*, X. Such, G. Caja, and J. Piedrafita, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

With the aim to study the changes in the cisternal traits of the udder of dairy ewes, a total of 212 primiparous and multiparous dairy ewes (Manchega, MN; n= 133; and, Lacaune, LC; n= 79) were used during suckling (wk 0 to 5) and milking (wk 6 to 20) periods. Udder evaluation was done 8 h after the a.m. machine milking (0800 h) at 30, 60 and 105 d of lactation. Milk yield, machine fractioning and main udder traits (depth, length and teat distance) were also measured throughout the milking period. Cisternal scans were obtained by using a portable ultrasound scanner with a 5 MHz and 80° sectorial transducer and their area measured. Cisternal milk was measured after drainage by using a teat cannula, and alveolar milk was machine milked after an oxytocin i.v. injection (4 IU/ewe). Milk yield varied according to breed (MN, 0.86 l/d; and LC, 1.69 l/d; P<0.001) and lactation stage (P<0.001). Machine milking fractioning (machine milk: stripping and residual milk) was 62:38 and 79:21 for MN and LC (P<0.001), respectively. Cisternal area (MN, 14 cm²; and LC, 24 cm²) and cisternal milk (MN, 149 ml; and LC, 275 ml) varied according to breed (P<0.001) and tended to increase with parity (P<0.10). Moreover, both cisternal area and cisternal milk, decreased in both breeds through lactation (P<0.001). Values for cisternal area were: MN (15.9, 13.7 and 12.3 cm²) and LC (24.6, 24.0 and 22.2 cm²); and for cisternal milk were: MN (178, 161 and 109 ml) and LC (335, 263 and 228 ml), for 30, 60 and 105 d, respectively. Alveolar milk decreased with lactation stage in both breeds (P<0.001) but only showed a tendency between breeds (MN, 160 ml; and LC, 194 ml; P= 0.060). Cisternal area and cisternal milk were correlated (r= 0.76; P<0.001) in both breeds, as well as milk yield during the milking period (r= 0.42 to 0.60; P<0.01) and udder size traits (r= 0.21 to 0.51; P<0.05). Positive correlations of cisternal area with machine milking fractions (r= 0.47 to 0.55) were also observed. Results indicate that

cisternal scanning is an efficient method to evaluate the cistern size and the productive capacity of the ovine udder.

Key Words: Cisternal Milk, Alveolar Milk, Udder Scans

13 Insulin response to amino acid infusions in Holstein cows. C. A. Toerien* and J. P. Cant, *University of Guelph, Guelph, Canada.*

Despite reported positive effects of insulin (INS) on milk precursor availability, milk protein production and milk yield, few studies have focussed on the effect of individual amino acids on insulin release in dairy cows. In Experiment 1, our objective was to investigate the insulin response in non-pregnant cows in early lactation (EL; mean \pm SEM: 32 \pm 1 kg milk/d) to pulse i.v. infusions of phenylalanine (Phe), arginine, glycine, histidine or lysine (at 14 mg/kg BW). Baseline INS values were similar across treatments, and all amino acids stimulated similar total INS release (as area under the curve; AUC). Peak response above baseline (ng/mL) was the highest for arginine (3.4 \pm 0.6) and differed from that of glycine and histidine (1.6 \pm 0.5 and 1.3 \pm 0.6; P < 0.05). In Experiment 2, we compared INS release to various levels of Phe, between non-pregnant lactating (Lact; 16 \pm 0.5 kg milk/d) and dry (Dry) cows. Treatments were pulse i.v. doses of Phe at 7, 14, 76, and 112 mg/kg BW. Baseline INS was higher in Dry cows across treatments. Contrary to responses in Dry cows, high levels of Phe failed to elicit an appreciable response in Lact cows in AUC or peak INS. Results indicate that physiological state plays an important role in regulation of INS release in dairy cows. Because INS stimulates protein synthesis in various tissues, caution should be used when applying the flooding dose Phe technique to measure protein synthesis in cows at different physiological stages.

		Treatments (mg Phe/kg BW)				Trt*Gr
Group		7	14	76	112	
AUC ¹						
(ng.mL ⁻¹ .min ⁻¹)	Dry	17.9 ^a	9.2 ^a	95.9 ^b	103 ^b	P<0.001
	Lact	-9.1 ^a	-7.4 ^a	1.21 ^a	0.9 ^a	
Peak INS ¹						
(ng/mL)	Dry	1.9 ^a	1.8 ^a	7.7 ^b	6.2 ^c	P<0.001
	Lact	0.8 ^d	0.9 ^d	1.7 ^a	2.0 ^a	

¹ Differences within and between groups in AUC and Peak INS reported at P < 0.05.

Key Words: Insulin response, Amino acids, Dairy cows

14 Involvement of Oct-1 in transcriptional regulation of beta-casein gene expression in mouse mammary gland. Feng-Qi Zhao*¹ and Takami Oka², ¹University of Vermont, Burlington, Vermont, ²National Institute of Health, Bethesda, Maryland.

Mouse beta-Casein gene promoter contains a region termed block C which is crucial for its gene transcription induced by lactogenic hormones. Nuclear extracts from mouse mammary glands contain at least two binding complexes (DS1 and DS2) which specifically bind to double-stranded block C region DNA. The binding sequence of these complexes was identified to be 5'-AAATTAGCATGT-3' which contains a sequence element related to the consensus octamer motif's complement ATTTG-CAT. In the present study, we demonstrate that this sequence element indeed is the binding site for octamer-binding transcription factor (Octs) and Octs represent the double-stranded DNA binding proteins specifically binding to the block C region. Formation of the specific double-stranded binding complexes can be completely blocked by Oct binding motif oligonucleotides and anti-rOct1 antiserum. We also show that Oct-1B represents at least partial, if not all, double-stranded binding protein, DS1, in mammary nuclear extract. Oct-1B may function as a transcriptional activator on casein gene promoter. The Oct binding activity to beta-casein gene promoter in the mammary gland is affected under influence of hormones both in vitro and in vivo. The DS1 binding activity can be induced by the combination of insulin, hydrocortisone

and prolactin in virgin mouse mammary gland organ culture and induced by injection of progesterone or the combination of progesterone and estradiol in virgin mice.

Key Words: Transcriptional regulation, beta-Casein gene, Oct-1

15 Synthesis of insulin-like growth factor binding proteins by a bovine mammary cell line. F Cheli^{*1}, A Baldi¹, L Rossi¹, M Vestergaard², and S Purup², ¹Dept. VSA, University of Milan/I, ²Danish Institute of Agricultural Sciences/DK.

The insulin-like growth factor binding proteins (IGFBPs) are a family of locally-produced growth regulators involved in mammary gland development. The production of IGFBPs within the mammary gland is species specific and depends on the stage of mammary gland differentiation. The aim of this work was to investigate whether bovine mammary epithelial cells (BME-UV1) produce IGFBPs and whether retinoic acid (RA) modulates the production in vitro. BME-UV1 cells were kept cultured in either control medium or in media supplemented with either, insulin (1 µg/ml), all-trans-retinoic acid (1 µM), or insulin+RA. Cell proliferation was evaluated at 48 and 72 h. At the same time samples of the medium were collected. Concentration of IGFBPs was evaluated by Western ligand blotting. Autoradiographs from the blots were exposed for 14 days and were evaluated by desktop scanning densitometry. RA inhibited ($P<0.05$) proliferation of both control and insulin-stimulated BME-UV1 cells by 30 and 26%, respectively. IGFBP-2 and IGFBP-3 were detected in BME-UV1 culture medium. RA affected the relative distribution of the two IGFBPs in the culture medium. RA significantly ($P<0.01$) increased IGFBP-2 content in both control and insulin-stimulated cells. In conclusion, BME-UV1 cells produce IGFBP-2 and IGFBP-3 and the production seems to be regulated by RA. Results also indicate that RA-induced inhibition of BME-UV1 cell proliferation is related to an increase in IGFBP-2 in the culture medium.

Key Words: bovine mammary cells, retinoic acid, IGFBP

16 Influence of dietary starch and of phase of lactation on haematological markers of oxidative stress in early lactation. G. Stradaoli¹, G. Gabai², and B. Stefanon^{*1}, ¹Dipartimento di Scienze della Produzione Animale - Università di Udine (Italy), ²Dipartimento di Scienze Sperimentali Veterinarie - Università di Padova (Italy).

Ten Friesian heifers were randomly assigned to two groups and fed until 30 DIM a basal TMR. At 35 DIM the control group (CTR, 24% starch/DM) continued to receive the same ration and the experimental group (EXP) was allotted to the experimental diets, which consisted in a stair step compensated starch regimen. Experimental diets were designed isoenergetic in order to have a reduction of starch (LSD, 21% starch/DM) followed to an increase (HSD, 28% starch/DM) of starch contents, with a final return to the basal diet. Blood was sampled at 37, 50, 60, 70, 80 and 94 DIM and analysed for glutathione peroxidase activity (GPx), glutathione (GSH), malondialdehyde (MDA), glucose (GLU), beta-hydroxy butyrate (b-OHB) and free fatty acids (FFA) concentrations. The stair step compensated starch regimen did not significantly affect milk yield and FCM between the groups during the experiment, the average milk yield for the EXP group being 25.88 kg/d, lower than the 27.42 kg/d of the CTR group. Plasma GLU was significantly lower with LSD diet and higher with HSD compared to mean values at 37 DIM. Plasma b-OHB significantly decreased in the EXP group at 70 DIM, when the LSD was replaced by HSD, but no variations were observed for plasma FFA concentrations. GPx activity decreased considerably after HSD administration to the EXP group (DIM 70 and 80), and recovered to initial mean value after return to basal diet (94 DIM). GSH concentrations, a measure used to identify antioxidant pool depletion, were not statistically affected from dietary variations of starch, although numerically lower mean values were observed during the LSD and HSD administration to the EXP group. Plasma MDA was significantly higher ($P<0.001$) for CTR group compared to EXP group, as was the interaction "dietary treatment" X "DIM" at 60 and 80 DIM. The results indicated that a moderate starch variation in the diet can contribute to enhance specific scavenger enzymatic activity, i.e. GPx, but did not substantially cause a reduction of blood antioxidant pool or an enhancement of MDA. The variations of plasma MDA were positively related to milk yield, indicating that milk production per se is a factor

potentially affecting the level of oxidative stress during the early phase of lactation in dairy cows.

Key Words: Oxidative stress, Milk yield, Dairy cows

17 Effect of milking and a suckling/milking combination on oxytocin and prolactin release and on milk yield in crossbred Gir x Holstein cows. J. A. Negrao^{*1} and P. G. Marnet², ¹USP/FZEA, FAPESP, Pirassununga/SP, Brazil, ²UMR INRA/ENSAR, Production de lait, Rennes, French.

Unspecialized cattle farmers in Brazil have used crossbred Gir x Holstein cows to produce both calves and milk during spring and summer in extensive systems. Traditionally, these crossbred cows are reputed not to be well-adapted to machine milking and are milked with their calves. However, this type of management increases the labour of milkers and also milking time. For these reasons, 10 Gir x Holstein cows (F2) were used to evaluate the effect of different milking methods on oxytocin (OT) and prolactin (PRL) release and on milk yield. All experimental cows were milked twice/day: 5 cows were suckled by their calves, immediately before and after milking (SM group) and the other 5 cows were separated from their calves and submitted to exclusive milking (M group). Milk yield was recorded throughout lactation. Blood samples were taken on days 60, 61, 62 and 63 of lactation, before and after udder stimulation. Plasma concentrations of OT and PRL were measured by EIA and RIA method, respectively. Highest OT levels were observed during suckling, however there were no significant differences between peak levels of OT measured during suckling and milking in the SM group. At the same time, both groups had similar levels of OT during machine milking, however, the hormone profiles were different because OT increased more rapidly in the SM group (2 min after the beginning of milking) than in the M group (5 min). In general, the SM group showed higher PRL levels than the M group and during suckling, PRL levels were significantly higher in the SM than in the M group. Despite these results, SM cows produced more milk (milking plus suckling, 18.4 ± 1.2 L/day) than M cows (15.0 ± 0.4 L/day). Our results indicate that both type of management were effective to induce OT and PRL release in crossbred Gir x Holstein cows.

Key Words: Milking/suckling, Oxytocin, Prolactin

18 Milk emission during machine milking in dairy sheep. M. Rovai^{*}, X. Such, G. Caja, and J. Piedrafita, Universitat Autònoma de Barcelona, Bellaterra, Spain.

The aim of this work was to compare the milkability of Manchega (MN, 1.03 L/d, n=133) and Lacaine (LC, 1.71 L/d, n=79) dairy ewes. The kinetic parameters of milk emission during machine milking were measured at 6, 10 and 14 weeks post-partum. Data were recorded by the manual method in two successive days for individual udder halves during the evening milking. The curves were classified into three groups: 1 peak (1P), 2 peaks (2P) and in plateau (IP). The last type refers to ewes with larger emission curves and did not show clear differences between peaks (1 and 2). The frequency of different curve types (1P:2P:IP) was 25:66:9 and 5:60:35 for MN and LC, respectively, which means a greater milk ejection reflex in LC ewes (95% vs 75%). Milk production varied according to curve type in both breeds (0.82, 1.03, 1.16 L/d in MN and 0.93, 1.68, 1.82 L/d in LC for 1P, 2P and IP, respectively). The IP as compared with 2P, showed greater total emission volume (0.30 vs 0.24 L) and total time of emission (49 vs 46 s). As compared to MN ewes, LC showed greater ($P<0.001$) flow rate (0.39 vs 0.29 L/min), milk volumes (0.28 vs 0.16 L) and emission time (44 vs 39 s) for all curve types. All parameters of milk emission kinetics increased with age in LC ewes ($P<0.01$), whereas in MN ewes the differences were observed only for some parameters which may be due to low variation in milk yield with age in MN ewes in this experiment. The frequency of milk emission type curves varied according to the parity number, showing an increase in the ejection reflex with age. Throughout lactation, all kinetic parameters decreased ($P<0.001$) except time of latency (28 s) and second peak flow (37 s) that remained constant in 2P ewes, suggesting that the time of milk ejection reflex did not change throughout lactation. Moreover, the percentage of ewes presenting the ejection reflex decreased throughout lactation. In conclusion, herds selected for high milk production (e.g. LC ewes) tended to have a better milk ejection reflex (2P and IP) and milkability.

Key Words: Dairy Ewes, Milking Kinetics, Milk Ejection

19 Induction of milk yield decrease and mammary gland involution in lactating Holstein cows and female rats. L. Delbecchi*, N. Miller, D. Petitclerc, and P. Lacasse, *AAFC-Dairy and Swine R&D Centre, Lennoxville, Quebec, Canada.*

Increasing amounts of estrogens in the blood of pregnant lactating cows may be one factor inducing the progressive involution of the mammary gland after the peak of lactation. In a first experiment, non-pregnant, mid-late lactation cows received sc. injections of either 17-estradiol (15 mg/cow/day; treated group, n=4) or 95% ethanol (control group, n=4) from d 0 to d 8. Measurement of milk production (d -10 to d 20) and evaluation of milk composition (before, during and after estradiol injections) showed that treated cows presented signs of mammary gland involution. Milk production was reduced ($P < 0.01$) in treated versus control cows by 14.8% on d 3, 37.2% on d 6, 76.5% on d 8, and 81.6% on d 11. Between d 0 and d 7, in treated cows, milk fat content and lactose concentration decreased ($P < 0.05$) by 37.6% and 15.9%, respectively, while milk protein content increased by 61.9% ($P < 0.05$). Control cows showed no significant variation in these parameters during the same period. Quantitative RT-PCR was performed on RNA extracted from mammary biopsies taken at d 0, d 1, d 2, and d 4. Levels of b-casein mRNA were reduced ($P < 0.05$) by estradiol but those of bax and bcl-2 were not significantly affected, suggesting a lack of short-term effect of estradiol on regulation of apoptosis in the mammary gland. In a second experiment, three potential inhibitors of estradiol, i.e. trans-retinoic acid (tRA), melatonin, and mimosine were tested in lactating female rats. Milk production was reduced ($P < 0.05$) in rats injected with estradiol as compared to controls. Melatonin and mimosine showed no significant effect ($P > 0.1$) on this reduction, while tRA enhanced it ($P < 0.01$). Analysis of gene expression is currently performed on mammary biopsies taken at the end of treatments. These results support the hypothesis that estrogens produced by the fetal-placental unit induce a gradual decline in milk production in pregnant lactating cows, but the molecular bases for this effect remain unclear. Work supported by Dairy Farmers of Ontario and Agriculture and Agri-food Canada.

Key Words: Involution, Mammary gland, Estrogens

20 Cloning lactoferrin gene in a novel expression vector and its expression/secretion in bovine mammary cells. N Bissonnette*, P Lacasse, and D Petitclerc, *Agriculture and Agri-Food Canada, Dairy and Swine Development and Research Center.*

Milk is a source of nutrients and a carrier of various forms of specific factors influencing bacterial growth, which may have significant benefit for the health of the suckling neonates. Milk proteins, such as lactoferrin (LF), are part of the innate immune system with antimicrobial properties and are an important component of this line of defence of the mammary gland. LF is a glycoprotein naturally produced by mammary cells and is found in milk of human (1-6 g/L) and cows (0.01-0.1 g/L). The aim of this study was to develop a molecular tool that permits the cloning and the expression of a bactericidal gene without killing the bacteria when the DNA vector is produced but allowing its full bactericidal expression when secreted by transfected eukaryotic cells. As conventional eukaryotic vectors with commonly used promoters (CMV, RSV or SV40) permit a basal expression in bacteria, others and we did not manage to clone lactoferrin gene in bacteria using such expression vectors. Expression systems reported so far to produce recombinant LF protein have used molds or yeasts. As glycans on mammalian glycoproteins influence their functions in many different ways, the major drawback of these lower eukaryotic systems is their inappropriate post-translational modifications. Hence, a method of inhibiting, in bacteria, LF gene expression by using a single eukaryotic expression vector without any repressor/activator molecule was developed. This system allowed the cloning of the bactericidal lactoferrin gene in an expression vector using bacteria as a host and permitted the production of high amount of vector by bacteria. Subsequently, this vector allowed the secretion of 200 µg/L of LF using our eukaryotic expression vector when transfected in bovine mammary cells. Therefore, DNA expression vector could be quantitatively produced by bacteria; thereby, large quantity of a bactericidal therapeutic gene, therein lactoferrin, could be used with the aim of being expressed as antimicrobial protein in transfected or transgenic eukaryotic cells.

Key Words: lactoferrin, expression vector, gene therapy

21 Effect of milking interval on milk yield and quality and the rate of recovery during subsequent frequent milking. K. Stelwagen*, V.C. Farr, and S.R. Davis, *AgResearch Ltd., Hamilton, New Zealand.*

Forty multiparous cows (DIM: 118-18) on an all-pasture diet were used in a completely randomised block design to examine the effects of milking interval (MI) on milk yield and quality, and its recovery during subsequent frequent milking. Following 2 d of normal twice-daily milking cows were not milked for either 6, 12, 18, 24 or 30 h, after which they were milked every 6 h for 24 h. Means shown are for, respectively, the 6, 12, 18, 24 and 30-h MI. Milk yield increased with increasing MI, but plateaued after 24 h of milk accumulation (4.7^a vs. 8.2^b vs. 11.5^c vs. 15.2^d vs. $16.4^d \pm 0.6$ kg, $^{abcd}P < 0.01$). Although, yield recovered to at least pre-MI yields for all groups, the rate of recovery was slowest for the highest MI (regression coefficients: 0.72^a vs. 0.70^{ab} vs. 0.68^b vs. 0.67^{bc} vs. $0.64^c \pm 0.02$ kg/h, $^{abc}P < 0.05$). The decrease in milk secretion after 18 h of milk accumulation coincided with an increase in mammary tight junction permeability, based on plasma lactose levels (27^a vs. 29^a vs. 47^a vs. 255^b vs. $413^c \pm 40$ µM, $^{abc}P < 0.001$). Increased permeability increased the concentration of serum albumin in milk (184^{ab} vs. 146^b vs. 211^{bc} vs. 235^c vs. $234^c \pm 19$ µg/ml, $^{abc}P < 0.07$), and differences remained during the first three subsequent 6-hourly milkings. SCC ($\times 1000$ /ml, ln-transformed) were not different at the end of each MI, but were significantly elevated in the milk from cows in the 24-h and 30-h groups during the subsequent frequent milking period (4th 6-hourly milking: 4.0^a vs. 4.1^a vs. 4.4^a vs. 5.0^b vs. $5.1^b \pm 0.2$, $^{ab}P < 0.05$). This is consistent with earlier data on once-daily milking, showing an increase in SCC after a 24-h lag phase. In conclusion, the rate of milk secretion begins to decrease with MIs excess of 18 h, which may be, at least partly, related to increased mammary tight junction permeability, and leads to poorer milk quality. The adverse effects (except SCC) can be reversed if the long MIs are followed by a 24-h period of frequent milking.

Key Words: Milking interval, Milk quality, Tight junction

22 Leptin variations in dry and lactating periods of dairy cows with different genetic merit. R. Lombardelli¹, P. Bani¹, C. Delavaud², Y. Chilliard², and G. Berton^{1*}, ¹UCSC, *Facoltà di Agraria, Piacenza, Italy*, ²INRA-UHRH, *Theix, France*.

Even though leptin is a quite recently discovered hormone, it has been intensively studied suggesting that it operates both directly and indirectly to orchestrate complex pathophysiological processes. In a previous paper we did demonstrate that, in the early lactation, dairy cows of different genetic merit mobilise their protein and fat reserves with a different intensity. To ascertain a possible role of leptin, 11 dairy cows of low (LG), medium (MG) and high (HG) genetic merit, 50 days before to 300 days after calving were checked: daily for milk yield and dry matter intake, twice a week for blood metabolites and hormones (including leptin) and fortnightly for live weight (LW) and BCS (on a 0-5 scale). The 300 days' mean milk yield was: 20.6 (LG), 27.2 (MG) and 32.8 kg/d (HG). Maximum post-partum LW loss was lower in LG (6%) than in MG (14.6%) and HG (13.8%). The level of leptin was not strictly related to the genetic merit, but 5 animals showed constantly low values (1.5 - 3.5 ng/ml) during dry and lactation stages; 5 more animals showed quite high values during dry period (7 - 11 ng/ml), a sharp decline after calving (1.5 - 3.5 ng/ml) and a partial recovery afterwards (2.5 - 4.0 ng/ml). The last one showed constantly high values during the whole experiment. Among the main data to be discussed there is the positive correlation between leptin and BCS found in LG cows only. Moreover, glucagon is related to leptin but in a positive way for LG cows whereas the reverse is true for the HG ones. Other important data are the higher live weight (but not BCS) and lower GH values recorded in the cows with higher leptin during late pregnancy. Also different, but not significantly, are milk yield, DMI and insulin, all higher in the latter cows. (Supported by RAISA- CNR).

Key Words: Leptin, Genetic merit, Dairy cow

23 Comparison of milk yield and of oxytocin and cortisol release during machine milking in Gir, Gir/Holstein and Holstein cows. J. A. Negro^{*1} and P. G. Marnet², ¹USP/FZEA, FAPESP, Pirassununga/SP, Brazil, ²UMR INRA/ENSAR, Production de lait, Rennes, French.

Gir cows (adapted to tropical conditions) and Holstein bulls (more productive) have been crossbred in Brazil to improve dairy production. In general, this crossbreeding program was a success and at present, many specialized farmers have Holstein cows with varying percentages of Gir blood. Although Gir cows and Gir/Holstein cows are reputed to be easily stressed and not well-adapted to machine milking, adaptation to exclusive machine milking has not been described in the literature for these cows. Taking this into account, 6 Gir cows (group G), 6 Gir x Holstein cows (F3; group GH) and 6 Holstein cows (group H) were used to evaluate the effect of exclusive machine milking on oxytocin (OT) and cortisol (CORT) release and on milk yield. Milk yield was recorded throughout lactation. Blood samples were taken on days 45, 48, and 51 of lactation, before and after milking. Plasma concentration of OT was measured by EIA method and CORT was measured by commercial EIA Kit (dsLab Inc). As expected, milk yield was significantly higher in the H group (25.6 ± 3.3 L/day) than in the GH group (20.2 ± 1.7 L/day), and the GH group produced more milk than the G group (13.1 ± 1.0 L/day). In contrast, all groups exhibited similar levels of OT, although OT increased more rapidly during milking of the H and GH groups (1 min) than of the G group (3 min). Simultaneously, CORT levels were significantly different for groups, the G group presented highest levels of CORT than GH and H groups. Our results indicate that G, G/H and H groups presented similar release of OT during exclusive milking, however CORT levels were inversely related to milk production.

Key Words: Milking, Oxytocin, Cortisol

24 Mixed linear model analysis of factors affecting the evolution of milk electrical conductivity along lactation in dairy cattle. N.P.P. Macciotta¹, M. Mele^{*2}, A. Cappio-Borlino¹, and P. Secchiari², ¹Dipartimento di Scienze Zootecniche - Università degli Studi di Sassari, Italy, ²D.A.G.A. Settore Scienze Zootecniche - Università di Pisa, Italy.

Electrical conductivity (EC) of cow milk is affected by the health status of the mammary gland but also by other factors that usually affect milk yield such as variations among cows, Test date, stage of lactation and parity. In order to evaluate the effects of all these factors on EC, Test Day (TD) records of an index of EC obtained by means of a computerized milk meter and milk yields of 138 Holstein Friesian cattle affected by clinical mastitis were analysed by the following mixed linear model: $Y = H + TD + PA + DIM + MAST + DIM(MAST) + LATT + E$ where H is the effect of the herd (2 levels), PA is the effect of parity (1, 2, 7), TD is the effect of test date (1020 levels), DIM indicates the effect of lactation stage (30 levels of 10d each), MAST is the effect of the period of mastitis occurrence (3 levels: $MAST1 = <100d$, $MAST2 = 99 <$ and <200 , $MAST3 = >199$), LATT is the random effect of individual lactation, E is the random residual. EC and milk yield curves for different classes of period of mastitis occurrence were constricted by plotting DIM(MAST) estimates against days in milking. EC tends to increase along the lactation, with a different behaviour in the different classes of period of mastitis occurrence and with a variance among animals equal to about 50% of the total random variability. EC in MAST1 cows was higher than in MAST2 and MAST3 cows at the beginning of lactation (mS 12.07 vs. 11.43 and 11.55 respectively) but curves of MAST1 and MAST2 were quite similar from about 150 DIM. The EC curve of MAST3 cows showed an increasing rate markedly lower than the other two classes during the whole lactation. Parity affected EC, with first calving cows having lowest values. Milk yield was affected by all fixed factors considered in the analysis except from MAST class; however, lactation curves separated for this last effect show a low peak for cows having mastitis >100 DIM and a higher persistency for those that were affected by the disease in the last part of lactation.

Key Words: Electrical conductivity, mastitis, milk

25 Effect of stimulation intensity on oxytocin release before and after milking. D. Weiss^{*}, A. Dzidic, and R.M. Bruckmaier, *Institute of Physiology, Techn. Univ. Munich-Weihenstephan.*

Oxytocin (OT) released from the pituitary causes myoepithelial contraction and milk ejection. Elevated concentrations of OT are necessary throughout the whole milking process to ensure complete milk ejection. The objective of this study was to test the effect of teat stimulation intensity on the level of OT released. Six Brown Swiss cows were machine milked at 5 a.m. and 4 p.m. and blood samples were taken during milking at 1-min intervals for OT analysis. Milk flow was recorded on a quarter level. Control milking (CM) corresponded to daily milking routine and included forestripping, dry paper cleaning and a 1-min vibration stimulation before the start of milking. In addition, vacuum in liner closed position without pulsation was applied, for 5 min, either before the start of milking (LCBM) or after the end of milking (LCAM). In a third treatment a 1-min vibration stimulation was applied to one quarter before the end of milking (STIMO). Stripping was performed in all treatments if total milk flow declined below 0.3 kg/min. Milk yield, milking time and average milk flow rate did not differ between treatments. During liner closed phase before milking (LCBM) OT concentrations were significantly ($P \leq 0.05$) higher compared to the period before teat cleaning in CM. Area under curve (AUC)/min during this period was 7.5 ± 1.0 pg/ml and 5.2 ± 0.9 pg/ml, respectively. The slightly increased OT concentrations in LCBM were sufficient to induce the alveolar milk ejection as indicated by the absence of bimodal milk flow curves in LCBM. LCAM had no obvious stimulatory effect on OT release, the decline in OT concentrations after the end of milking was similar in LCAM and CM. In STIMO, no effect of the additional stimulation on OT levels could be observed as compared to CM. In conclusion, different degrees of stimulation by the milking machine release different amounts of OT. However, only slightly elevated OT levels induce milk ejection at the start of milking.

Key Words: oxytocin, cow, milking

26 Factors affecting level and post-feeding behaviour of insulin in dairy cows. G. Bertoni^{*}, E. Trevisi, R. Lombardelli, and F. Piccioli Cappelli, *UCSC, Facoltà di Agraria, Piacenza, Italy.*

It is well-known that blood insulin level is reduced after calving and particularly in high yielding dairy cows although the data regarding the insulin release factors and/or its receptors sensitivity seem contradictory. To contribute to clarify some of these aspects we have studied the post-feeding behaviour of blood insulin in cows with different parity (trial 1) or genetic merit (trial 2) during the last month of pregnancy and the first 3 months of lactation. In the 1st trial 4 cows were considered in their 1st (L1) and 2nd lactation (L2); while 8 multiparous cows, 4 of high (HG) and 4 of average (AG) genetic merit, were used in the 2nd trial. Blood samples were taken every week before the morning meal and 1, 2, 3, 4, 5 and 6 hours after it, for metabolic profile and insulin determination. The environment conditions and diets were kept constant during the trials, while feed intake, milk yield and BCS were recorded. It is confirmed that insulin in dairy cows is strongly reduced before calving and rises again 1-2 weeks later, reaching the levels of dry period after 10 weeks. Furthermore, the after-meal insulin increase is stronger in dry period (+30-50%) than in the first 2 months of lactation (+10-30%). L1 and L2 of the same cows seem to have similar insulin values and behaviour after meal, particularly from 2 weeks before to 8 weeks after calving. HG showed lower levels of insulin before and after calving ($P < 0.05$ vs AG). As regards the after-meal behaviour, HG had a similar but more prolonged rise in dry period, whereas the increase was less marked after calving. These variations were related to the glucose levels (positively), but particularly in AG cows and around calving; a negative correlation has been observed with β OHB, NEFA and BCS, particularly for HG cows after calving. In general, insulin changes do not seem strictly related to the energy balance indices. It appears that insulin level and after-meal behaviour are strongly affected by stage of lactation and that genetic merit and/or parity could contribute to explain them.

Key Words: Insulin, Post-feeding behaviour, Dairy cow

27 Evidence for the presence of the cationic amino acid transporter CAT-1 in porcine mammary gland during lactation. J. Perez Laspiur*, J.L. Burton, P.S.D. Weber, and N.L. Trottier, *Michigan State University*.

Biomedical literature suggests that mammary epithelial cell expression of the CAT-1 cationic amino acid transporter is important in determining cell activity. It is specific for transporting lysine, and thus may be involved in regulating milk protein synthesis. Manipulation of CAT-1 expression may help producers control the volume and quality of milk for neonatal animals. The objective of the current study was to determine if CAT-1 is expressed in porcine lactating mammary tissue. A multiparous sow was sacrificed on day 19 of lactation for this work, and the udder removed immediately following cessation of heartbeat. Four anterior mammary glands (two from each lateral side) were isolated, the parenchymal tissue collected and cut into approximately 1.0-g pieces and frozen in liquid nitrogen. Total RNA from mammary tissue was isolated using the TRIzol Reagent method. Samples (10- μ g) of total RNA were run in duplicate on a Northern blot to assess CAT-1 gene expression. Expression of CAT-2 (another member of the CAT family of amino acid transporters) was used as a negative control and β -actin expression as a RNA loading control. Duplicate liver RNA samples from a prepubertal gilt were used as the positive control for CAT-2 expression. Human CAT-1 and CAT-2 cDNA probes (donated by Dr. E. I. Closs, Johannes Gutenberg University, Germany) and a rat β -actin cDNA were 32 P-labeled and hybridized sequentially to the Northern blot with complete stripping of the probes between hybridizations. Resulting autoradiographs revealed low level expression of CAT-1 in day 19 of lactation mammary tissue with no detectable expression in liver. As expected, CAT-2 was highly expressed in liver but not in mammary parenchyma. These preliminary results are the first to show that CAT-1 is expressed during lactation in porcine mammary tissue.

Key Words: cationic amino acid transporter, lactating mammary gland, porcine

28 Oxytocin release and milk ejection induced by teat cleaning in a single stall automatic milking system. A. Dzidic, D. Weiss, and R.M. Bruckmaier*, *Institute of Physiology, Techn. Univ. Munich - Weihenstephan, Freising, Germany*.

Oxytocin (OT) is released in response to tactile teat stimulation and causes alveolar milk ejection. The objective of this study was to evaluate the effect of teat cleaning by two rolling brushes on OT release and milk ejection during milking in a single stall automatic milking system (AMS, Merlin, Lemmer-Fullwood). Forty-eight German Fleckvieh cows were investigated during their voluntary milkings. Five treatments B0 (no brushing), B1 (1 brushing cycle for 16 s, 4 s per teat), B2 (2 brushing cycles), B4 (4 brushing cycles) and B6 (6 brushing cycles) were performed for 2 days each and quarter milk flow was recorded. In addition blood samples were taken from 10 cows during milking at 1-min intervals for OT determination in treatments B0, B2, B4 and B6. Basal OT concentrations were similar (2.7 to 3.8 pg/ml) in all treatments. At the start of milking, OT concentration was lower ($P<0.05$) in B0 as compared to all other treatments. One min after the start of milking OT concentrations did not differ between treatments (20.8 to 26.8 pg/ml). OT concentrations throughout milking (AUC/min) were 26.5 ± 4.1 , 25.6 ± 4.9 , 20.2 ± 2.7 and 19.8 ± 3.1 pg/ml in B0, B2, B4 and B6 respectively. The portion of bimodal curves decreased ($P<0.01$) with increasing number of brushing cycles (46, 25, 11, 1 and 0 % in B0, B1, B2, B4 and B6 respectively). Time until milk ejection occurred, recorded in B0, decreased ($P<0.05$) with increasing degree of udder filling (defined as a percentage of actual milk yield from maximum milk yield in month two of the current lactation). At low degree of udder filling (i.e. after short interval from previous milking) cows needed a longer pre-stimulation for well-timed induction of milk ejection and to reduce number of bimodal curves. In conclusion, the teat cleaning device in the used AMS was suitable to induce milk ejection in cows before the start of milking. Duration of teat cleaning needs to be adapted to the actual degree of udder filling.

Key Words: Oxytocin release, Milk ejection, AMS

29 mRNA expression of immunologically important factors and milk proteins in mammary tissue of dairy cows during LPS-induced mastitis. S Schmitz, MW Pfaffl, HHD Meyer, and RM Bruckmaier*, *Institute of Physiology, Techn. Univ. Munich-Weihenstephan, Freising, Germany*.

Inflammatory factors are known to increase during mastitis. This study was conducted to determine changes of mRNA expression of various immunologically important factors in mammary tissue during the first 12 h of lipopolysaccharide (LPS) induced mastitis. Five healthy lactating cows were injected in one quarter with 100 g E.coli-LPS (O26:B6) and the contralateral quarter with saline (9 g/l) serving as control. mRNA expression in mammary biopsy samples of various factors at 0, 3, 6, 9 and 12 h after LPS administration was quantified by real-time RT-PCR. Blood samples were taken following the same time course and rectal temperature was measured at 1-h intervals. Temperature increased until 5 h ($P<0.05$) after LPS administration and decreased to pretreatment levels within 24 h after LPS-challenge. Blood leukocyte number decreased ($P<0.05$) from 0 to 3 h from $7.71.1 \times 10^9/l$ to $5.71.0 \times 10^9/l$ and thereafter recovered to pretreatment levels until 12 h after LPS-challenge. In LPS-challenged quarters tumor necrosis factor α and cyclooxygenase-2 mRNA expression increased to highest values ($P<0.05$) at 3 h after LPS-challenge. Lactoferrin, lysozyme, inducible nitric oxide synthase mRNA expression increased ($P<0.05$) and peaked at 6 h after challenge, while platelet-activating factor acetylhydrolase mRNA increased only numerically. mRNA expression of the investigated factors did not change in control quarters. mRNA expression of insulin-like growth factor-1, 5-lipoxygenase and of α S1-casein (CN), α S2-CN, β -CN and β -lactoglobulin did not change significantly, whereas mRNA expression of α -lactalbumin decreased ($P<0.05$) in LPS-treated and control quarters and that of κ -CN only in the LPS-treated quarters. In conclusion, mRNA expression of most inflammatory factors changed within hours, whereas that of most milk proteins remained unchanged.

Key Words: LPS-challenge, Mastitis, Inflammatory factors

30 Body lipid change in lactation: consequences for the prediction of energy requirements. N. C. Friggens*, K. L. Ingvarsen, and G. C. Emmans, *Danish Institute of Agricultural Sciences, Foulum, Denmark*.

The size of the body lipid reserves (L) of the dam changes in a characteristic and repeatable manner through lactation in virtually all mammals. This is an evolutionary adaptation designed to support the changing reproductive priorities of the dam that is largely independent of current feed availability. Pregnancy leads to an increase in L to help meet the nutritional demands of the following lactation. Lactation is characterised by an initial decline in L followed by a return to the pre-pregnancy level. These patterns of changing L persist even under conditions that can reasonably be assumed to be nutritionally non-limiting. Thus there is a genetically driven, and therefore predictable, cycle of body energy mobilisation and deposition. Prediction of the cow's energy requirements can be substantially improved, particularly in early lactation, by incorporating genetically driven body energy mobilisation. With very few exceptions, existing prediction systems do not account for this. This paper presents in detail a method to quantify the genetically driven rate of change of L (dL/dt) at any given timepoint in lactation. The method requires assumptions about target levels of L at calving and in the pre-pregnant state, and about the time taken from calving to return to the pre-pregnant state. These assumptions are discussed and experimental results presented concerning the effects of breed and parity on the parameter estimates. The method requires input estimates of actual L at calving and time from calving to subsequent conception. A method to estimate L from body condition score and liveweight is described. In addition to being a practical means to improve prediction of energy requirements, this method provides a useful basis for exploring genetic variation in body lipid mobilisation and characterising the consequences of genetic selection on the lactational cycle in body lipid reserves. These issues are discussed.

Key Words: Lipid mobilisation, Lactation, Energy

31 Serum insulin-like growth factor 1 and placental lactogen profiles in Holstein nulliparous and multiparous cows in early gestation. W. J. Weber^{*1}, C. R. Wallace², H. Chester-Jones¹, and B. A. Crooker¹, ¹University of Minnesota, St. Paul, ²University of Maine, Orono.

A positive relationship between serum insulin-like growth factor (IGF-1) and placental lactogen (bPL) in dairy cattle suggests that the increase in bPL may contribute to an increase in IGF-1 during gestation. However, this relationship is not well established. Objectives of this study were to examine the relationship between serum bPL and IGF-1 in nulliparous and multiparous Holstein cows in early gestation. Blood samples from nulliparous (n=17) and multiparous (n=15) cows were collected (\pm 3d) at 56, 70, 84, 98, 112, 140 and 168 d of gestation. Multiparous cows were less than 200 days in milk when sampling was initiated. Serum samples were analyzed for IGF-1 and bPL by RIA. Data were analyzed as repeated measures using PROC MIXED and results reported as least squares means. Means were considered different when $P < 0.05$. Serum bPL was less in nulliparous than multiparous cows ($0.16, 0.31 \pm 0.03$ ng/ml) and increased from d 56 to 168 of gestation ($0.11^a, 0.15^b, 0.19^{bc}, 0.20^c, 0.26^d, 0.31^e, 0.43^f \pm 0.03$ ng/ml). The rate ($2.7 \mu\text{g}\cdot\text{ml}^{-1}\cdot\text{d}^{-1}$) and overall (0.32 ng/ml) increase in bPL was similar for both parities from d 56 to 168 of gestation. Serum IGF-1 was greater in nulliparous than multiparous cows ($231, 115 \pm 5.0$ ng/ml) and increased from d 56 to 168 of gestation ($164^a, 167^a, 168^a, 165^a, 174^{ab}, 182^{bc}, 191^c \pm 5.2$ ng/ml). Although there was no interaction, the increase in IGF-1 in multiparous cows (35 ng/ml, 33%) was greater than in nulliparous cows (20 ng/ml, 9%) during this 122 d interval. From 56 to 98 d of gestation, serum bPL and IGF-1 in multiparous cows were relatively stable but both began to increase by d 112 and continued to increase through d 168 of gestation. The greater IGF-1 concentration in nulliparous cows made this relationship less apparent. The strong relationship between bPL and IGF-1 during early gestation supports the concept that bPL may play a role in regulating serum IGF-1.

Key Words: Gestation, IGF-1, bPL

32 Detecting beta-casein and beta-lactoglobulin variants using real-time PCR taking advantage of single nucleotide polymorphisms in milk cell DNA. Ralf Einspanier^{*1}, Andreas Klotz¹, Johann Buchberger², and Ingolf Krause², ¹Institute of Physiology TU Munich Germany, ²Institute of Chemistry TU Munich Germany.

In cattle several genetic variants for the beta-casein and the beta-lactoglobulin locus have been described. With regards to a possible selection of genotypes being favorable to cheese making, we have applied a new technique (real-time-PCR) to determine the main genotypes of bovine beta-LG and beta-CN variants. The aim of this study was to rapidly detect genetic variants of beta-casein (beta-CN A1, A2, B) and beta-lactoglobulin (beta-LG A, B, C, D) directly from milk. Through introducing non-invasive and faster methods it appears advantageous to use milk cells instead of other DNA sources like blood. After the initial characterization of distinct mutations in the genome using PCR amplification, deduced proteins were verified by isoelectric focusing of corresponding milk samples. Furthermore, a partial nucleotide sequence of the beta-LG-gene D, containing allele-specific point mutations, could be determined. For beta-CN allele-specific mutations occur at amino acid residue 67 and 122, whereas for the beta-LG variants specific mutations occur at amino acid residues 45, 59, 64 + 118. Based on specific PCR fragments generated from milk cell DNA, genotyping of alleles of beta-CN and beta-LG or admixtures becomes efficient and simultaneous. Hence, a real-time PCR approach (LightCycler) was established specifically distinguishing three important beta-CN milk protein variants with remarkable benefits when compared to other DNA-based mutation detection systems. As a consequence, genotyping of cattle will become more easily and faster through introducing this new technique.

33 Effect of contact time between calves and cows on IgG transfer, cortisol release, milk yield and residual milk. F. A. Paiva, A. R. Bueno, A. Saran-Neto, M. S. Freiria, and J. A. Negro^{*}, USP/FZEA, FAPESP, Pirassununga/SP, Brazil.

At parturition, cows and calves remain in contact for several hours and this period is essential for adequate absorption of IgG and for survival of neonates. During extended contact time, cows become selective and take longer to adapt to milking. Our objective was to verify if contact

time between cows and calves could influence IgG transfer and milking adaptation. Thus, 18 Holstein cows and their calves were divided into 3 groups: SC group (short contact); cows and calves remained 6 h in contact, PC group (periodic contact); cows and calves were brought together twice/day for 30 min and LC group (long contact); cows and calves remained in contact for 3 days. Following, cows and calves of the SC and LC groups were definitively separated. After separation, all calves received 4L of colostrum/day. All groups were submitted to 2 milkings/day, without calves. Blood samples were taken once a day from cows and calves, from parturition to 4 days post-parturition. Milk yield and residual milk were measured on days 4, 15 and 30 of lactation. Cortisol (CORT) level was measured using EIA kit (dslabs, Inc) and IgG level was determined by radial immunodiffusion. After parturition, all cows had similar levels of IgG. Before separation, LC calves presented lower CORT levels than other calves but after separation, LC calves had a higher increase in CORT levels than PC calves. CORT profiles of cows were similar, however LC cows exhibited higher CORT levels after separation than PC and SC cows. During first milkings, SC and PC cows produced more milk (19.5 ± 1.1 L and 19.2 ± 0.5 L, respectively) than LC cows (16.5 ± 5.6 L). On day 4, residual milk was higher for LC and PC cows (6.53 ± 0.7 L and 5.6 ± 0.4 L, respectively) than for SC cows (2.0 ± 0.2 L). On days 15 and 30, milk yield and residual milk were similar for all groups. Our results indicate that IgG transfer was adequate to all calves, and that adaptation to milking was not influenced by contact time between cows and calves.

Key Words: Milk ejection, Milk residual, Cortisol

34 Prolactin receptor expression responds to photoperiod similarly in multiple tissues in dairy cattle. T. L. Auchtung^{*1}, B.C. Pollard¹, P.E. Kendall¹, T.B. McFadden², and G.E. Dahl¹, ¹University of Illinois, Urbana, IL, ²University of Vermont, Burlington, VT.

Photoperiod (PP) influences circulating prolactin (PRL) concentrations in cattle. Prolactin exerts its effects through its receptor, which has two isoforms in the bovine. Therefore, it is likely that PP also has an effect on PRL receptors (PRLR), which are present in many tissues of the body. The objective of this experiment was to identify the effect of photoperiod on PRLR expression in multiple tissues of dairy cattle. Holstein steers (n = 10) were maintained on either long day photoperiod (LDPP; 16 h light: 8 h darkness) or short day photoperiod (SDPP; 8 h light: 16 h darkness) for 9 wk, then photoperiod treatments were reversed for four weeks. Liver tissue was obtained via biopsy at 2-wk intervals throughout the 13 wk experiment. Lymphocytes were isolated from blood collected on heparin at four times during the experiment. Density gradient centrifugation of the buffy coat through Histopaque-1077 was followed by washing of cells with RPMI-1640 cell growth media. Mammary tissue was collected via biopsy at the end of the experiment. Isolation of RNA from all tissues was performed using Trizol reagent and RNA was converted to cDNA prior to real-time PCR. Concentrations of plasma PRL, measured by RIA, were greater ($P < 0.05$) in LDPP than SDPP animals. Compared to LDPP, SDPP increased ($P < 0.01$) expression of PRLR mRNA in liver at Week 5, and responses to photoperiod at Week 13, four weeks after the treatment reversal, were similar to those at Week 5 ($P < 0.05$). Lymphocyte responses were similar, with SDPP increasing PRLR mRNA expression significantly ($P < 0.05$) over LDPP, both before and after the treatment reversal. Expression of PRLR mRNA in mammary tissue was also increased ($P < 0.01$) in SDPP animals relative to LDPP. In summary, PRLR mRNA expression in liver, mammary, and lymphocytes is increased in animals on SDPP treatment as compared with LDPP. Expression of PRLR in lymphocytes provides a minimally invasive method to monitor PRLR expression in multiple tissues.

Key Words: Cattle, Prolactin Receptor, Photoperiod

35 Possible role of enterolactone on mammary development and lactation in cattle. S Purup, M Vestergaard, MR Weisbjerg, T Hvelplund, and K Sejrsen^{*}, Danish Institute of Agricultural Sciences, Foulum.

The lignan enterolactone (Enl) is produced by microbial fermentation of the phyto-estrogens secoisolariciresinol (Seco) and matairesinol (Mata) in the gastro-intestinal tract. Seco and Mata occur as glycosides in wholegrain cereals, seeds, nuts, vegetables and berries. The objective of the present study was to measure the concentration and bioactivity of

Enl in milk and blood and to investigate the effect of Enl on proliferation of mammary epithelial cells in culture. Blood and milk was collected from 35 dairy cows fed diets either with grass-clover silage or whole-crop barley silage as the main roughage. Concentrations of Enl in whey and serum was measured by TR-IFMA. Bioactivity of whey and serum was studied in mammary epithelial cells isolated from prepubertal heifers and cultured in collagen gels for 5d. Proliferation of epithelial cells was determined during the final 24 h of culture using [methyl-³H]thymidine incorporation as a measure of DNA synthesis. The effect of Enl on mammary epithelial cell proliferation was investigated by addition of Enl in concentrations of 10-100,000 ng/ml. Concentrations of Enl were 1.84 and 2.40 ng/ml ($P < 0.10$) in whey and 177 and 249 ng/ml ($P < 0.01$) in serum from dairy cows fed diets based on grass-clover silage and whole-crop silage, respectively. Whey or serum added to mammary epithelial cells in concentrations of 0.5-10% in culture medium showed no significant differences in cell proliferation due to silage type. The effect of Enl added to cell culture medium on mammary epithelial proliferation was biphasic. Enl at low concentrations (10 and 100 ng/ml) stimulated proliferation slightly (approximately 15%; $P < 0.06$ and $P < 0.05$, respectively), whereas higher concentrations ($> 10,000$ ng/ml) strongly inhibited ($P < 0.01$) cell proliferation. Maximal inhibition at 100,000 ng/ml corresponded to a 97% inhibition ($P < 0.001$) of mammary cell proliferation. It is suggested that phyto-estrogens such as Enl may have a role in mammary development and lactation in cattle.

Key Words: Enterolactone, Mammary Cells, Cattle

36 Effects of omitting one milking per week on milk yield, milk composition and udder health of dairy cows. M. Ayadi¹, G. Caja^{*1}, X. Such¹, E. Albanell¹, M. Ben M'Rad², and R. Casals¹, ¹Universitat Autònoma de Barcelona, Spain, ²Institut National Agronomique de Tunisie, Tunisia.

Five Holstein dairy cows (milk yield: 21.0 ± 3.4 l/d; 227 ± 67 DIM) were used for 10 weeks to study the effect of omitting one milking per week (Sunday afternoon) throughout lactation on milk yield, milk composition and udder health. Cows were milked twice a day (8.00 and 18.00 h) but on Sunday one milking only was performed at 12.00 h. Milk yield from each milking was recorded. Milk samples were taken individually from each milking to analyze milk composition and somatic cell count (SCC). Average milk yield and composition for Friday and Saturday were used as reference values to evaluate the effect of changing the milking frequency. Milk yield and milk composition did not vary ($P > 0.14$) during the experimental weeks, but SCC increased with lactation stage. On Sundays, milk yield (15.6 l/d), fat content (3.38%) and log SCC (2.59) decreased by 29, 21 and 27% ($P < 0.05$), respectively, as a result of omitting one milking. On Mondays, milk yield (23.9 l/d), fat content (4.84%) and log SCC (3.02) increased by 9, 14 and 100% ($P < 0.05$), respectively. The raise in SCC was dependent on the previous levels. All values reached the average level by Wednesday. Milk

protein (3.47%) increased by 2% and lactose (4.37%) decreased by 2% ($P < 0.05$) by Saturday. Compared with estimated values for 14 milkings/week, omitting one milking per week decreased the weekly yields of milk (3%), fat (4%), protein (5%) and lactose (5%), but milk SCC increased by 25%. Milk yield loss varied according to the cow's yield but not to lactation stage. Clinical mastitis was not observed in any cow at any time. We conclude that omitting one milking per week could be an adequate strategy to reduce farm labor (7%) without important losses in milk yield in farms with low milk SCC values. Official milk recording should be conducted in the middle of the week to avoid residual effects from the milking omission. An improvement in the farmer's quality of life is also expected.

Key Words: Milking Frequency, Milking Suppression, Milk Composition

37 Effects of conjugated linoleic acid (CLA) on milk fatty acid profiles and activities of lipogenic enzymes in the mammary gland, liver and adipose tissue of lactating rats. A. A. Hayashi^{*1}, S. R. Medeiros², and D.P.D. Lanna¹, ¹ESALQ/ USP/ SP, Brazil, ²Embrapa /Gado de Corte/ MS, Brazil.

The objective of the present study was to evaluate the effects of feeding a mixture of CLA isomers on milk fatty acid profiles and the activities of lipogenic enzymes in lactating rats. Dams were fed either a control diet or a diet supplemented with 2.5% of calcium salts of CLA-60 from parturition to the 15th day post-partum. The CLA-60, (Church & Dwight, Princeton, NJ) contained different isomers of CLA (24% c/t 9,11; 35% t,c 10,12; 15% c,t 8,10; 17% t,t 11,13 and 9% others). On the 15th day post-partum, the rats were anesthetized, milked and killed by exsanguination. Mammary gland, liver and adipose tissues were immediately freeze-clamped for subsequent assays of activities of enzymes involved in lipid synthesis. Pups growth were decreased by CLA ($P < 0.01$) and concentration of 12:0 to 16:0 fatty acids in the milk of CLA-fed rats were lower compared to the control. The Fatty acid synthase (FAS) activity was decreased by CLA in the mammary gland, adipose tissue and liver (by 43%, $P < 0.01$, 56%, $P < 0.01$ and 68%, $P < 0.01$ respectively). The activities of Glucose-6 phosphate dehydrogenase (G6PDH) and 6-phosphogluconate dehydrogenase (6PGDH) were decreased in all three tissues, by 35%, $P < 0.01$; 36%, $P < 0.05$ and 65%, $P < 0.05$ for G6PDH, and by 28%, $P < 0.01$, 22%, $P = 0.10$ and 53%, $P < 0.01$ for 6PGDH, for mammary, adipose and liver tissues respectively. In contrast, NADP malate dehydrogenase enzyme activities were unchanged by CLA supplementation to the diet in all tissues. Thus, CLA altered processes associated with de novo fatty acid synthesis. Furthermore, the reduction in the activities of these enzymes, with CLA treatment, was consistent with changes in milk fatty acid profiles, and similar to observations of feeding calcium salts of CLA-60 to lactating cows.

Key Words: Conjugated linoleic acid, Lactation, Lipogenesis

Forages and Pastures

The J. W. Thomas Forage Symposium: A Discussion on Silage Fermentation Issues

38 Microbiology of silage. Thomas Rehberger^{*1}, ¹Agtech Products, Inc, Waukesha, WI.

Silage is one of the largest microbial fermentation products with an estimated 102 million tons of corn silage alone made in the United States annually. Silage is a natural process-utilizing native, and in some instances inoculated, lactic acid bacteria for the preservation of crops. The microbiology of the dynamic process of ensiling will be discussed in context of the four phases of the ensiling process: aerobic, fermentation, stable and feedout. Emphasis will be placed on how management practices impact the microbial ecology of silage. The stability of silage during feedout depends on the surviving microorganisms during the aerobic, fermentation and stable phases and their production of organic acids from the plant carbohydrates during these phases. The importance of the homofermentative and heterofermentative lactic acid bacteria in controlling the major spoilage organisms for each of the major silage crops will be discussed. New plant varieties and crop processing techniques impact the availability of plant nutrients and offer new challenges for maintaining quality silage. Recent advances in molecular biological techniques utilizing PCR amplification of regions within the 16s rDNA gene will provide

a better understanding of the complex microbial ecosystem of silage and provide new insights into producing quality silage.

Key Words: silage, microbiology, lactic acid bacteria

39 The history and future of silage inoculants. Limin Kung, Jr.^{*1}, ¹The University of Delaware.

Silage fermentation is a result of many interactions between microorganisms. Adding microorganisms in hopes of improving the fermentation process was practiced in the early 1900s. Intensive research began in the 1960s and widespread commercialization followed in the late 1970s. Homolactic acid bacteria (e.g. *Lactobacillus plantarum*) were the primary organisms of choice because of their high theoretical efficiency of fermenting sugars to lactic acid. Early research yielded variable results because of low application rates and poor shelf life. In addition, not all of these organisms were rapid growers. The evolution of inoculants with other homolactic bacteria (e.g. *Enterococcus* or *Pediococcus* sp.) followed with marked improvements in application rates (minimum of 100,000 cfu/g of fresh forage) and manufacturing (e.g. fermentation, freeze drying, packaging and moisture scavengers). One drawback of

using only homofermentative bacteria is that they often make aerobic stability worse because the production of antifungal end products is usually suppressed. Species of propionibacteria were introduced as silage inoculants in the late 1980s in hopes of producing propionic acid and alleviating this problem but have met with limited success. Over the last 15-20 y, researchers have studied the application of killer yeasts to improve aerobic stability, bacteriophages to inhibit clostridia, and incorporation of cellulase genes into lactobacilli for improved fiber digestion in silage, but these applications have not been commercialized. Recently, identification of *L. buchneri* by Muck (1996) has led to a new paradigm to improve the aerobic stability of silages. This organism, is a heterolactic bacterium that can anaerobically convert lactic acid to acetic acid, 1,2 propanediol and ethanol and has made us reevaluate the theory of only using homolactic acid bacteria as silage inoculants. The dynamic nature of silage fermentation provides an open canvas for future research which may include identification of organisms that produce bacteriocins and antifungal compounds or that may have direct-fed microbial activity in the rumen.

Key Words: Silage, Inoculant, Fermentation

40 The end products of silage fermentation and their relationships to animal performance. Richard Muck*¹ and Limin Kung, Jr.², ¹USDA, ARS, US Dairy Forage Research Center, ²University of Delaware.

Analysis of silages for fermentation products is now possible on a routine basis, but how useful are these analyses as predictors of animal performance? The commonly reported silage fermentation end products are lactic acid, the volatile fatty acids (VFA; acetic, propionic and butyric), and ethanol. All but butyric acid can be produced by least two groups of common fermentative silage microorganisms (lactic acid bacteria, enterobacteria, clostridia, yeasts). This multiplicity of sources for a given product can complicate the interpretation of a fermentation profile for a given silage. Fermentation by any of these microorganisms usually results in an increase in the energy density of the silage compared with the fresh crop because dry matter losses from fermentation generally are greater than the accompanying energy losses. However, ensiling does not improve animal performance compared with the fresh crop. The reduction in performance has been attributed principally to two factors: reduced rumen microbial fermentation and reduced intake. The VFAs in silages are a source of energy for the cow but not for rumen microorganisms. Ethanol is poorly fermented in the rumen. Thus a ration high in VFA might be expected to produce less microbial protein than one low in VFA. Studies of silage inoculants where fermentation has been shifted from VFA production to lactic acid do show trends toward improved nitrogen efficiency, but effects are small. Reduced intake has been observed in silages high in fermentation products, particularly butyric acid, acetic acid and ethanol. However, addition of these acids to good silages has not reduced intake or performance. Also inoculating silage with heterofermentative lactic acid bacteria has not reduced animal performance even when the resulting silages had acetic acid concentrations above 5% dry matter. These results suggest that the dominant microorganisms in a silage affect animal performance through mechanisms other than the major end products of fermentation. Thus, fermentation product analyses are not necessarily accurate forecasters of animal performance but can be very useful in both troubleshooting performance problems and developing practical solutions to those problems, as will be discussed.

Key Words: Silage, Fermentation, Performance

41 Improving protein utilization in silages to increase animal performance and reduce environmental burden. Ed Charmley*, AAFC Crops and Livestock Research Centre, Nappan, NS, Canada.

Silage normally contains between 12 and 22 % crude protein (CP). While such levels should be adequate for most productive livestock, in silages they are not. This is because of poor utilization of N in silage. Most silage-based production rations require supplemental protein to meet requirements for growth or lactation in ruminants. Silage protein is highly degradable in the rumen and as such is a poor supply of dietary protein and peptides to the small intestine. The situation is exacerbated by a scarcity of available energy in the rumen which limits microbial protein synthesis. Associated with poor utilization of silage N by ruminants are concomitant high losses of silage N to the environment. Poor utilization of silage N by ruminants is attributed to proteolytic activity by crop enzymes shortly after harvest and further microbial breakdown of protein during ensilage. The production of low molecular weight nitrogenous compounds, including ammonia, amines and amides, has a negative effect on voluntary intake of silages. This appears to relate to an ammonia burden in the blood stream as well as specific appetite suppressing characteristics of certain compounds. The poor utilization of silage N in combination with lower voluntary intake of silages can seriously limit ruminant production. Availability of protein supplements is likely to be reduced in future, making it more important than ever to maximize the use of the protein in forages and particularly silage. Methods to improve silage protein utilization exist, including improved crop drying rates, use of microbial and chemical additives and use of, or selection for, crops having characteristics that reduce protein solubility. In future, the emphasis will move away from additives and towards plant breeding and management practices. The ultimate goal will be to use ensiling technology to improve upon the protein quality characteristics of the original crop, thus tailoring the protein characteristics of the silage with the requirements of the animal.

Key Words: Silage, Protein utilization, Animal performance

42 Reflections and concluding remarks. J.W. Thomas*, Michigan State University.

Titles of abstracts and symposia about forages in 2002 are somewhat similar to those of the 1950s and 1960s. This similarity disappears when one examines the complexity and significance of the contents, the results and the discussions of current presentations. Silage microbiology has progressed from attempting to identify the bacteria to using strains of desirable bacteria as inoculants to improve silage quality and decrease losses. Chemical changes during ensiling are being directed to make a more nutritious product and to improve animal performance instead of merely identifying and characterizing these chemicals. When optimum end products are identified, modified organisms could be used as inoculants. Procedures that can be economically viable in large animal facilities have been developed in place of those used in smaller units. For instance, we evaluate silage in bunker silos rather than small cement stave silos and large hay bales not 40 lb. bales. We evaluate forages for large groups of cows using total mixed rations not a forage for individual cows. All this has been accomplished by the innovative and cooperative efforts in the research by academic staff, graduate students and industry personnel. My investigations involved over 23 faculty and 59 students in the areas of forage harvesting, storing and feeding practices.

Key Words: Silage inoculants, Silage chemistry, Forages

Physiology Improving Reproductive Efficiency with Hormone Treatments

43 Optimization of timed insemination programs and integration with bST to increase pregnancy rates in lactating dairy cows. W. W. Thatcher*¹, L. Badinga¹, S. M. Pancarci¹, F. Moreira¹, R. Pershing¹, A. Guzeloglu¹, T. R. Bilby¹, S. Kamimura¹, and J. Santos², ¹University of Florida, Gainesville, FL, USA, ²University of California, Davis, CA, USA.

Ovsynch permitted timed insemination with normal fertility. Pregnancy rate of cyclic cows was increased ~20% with a pre-synchronization program of two PGF_{2α} injections 14 days apart and initiation of the

Ovsynch program 12 days after the 2nd PGF_{2α}. This enhancement in fertility is associated with placement of cows in early diestrus (i.e., d5-10) at initiation of Ovsynch to avoid early metestrus and late diestrus. Following pre-synchronization with PGF_{2α}, ECP has provided alternative systems for timed insemination (Heat Synch: GnRH[d0]-PGF_{2α} [d7]-ECP[d8;1mg]; Double ECP: ECP[d0; 2mg]-PGF_{2α} [d10]-ECP[d11;1mg]) with pregnancy rates comparable to Ovsynch. Strategies to enhance embryonic development and survival include injection of bST (Posilac, 500 mg) at the time of insemination within a Pre-synchronization/Ovsynch program that increased pregnancy rates

~17%. In vitro studies indicated that both bST and IGF-I reduced frequency of unfertilized oocytes and stimulated embryonic development to the blastocyst stage. Lactating dairy cows received +/- bST (500 mg, Posilac) at 16 h after the 2nd GnRH of Ovsynch and were sacrificed at either d 3 or d 7 post-ovulation to examine oviductal and uterine genes of the IGF system. In bST-treated cows, levels of IGF-II mRNA were higher (+ 250%) in oviducts but lower in uteri (- 60%; $P < 0.05$) than control cows. Regardless of site or stage, IGFBP-3 mRNA levels were higher (+ 125%) in bST-treated cows. At D7 of the estrous cycle, GHR mRNA was decreased (- 30%) in bST-treated cows. Oviductal IGF-I luminal contents did not change; whereas, uterine IGF-I luminal contents increased ($P < 0.01$) between d 3 and 7, and were higher in bST-treated cows. In multiparous non-lactating dairy cows, bST treatment reduced pregnancy rates (19% < 60%) at d 17 based on presence of a conceptus. BST fertility responses are likely to involve both direct as well as complex and tissue specific regulation of IGFs and IGFBPs within both the embryo and reproductive tract and may be sensitive to lactational status.

Key Words: bovine somatotropin, timed insemination, embryo

44 Use of CIDR-B for regulating reproduction. Reuben J. Mapletoft*¹ and John P. Kastelic², ¹University of Saskatchewan, Saskatoon, SK Canada, ²AAFC, Research Centre, Lethbridge, AB Canada.

Our knowledge of the physiology of the bovine estrous cycle has expanded greatly in recent years, primarily because of the use of ultrasonography to observe ovarian changes and follicular wave dynamics. With this new knowledge has come new methods of manipulating and controlling ovarian function. The use of CIDR-B devices for the synchronization of estrus in cattle is now well accepted throughout the world; in fact, Canada and the USA are two of the last countries to have CIDR-B devices available for use in bovine practice. The use of CIDR-B devices along with other hormone products, such as GnRH and pLH, has permitted fixed-time AI with high pregnancy rates in the beef herd. Recent research, such as that with the use of estradiol along with CIDR-B devices, offers new and exciting ways that we may be able to manipulate the bovine estrous cycle. Experiments described in this report demonstrate several different methods of eliminating estrus detection permitting fixed-time AI in heifers and lactating beef cows with highly acceptable pregnancy rates. Recent data suggest that steroid hormones readily available on the veterinary pharmaceutical market such as estradiol cypionate (ECP) and injectable progesterone can be successfully used to synchronize follicular wave emergence and ovulation

in a CIDR-B-based fixed-time AI program. Various other approaches will be discussed including the synchronization of recipients used in embryo transfer and the resynchronization of animals not conceiving to the fixed-time insemination.

Key Words: Bovine, Reproduction, CIDR-B

45 A review of methods to synchronize estrus in postpartum beef cows and replacement beef heifers. D.J. Patterson*, F.N. Kojima, and M.F. Smith, *University of Missouri.*

This review will consider methods currently available to control estrous cycles of postpartum beef cows and replacement beef heifers. Development of methods to control the estrous cycle of the cow has occurred in five distinct phases. The physiological basis for estrus synchronization followed the discovery that progesterone inhibited preovulatory follicular maturation and ovulation. Regulation of estrous cycles was believed to be associated with control of the corpus luteum, whose life span and secretory activity are regulated by trophic and lytic mechanisms. Phase I included efforts to prolong the luteal phase of the estrous cycle or to establish an artificial luteal phase by administering exogenous progesterone. Later, progestational agents were combined with estrogens or gonadotropins in Phase II; whereas Phase III involved prostaglandin F_{2α} (PG) and its analogs as luteolytic agents. Treatments that combined progestational agents with PG characterized Phase IV. Precise monitoring of ovarian follicles and corpora lutea over time by transrectal ultrasonography expanded our understanding of the bovine estrous cycle and particularly the change that occurs during a follicular wave. We now know (Phase V) that precise control of estrous cycles requires the manipulation of both follicular waves and luteal lifespan. This review will include specific discussion of progestins, PG, and gonadotropin-releasing hormone (GnRH) and the various combinations of these hormones or their analogs being used to more precisely control the interval and timing of estrus following treatment. The review will also address the potential benefits of these treatments in eliciting response among periparturient heifers and anestrous cows, and point to the flexibility in matching specific protocols with the particular beef management system involved. The review will conclude with a discussion of recent advances in the development of economical methods of artificially inseminating beef cows and heifers at a fixed time with high fertility, which would potentially result in a dramatic increase in the adoption of AI in beef herds.

Key Words: Estrus Synchronization, Beef Cattle, Artificial Insemination

Swine Species Value-Added Pork Products for 21st Century Consumers

46 Economic analysis of production factors important in developing value-added pork products. R. L. Plain*¹, ¹University of Missouri - Columbia.

Value-added agriculture has become a topic of great interest among farmers. Many hog producers are excited about the potential to add value to their hogs through non-traditional marketing arrangements. There are three general approaches to value-added pork: through niche markets, through commodity markets and through vertical integration. Adding value to pork by marketing through a niche is based on selling the product to consumers at a premium over what is charged for commodity pork. Consumers are willing to pay this premium if they perceive there is greater value in the niche market product. The source of this enhanced value is frequently associated with one of three areas - environmental (the pork is better for the environment or the animal, e.g. pasture produced pork), health (the pork is better for the consumer, e.g. organic pork), or social (the pork is better for the community, e.g. family or locally produced pork). Adding value to pork when marketing through a commodity market is based on producing an animal that has greater value to the packer. This added value may arise from some trait of the hog (e.g. leaner, less PSE) or of the transaction (e.g. volume sales or scheduled delivery) between the producer and the packer. The third approach to value added pork involves forward integration of the hog producer in the pork chain. Many hog producers are investigating the potential to slaughter, process and distribute the pork from their hogs. This interest arises from the belief that they can market their pork at a

higher price through a niche or that they can capture some of the profits being earned by the firms in the middle of the pork chain. Whether marketing value-added pork through a niche, a commodity market or more directly to consumers, the added value must be greater than the additional cost in order to be profitable.

Key Words: Pork production, Value-added, Economic analysis

47 Breeding and genetics in the evolving swine industry. J.A.B. Emsley*, *PIC, Franklin KY, USA.*

Over the last forty years, the 20th century consumer has benefited directly in lowered cost of pork because of improved productivity and efficiency of the swine production industry. Technology developments, including powerful statistical methods and faster computers, have permitted an increasingly comprehensive approach to genetic improvement at the macroscopic level. Results include 33% less feed to the same weight and 33% more lean. Tools that probe the sub-microscopic level of the swine genome now offer the added precision and fine-tuning needed to navigate customized genetic pathways that yield, at lower cost, food of the kind and quality that consumers will demand and pay for in the next forty years, into the 21st century. Knowledge of gene action and gene-gene interaction offers promise of direct means of improvement in disease resistance, animal well-being, meat quality and human health. Food marketers will ensure that, from these technical gains, a variety of pork products will result. Industry demands for tailored

genetic decision-making deeper into the pork chain will call for extraordinary skill and experience. GMO will continue to be examined as an option while society debates the risks and benefits. Driving the revolution in healthy genetic improvement efforts are the following factors: consumers are likely to want from their food more health-enhancing qualities, safety, convenience and value; industry integration of linked sectors will call for genetic decision-makers to optimize weightings on many measures throughout the pork chain, from reproduction to food processing; confidence in the food supply will necessitate traceability at low cost; selection decisions will increasingly need to factor in any interactions between genotype and environments, intrinsic and extrinsic; technology will continue to refine functions in all sectors of the pork chain and offer more control; DNA testing costs per data point will decrease substantially; accrued knowledge about genes and their effects will increase geometrically; capabilities in information processing will continue to increase dramatically; breeding decisions will require close integration of input from several disciplines.

Key Words: Swine Industry, Healthy Genetic Improvement, Technology

48 Evaluating the functional quality of pork. Eric Berg*, *University of Missouri-Columbia*.

Pork quality can be characterized by level of freshness, wholesomeness, grade, color (appearance), eating satisfaction or processing attributes (functionality). Many factors influence pork quality characteristics: 1)

genetics; 2) nutrition; 3) growth promotants 4) pre-slaughter handling and transportation; 5) immobilization (stunning procedure); 6) dehairing; 7) post-slaughter handling; and 8) packaging and storage. Early postmortem measurement of pH and temperature are common measurements taken to identify potential meat quality problems, yet these easily obtained measures do not quantify the specific factors that affect pork functionality (use in further processed or value-added products) and (or) consumer acceptance (retail marketability). The CIE L*, a*, b* scale was designed to represent the human perception of color and has been used to evaluate fresh pork color and incorporated into computerized vision analysis systems that identify and sort acceptable and unacceptable colored lean. Early fiber-optic probe (FOP) instruments developed to predict the functional component of pork (water holding capacity; WHC) were totally dependent on the marginal relationship between fresh pork color and WHC. More recently, FOP probes operating in the near infrared (NIR) region of the color spectra have been developed to quantify glycolytic potential or collagen content of fresh pork. Due to the large number of factors that can influence pork quality and the marginal predictive ability of the more commonly used predictors (pH and color), development or identification of electronic equipment used to measure pork quality must account for, or attempt to quantify, functional meat quality from basic meat biochemical, physiological, molecular, and (or) structural factors that ultimately influence the appeal of pork.

Key Words: pork, quality, electronic equipment

Graduate Paper Competition CSAS Graduate Student Competition

49 Variation in phytate content in Ontario soybean samples. S.D. Leech* and C.F.M. de Lange, *University of Guelph, Guelph, Ontario*.

Characterization of phosphorus (P) content and phosphorus availability in feed ingredients is critical for addressing feeding costs and impacts of animal production on the environment. In feedstuffs for monogastric animals, phosphorus availability is inversely related to the proportion of phosphorus present in the phytate form (% phytate P). The objectives of this study were to identify variation in total P and phytate content among Ontario soybean samples cultivated under typical management conditions, and to explore rapid indicators of phytate content. A total of 108 samples were analyzed: 58 samples representing 13 varieties and 13 growing locations in 1999; 50 samples representing 12 varieties and 12 growing locations in 2000. Nine subsets of samples from varieties grown at various locations allowed an assessment of the effects of location, variety and year on total P and phytate content. Analysis for P and phytate contents were conducted according to AOAC procedures and checked for repeatability and accuracy using potassium phosphate and sodium phytate standards. Total P content (%) averaged 0.55 (SD 0.08) in 1999 and 0.61 (SD 0.09) in 2000; phytate content (%) averaged 1.07 (SD 0.20) in 1999 and 1.27 (SD 0.26) in 2000; % phytate P (%) averaged 54.7 (SD 4.6) in 1999 and 57.9 (SD 5.1) in 2000. Location and year effects were observed in the majority of sample subsets for total P and phytate content ($P < 0.05$), but not for % phytate P. Variety effects on these three measures were absent ($P > 0.05$) in most sample subsets. Location and variety effects explained a large proportion of the variation in total P ($R^2 > 0.75$), phytate content ($R^2 > 0.72$) and % phytate P ($R^2 > 0.44$). A strong correlation existed between total P and phytate content ($R^2 = 0.87$; $SEE = 0.09$). Considerable variation in total P and phytate content was observed among Ontario soybean samples with differences largely attributable to location effects.

Key Words: Phosphorus availability, Phytate, Soybeans, Monogastric animals

50 Effect of supplementing corn-soybean-based diet with microbial phytase and organic acid in young pigs. F. O. Omogbenigun*, B. A. Slominski, and C. M. Nyachoti, *University of Manitoba, Winnipeg, MB*.

An in vitro assay and a 4-wk growth trial were conducted using 96 pigs weaned at 181 d to study the effect of microbial phytase (MP) and organic acid (OA) addition on nutrient digestion and growth performance. Four diets; positive control (formulated according to NRC, 1998; D1),

negative control (D1 without inorganic phosphorus [P]; D2), D2 + phytase (500U/kg; D3), and D3 + OA (D4) were used. In the in vitro assay, diet samples were incubated under simulated gut conditions to determine phytate hydrolysis. Addition of MP increased ($P = 0.003$) phytate hydrolysis by 54.5% over D1; this was further increased by 2.9% by adding OA. In the growth trial, each diet was randomly assigned to six replicate pens each with 4 pigs balanced for initial BW and sex. ADFI, ADG, and FCE were determined weekly. Six pigs per treatment were killed at the end of wk 4 to obtain ileal digesta, and the 3rd metatarsal bone from the hind right leg for nutrient digestibility and bone ash measurements, respectively. ADFI, ADG and FCE were similar among diets ($P = 0.79$), although ADG was 6.5% higher in pigs fed D4 compared to D1. Pigs fed D3 and D4 had a higher ($P = 0.003$) bone ash content than D1 fed pigs. Apparent ileal DM and CP digestibilities were similar ($P > 0.10$) among diets and averaged 80.7 and 79.4%, respectively. Of all amino acids (AA), only apparent ileal digestibility of isoleucine, histidine and aspartic acid were increased ($P < 0.05$) by MP and OA addition. Digestibilities of other AA were only numerically improved by MP and OA addition and that of essential AA averaged 79.4, 77.7, 80.1 and 81.6% for D1, D2, D3, and D4, respectively. Apparent ileal P digestibility was increased ($P = 0.0001$) and the amount of P excreted reduced ($P = 0.03$) by 19.9% due to MP + OA addition compared to D1. In conclusion, addition of MP and OA to pig starter diets improved P digestion and utilization and may also improve dietary AA utilization.

Key Words: Pigs, Microbial phytase, Organic acid

51 Utilization of apparent ileal digestible threonine intake for body protein deposition in the pig appears related to endogenous gut protein losses and microbial fermentation in the gut. C.L. Zhu*, Y. Yin, and C.F.M. de Lange, *University of Guelph, Guelph, ON, Canada*.

Previous studies showed that intake of soluble fiber (pectin) reduced utilization of apparent ileal digestible threonine (THR) intake for THR retention in body protein in pigs (from .87 to .79 at 0 and 120 g/kg diet pectin, respectively), while intake of insoluble fiber (cellulose) had little effect. The objective of this study was to relate THR utilization to aspects of digestion. Five barrows (16 to 46 kg BW), fitted with a simple T-cannula at the terminal ileum, were fed one of 5 experimental diets at 2.6 times maintenance energy requirements according to a 5 x 5 Latin square design. Pigs were adjusted to diets for 8 days prior to sampling feces and ileal digesta. Soybean and cornstarch-based diets were formulated with 0, 40, 80, 120 g/kg pectin or 80 g/kg cellulose, respectively, replacing cornstarch. At the distal ileum, flow (all in g/kg DM intake)

increased linearly ($P<.01$) with increasing diet pectin level for DM (133 to 218, SE 8), total THR (1.21 to 1.75, SE .09), endogenous THR (.68 to 1.54, SE .1; determined using the homo-arginine technique), NDF plus pectin (30.7 to 134.7, SE 5.2) and diaminopimelic acid (DAPA) (.097 to .203, SE .023). Intake of fecal digestible NDF plus pectin (71.4 to 192.7, SE 0.3) and fecal DAPA flow (.063 to .112, SE .008) increased linearly ($P<.01$) with diet pectin level. For the cellulose diet these values were: flows of ileal DM 212, total THR 1.30, endogenous THR 1.06, NDF plus pectin 75.35, DAPA .124; fecal digestible intake of NDF plus pectin 108.5, fecal DAPA flow .137. Across diets utilization of apparent ileal digestible THR was related most closely to ileal flow of endogenous THR ($R^2 = .90$) and NDF plus pectin ($R^2 = .95$), or to fecal digestible NDF plus pectin intake ($R^2 = .90$). Utilization of apparent ileal digestible THR intake appears related to both endogenous THR losses and microbial fermentation in the gut.

Key Words: Pigs, Threonine, Digestion

52 The optimal dietary level of vitamin B12 in gestating gilts. F. Simard*¹, F. Guay¹, J.P. Laforest¹, A. Giguere², C.L. Girard², and J. J. Matte², ¹*Universite Laval, Quebec, Qc, Canada*, ²*Agriculture and Agri-Food Canada, Lennoxville, Qc, Canada*.

Thirty-eight nulliparous Large-White x Landrace sows were randomly assigned to 5 dietary levels of vitamin B12 (B12) at 0, 20, 100, 200, and 400 ppb to evaluate, during gestation, the optimal level of dietary B12 on some aspects of B12 and homocysteine (Hcy) metabolisms as well as on reproductive performance. Hcy is a detrimental intermediate metabolite of the B12-dependent remethylation pathway of methionine. Treatments were applied for 2 estrous cycles before mating and throughout gestation. For all sows, the lactation diet contained 25 ppb of B12. Blood samples were collected from each sow, 7 times from initiation of treatments up to parturition, and thereafter, 4 times up to weaning (21 d). Liver samples were collected after slaughter at weaning. During gestation, plasma B12 increased (dietary B12 quadratic, $P<0.01$) with the levels of dietary B12. Average values (\pm SE) (pg/mL) were 71.8 ± 3.7 , 129.8 ± 4.9 , 171.4 ± 6.3 , 238.4 ± 6.0 , and 228.5 ± 8.5 for 0, 20, 100, 200 and 400 ppb of dietary B12. The maximal plasma B12 was estimated to be reached with 298 ppb of dietary B12 ($R^2=0.96$). These effects of gestation treatments persisted during lactation for plasma B12 (dietary B12 linear, $P<0.01$) as well as for liver B12 at weaning (dietary B12 quadratic, $P<0.04$). During gestation, plasma Hcy decreased (dietary B12 quadratic, $P<0.01$) with increasing levels of dietary B12. Litter size at parturition and weaning were influenced (dietary B12 quartic, $P<0.06$ and $P<0.02$, respectively) by dietary B12 during gestation. Litter size at parturition was 12.4 ± 0.5 for 100, 200 and 400 ppb vs 11.1 ± 0.8 for 0 and 20 ppb; the corresponding values at weaning were 10.9 ± 0.2 and 9.5 ± 0.7 . Treatment effects on litter weight at parturition were similar (dietary B12 quartic, $P<0.03$) to those on litter size, 17.4 ± 0.6 kg for 100, 200 and 400 ppb vs 15.3 ± 1.0 kg for 0 and 20 ppb. In conclusion, the dietary level of B12 required to maximize B12 status and minimize Hcy appears much higher (close to 300 ppb) than the level recommended by NRC (1998) of 15 ppb. The relevance of such high levels of dietary B12 for reproductive performance needs to be confirmed with a larger number of animals.

Key Words: Vitamin B12, Gestation, Gilts

53 Low protein diets can be fed to lactating sows with few adverse effects. D. J. McMillan*, S. Möhn, and R. O. Ball, *University of Alberta, Edmonton, Canada*.

The goal of feeding low protein amino acid (AA) supplemented diets is to reduce nitrogen excretion without reducing sow performance. We studied the effect of low protein AA supplemented diets on sow performance and nitrogen excretion for two consecutive parities. Eighty 2nd parity sows were fed either a conventional diet (HP) during lactation containing 19.3% CP or an isoenergetic diet containing 16.3% CP with added lysine and threonine (LP). Both diets met or exceeded all other nutrient requirements (NRC, 1998). Body weight of 2nd parity sows at farrowing was similar (206.8 kg, LP vs. 208.9 kg, HP). LP sows lost more weight from farrowing to weaning ($p = 0.004$) at 21 d. Sows receiving the LP diet consumed 500 g less per day during lactation than sows fed HP. Number of piglets born (11.22, LP vs. 11.20, HP), and weaned (10.42, LP vs.10.98, HP) were not significantly different. Average piglet weight at birth (1.37 kg, LP vs. 1.42 kg, HP) and weaning (6.22 kg, LP, vs. 6.38 kg, HP) were also not different. Wean to estrus

interval of 5.42 days (SEM 0.54) for LP sows was not different from HP sows (4.59 days, SEM 0.10). Third parity body weight of LP sows was slightly lower at farrowing (231.12 kg vs. 237.15 kg) but not significantly. Weight loss during the 3rd lactation was similar for both groups (4.94 kg, LP vs. 4.09 kg, HP). Feed intake for LP sows was 300 g per day lower than HP sows. Number of piglets born (12.18, LP vs. 12.32, HP), and average weight at birth and weaning were not different ($p > 0.1$). Number of piglets weaned was slightly different, with LP sows weaning 0.75 piglets less per sow ($p = 0.05$). Wean to estrus interval was not different (4.66 days, LP vs. 4.75 days, HP). Sow backfat measurements were not different at any stage. Calculated urinary nitrogen excretion was not different for 2 parities; LP sows excreted 30% less nitrogen during lactation than HP sows ($p < 0.01$). These results show that low protein diets can support similar performance of sows during lactation while significantly reducing nitrogen excretion.

Key Words: Low Protein, Sow, Lactation

54 Effects of sulphur amino acid (SAA) ratios and concentrations on the performance of weaned piglets. R.D. Harte*, A.K. Shoveller, R.F.P Bertolo, and R.O Ball, ¹*University of Alberta*.

Previously, we reported that the gut utilizes 35% of dietary methionine (MET) . The objective of this study was to investigate the interaction between ratio and total sulphur amino acid (TSAA) intake on growth performance and intestinal function and development in early-weaned piglets. 42, 10-d old piglets (3.7 kg SD=0.37) were weaned from the sow and housed in pairs for d 1-3. On d 4, piglets that had re-gained their weaning weight (3.7 kg SD=0.39) were randomly allocated to 1 of 7 test diets: diet 1(25% of MET requirement:25 CYS), diet 2(25:50), diet 3(50:25), diet 4 (50:50), diet 5(50:100), diet 6(100:50) and diet 7(100:100). The piglets received test diet for 7 d and daily feed intake, urinary nitrogen and body weights were recorded. On d 11, piglets were sacrificed and tissues were collected. The intake of excess CYS relative to MET acted to decrease piglet performance, both when MET intake was below requirement and when it was adequate. The intake of excess TSAA also decreased piglet performance. Piglet maximal performance was achieved when 100% TSAA requirement was fed at a 1:1 ratio of MET: CYS. Preliminary data indicates that both TSAA ratio and intake may influence some intestinal parameters.

Ratio	25:25	25:50	50:25	50:50	50:100	100:50	100:100	p		
%TSAA	50	75	75	100	150	150	200	diet	ratio	TSAA
ADG (g)	97	117	186	194	163	185	149	.001	.04	.002
ADFI (g)	140	127	191	197	174	184	181	.004	.02	.06
F: G	1.47	1.10	1.06	1.01	1.02	1.03	1.03	.0001	.85	.0001
NR(%)	70.2	65.5	77.7	84.5	84.1	83.6	78.8	.0001	.26	.0001

Key Words: Sulphur Amino Acids, Weaned Pigs, Growth

55 Fecal excretion of major odor-causing and acidifying compounds in response to dietary supplementation of chicory inulin extract in pigs. T. C. Rideout and M. Z. Fan, *University of Guelph, Ontario, Canada*.

Fecal excretion of major odor-causing and acidifying volatile compounds in response to dietary supplementation of chicory inulin extract was investigated with six Yorkshire barrows, average initial BW of 30 kg, according to a two-period cross-over design. Two diets, a control diet containing no inulin extract and a treatment diet with 5% inulin extract at the expense of cornstarch, were formulated to contain 16% CP from corn (51%) and soybean meal (29%). Each period lasted for 14 d with 10-d adaptation and 4-d collection of fecal samples. The fecal samples were analyzed for the following four major classes of odor-causing and acidifying compounds: 1) volatile fatty acids (VFA); 2) volatile sulfides measured as hydrogen sulfide (H₂S) unit; 3) nitrogen-containing compounds including ammonia (NH₃) and total nitrogen; and 4) phenols and indoles such as *p*-cresol, indole and skatole. Supplementation of chicory inulin at 5% had no effects ($P > 0.05$) on the fecal excretion of VFA, volatile sulfides, NH₃, *p*-cresol and indole. However, fecal excretion of total nitrogen was increased ($P < 0.05$, 6139.0 ± 122.0 vs 5103.0 ± 136.0 mg/kg DMI) and fecal excretion of skatole was decreased ($P < 0.05$, 9.07 ± 1.50 vs 18.93 ± 3.37 mg/kg DMI) in response to 5% chicory inulin supplementation. In conclusion, dietary supplementation

of 5% chicory inulin to corn and soybean meal diets is not optimal in reducing nitrogen-related odor and environmental pollution, but may be beneficial in minimizing the odorous emission associated with skatole.

Key Words: Odor-Causing Compounds, Chicory Inulin, Pigs

56 Thirteen polymorphic microsatellite markers for American mink. I.R. Vincent, A. Farid, and C.J. Otieno, *Nova Scotia Agricultural College*.

The objective of this study was to develop microsatellite markers for mink, a species for which fewer than 50 are reported. A mink genomic library was constructed by digesting DNA with *Sau3AI* and cloning 300 to 800 bp DNA fragments into the *BamHI* site of the dephosphorylated pGEM-3Z vector. The ligation product was used to transform competent *E. coli*, which were plated out on LB/ampicillin/IPTG/X-gal media and cultured overnight. Recombinant colonies ($n=5660$) were transferred onto LB/ampicillin media and were lifted onto Hybond-N+ nylon membranes after overnight growth. Colonies were fixed on membranes and were screened with an (AC)15 probe using a chemiluminescence DNA detection kit (ECL) following exposure to X-ray films. DNA inserts in the positively hybridized colonies were amplified by the polymerase chain reaction (PCR) using T7 and SP6 primers, and were bi-directionally sequenced. Thirteen microsatellite loci were detected and primers were designed to amplify the loci by PCR. Genotypes of 86 mink of different color types (black, brown, pastel) as well as wild mink were determined using an ABI 377 automated DNA sequencer. The number of alleles per locus were 4, 6, 7, 7, 8, 8, 8, 8, 9, 9, 9, 11 and 12, indicating that all the loci were highly polymorphic. Allele frequency distributions of the four mink types at the 13 loci were significantly different in 66 of the 78 pairwise comparisons.

Key Words: Mink, Microsatellite, Polymorphism

57 Persistence of transgenic DNA from Roundup Ready® canola during processing for feed and in vitro ruminal incubation. T.W. Alexander^{1,2}, R. Sharma¹, T.A. McAllister¹, R.J. Forster¹, Y. Wang¹, and W.T. Dixon², ¹*Agriculture and Agri-Food Canada, Lethbridge, AB*, ²*University of Alberta, Edmonton*.

Glyphosate tolerance in Roundup Ready® canola (RRC) is conferred by the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) coding region derived from *Agrobacterium tumefaciens* strain CP4. Persistence of this transgene in whole canola seed (WS), cracked seed (CS), meal (M), and diet prepared from the meal (D), and during in vitro ruminal incubation of these substrates, was studied to assess its potential for transfer to ruminal bacteria. The study included RRC and the parental line from which it was derived (PAR). Genomic DNA extracted from WCS exceeded 23 kb. Extracted DNA from M and D was highly fragmented, but did contain 23-kb genomic DNA. A portion of a gene of the Rubisco small subunit family served as a positive control for detection of plant DNA. This fragment (546 bp) was detected in WS, CS, M and D from PAR and RRC by PCR analysis. The complete 1363-bp EPSPS gene was detected in all RRC samples but not PAR. For batch culture, WS, CS, M and D (250 mg) were each incubated in 20 mL buffered ruminal fluid (39°C) for up to 48 h, and DNA was extracted from pellet (1000 × *g*) and supernatant. The Rubisco gene fragment was detected in all WS and CS pellets (RRC and PAR), but was not amplifiable beyond 8 h in pellets of M or D. Whole EPSPS gene was detected in RRC pellets from WS and CS (to 48 h), from M (at 0, 2, 4 and 8 h) and from D (0 and 2 h only). A 144-bp fragment of the EPSPS gene was detected similarly. All supernatants were negative for Rubisco and both amplicons of EPSPS gene. Bacterial DNA was detectable in all samples. Canola DNA is fragmented during processing for livestock diets, however, high molecular weight DNA and intact genes remain and are detectable in the diets. Lysis of plant cells during digestion exposes plant DNA to the ruminal environment and rapid degradation. Bacterial DNA was amplifiable for 48 h whereas endogenous and transgenic plant DNA were not, suggesting bacterial transformation by plant DNA is an extremely rare event.

Key Words: EPSP Synthase, Roundup Ready® Canola, Rumen

58 Elimination of *Escherichia coli* O157:H7 through the use of electrolyzed oxidizing (EO) water. S.M.L. Stevenson*, S.R. Cook, S.J. Bach, and T.A. McAllister, *Agriculture and Agri-Food Canada, Lethbridge, AB*.

Research into identifying sources, prevalence and transmission of microbial pathogens such as *Escherichia coli* O157:H7 in and among feedlot cattle is increasing. Studies have identified multiple environmental sources, including water, in which *E. coli* O157:H7 can remain viable for long periods of time. New technologies and farm management practices continue to be developed and modified in attempts to control the prevalence of pathogenic agents. Electrolyzed oxidizing (EO) water is produced by exposing deionized water containing 0.1% (w/v) sodium chloride to an electrolyzing chamber containing an anode and a cathode separated by a diaphragm. Anode- (pH < 2.5) and cathode- (pH > 11.0) EO waters result. Anode-EO water has been shown to eliminate water-borne pathogens. This study investigated the use of electroactivated water (Biostel North America, Inc.) for specific inactivation of *E. coli* O157:H7. *Escherichia coli* O157:H7 (approximately 10² cells) was exposed for 30 s to 0, 0.5, 1.0, 2.0, 4.0, 8.0 or 16% (v/v) solutions of anode-, cathode- or 50/50 combined EO water in sterile, 2X-distilled water, then 100-μL aliquots of the bacterial suspensions were cultured overnight on MacConkey agar. The cathode-, anode- and combined EO water products had pH of 2.02, 11.11, and 6.93, respectively, and were stable for at least 48 h. Exposure to the combined EO water at 2.0% (v/v) or the anode-EO water at 0.5% killed the *E. coli* O157:H7 cells completely. Conversely, the cathode-EO water was ineffective at 16% (v/v). Growth of *E. coli* O157:H7 cells exposed to 0% EO was not inhibited. No correlations between pH and inactivation of bacterial cells were identified. These results suggest that point source inactivation of potential waterborne pathogens by minimal concentrations of EO water solutions may be possible. Further study is necessary to determine the value and feasibility of using this novel technology in a feedlot environment.

Key Words: *Escherichia coli* O157:H7, Electrolyzed Oxidizing Water, Water Microbiology

59 Relationship between feeding behavior and performance of feedlot steers. D.D. Hickman^{*1,3}, K.S. Schwartzkopf-Genswein², R. Silasi², D.H. Crews Jr.¹, C.R. Krehbiel³, and T.A. McAllister¹, ¹*Agriculture and Agri-Food Canada, Lethbridge, AB*, ²*Alberta Agriculture, Food and Rural Development, Lethbridge, AB*, ³*Oklahoma State University, Stillwater*.

The relationship between eating patterns and performance of feedlot cattle was evaluated using 74 Charolais cross steers (277 ± 111 kg) blocked by BW and assigned to two feedlot pens equipped with a radio frequency identification system (GrowSafe Systems). Each pen featured five feeding stalls that allowed single animal access to a feed tub suspended on load cells. The system recorded animal ID and time, duration and amount of feed consumed during each bunk visit. It allowed calculation of daily variation in intake (DVI) for each steer, as well as the absolute difference between feed consumed by a steer and the amount allotted per head that day in that pen (DDC). Barley silage/barley grain diets were delivered 2 or 3X/d to meet ad libitum intake over a 213-d trial comprising backgrounding (BKGD) and finishing (FNSH) phases. Steers were weighed every 14 d. To relate feeding behavior to performance, steers were grouped by their DM intake, ADG and FE and categorized as average (within pen mean ± SD), high (> mean plus SD) or low (< mean minus SD). In BKGD and FNSH, the high ADG steers exhibited greater ($P < 0.001$) DVI and DDC (2.66 and 2.07 kg, respectively) than those with average ADG (DVI = 2.53 kg; DDC = 1.92 kg) or low ADG (2.22 and 1.70 kg); their intake was also higher ($P < 0.001$) than for the average or low ADG steers. As a group, steers with the best FE also had higher ($P < 0.001$) DVI (2.54 kg) than average- (2.35) or poor (2.22) FE steers, during BKGD, FNSH, and overall. Compared to average or poor FE steers, DM intake by best FE steers was highest during BKGD and lowest during FNSH ($P < 0.001$). Their bunk visits (6.06/d) were more frequent ($P < 0.001$) but they spent the least ($P < 0.001$) time eating (86.6 min/d). In this study, steers with more variable eating patterns performed better, contrary to industry perception.

Key Words: Cattle, Performance, Feeding Behavior

60 Observational study of factors associated with seasonal variation in milk urea nitrogen observed on intensively and extensively managed pastures, during the summer 2000 grazing season, in Prince Edward Island, Canada. E Leger, I Dohoo, G Keefe, J Wichtel, P Arunvipas, and J VanLeeuwen, *Atlantic Veterinary College*.

The effects of pasture management and pasture supplementation on milk urea nitrogen (MUN) were explored to better understand protein and energy interactions during the grazing period. The overall objective of this observational study was to identify the significant factors associated with seasonal variation in milk urea nitrogen, in dairy cows grazing intensively or extensively managed pasture. Pasture management, stage of lactation, sample date and pasture supplementation on MUN levels, were examined during the summer 2000 grazing period. In total eighteen dairy herds were assessed. Ten of the herds were intensive grazing management (IGM) farms and 8 were extensive grazing management (EGM) producers. Each farm was visited within 48 hours after each Atlantic

Dairy Livestock Corporation (ADLIC) test. During each visit, pasture and stored forages were sampled and a detailed questionnaire relating to nutrition and management was completed. Collected ration information was evaluated using a computerized ration evaluator (Spartan). Multilevel modeling (2327 records) was used to compute the relationships between the energy-protein ratio (EPR), a ratio which represents the protein and energy requirements relative to protein and energy delivery, grazing management, presence of rye grass, stage of lactation, milk production and their interactions on milk urea nitrogen. Stage of lactation, grazing management, milk yield, presence of ryegrass, the EPR and the interaction between intensive grazing management practices and the presence of rye grass were found to be significant predictors of MUN. Predicted MUN values were 3.9 units higher on IGM herds where rye grass was present when compared to EGM herds where ryegrass was absent.

Key Words: Milk Urea Nitrogen, Pasture, Dairy Nutrition

Graduate Paper Competition Dairy Foods

61 Purification and characterization of two types of bile salt hydrolase from *Bifidobacterium* spp. GB Kim* and BH Lee, *Dept. of Food Sci. & Agri. Chemistry, McGill University*.

Previous research has indicated that bifidobacteria possess higher bile salt hydrolase (BSH) activity than other probiotics. To investigate the diversity of bile salt hydrolase activity and to understand the molecular organization, BSH activities from 30 strains (22 strains of human origin and 8 strains of animal origin) of bifidobacteria were screened using natural bile salts as well as a synthetic chromogenic substrate (a conjugate of cholic acid and 5-amino-2-nitro-benzoic acid). Among 30 strains tested, only two strains from honey bee hind gut (*Bifidobacterium aasteroides* ATCC 25910 and *B. coryneforme* ATCC 25911) did not show BSH activity. All positive strains contained constitutive intracellular BSH enzymes. From the profiles of native PAGE and BSH activity staining, two groups (group A and group C) of BSH enzyme were revealed. Most of bifidobacteria originated from ATCC was classified as group A, while many of commercial strains belong to group C. Group A and C showed different electrophoretic mobility and chromatographic profiles from anion exchange and hydrophobic interaction columns. This suggests that BSH enzymes from the same group have some similarities in their structure and amino acids composition. To investigate the biochemical characteristics of two enzymes, bile salt hydrolases were purified from *Bifidobacterium bifidum* ATCC 11863, *B. infantis* KL412, *B. longum* ATCC 15708, *B. longum* KL507, and *B. longum* KL515. The N-terminal amino acid sequences determined by Edman degradation were homologous to those of several lactobacilli as well as *Clostridium perfringens*. The native molecular weight of the enzyme in all five strains was estimated to be between 140 and 160 kDa and the subunit molecular weight determined as 35 kDa, indicating that the BSH enzyme is a tetramer. The isoelectric point (pI) determined by isoelectric focusing (IEF) was 4.4 and 4.6 for the BSH enzymes of group A and C, respectively. The relationship between the BSH types, bile tolerance and the molecular characteristics of group A and C enzymes is currently under investigation.

Key Words: Bile salt hydrolase, Bifidobacteria, Probiotics

62 Exopolysaccharide production by *Lb. rhamnosus* RW-9595M. D. Bergmaier*¹, C. Lacroix¹, and C.P. Champagne², ¹Dairy Research Centre STELA, ²Food Research and Development Centre, Agriculture and AgriFood Canada.

Exopolysaccharides (EPS) synthesized by lactic acid bacteria (LAB) play an important role in the manufacturing of fermented dairy products. They contribute to the texture, mouthfeel, taste perception and stability of the final products. Furthermore, EPS could contribute to human health as prebiotics with positive effects on gut microflora. However the low production of EPS by LAB is a constraint for their commercial use as food additives. The immobilized cell technology (ICT) could be an attractive solution to enhance EPS production. The high biomass maintained in the reactor during repeated-batch or continuous culture could largely increase process productivity. In this study, bacterial growth and EPS production during batch and continuous cultures with *Lb. rhamnosus* RW-9595M, an efficient EPS producer, were

compared to repeated-batch cultures with cells immobilized on solid supports (ImmobaSil®). Cultures were conducted at pH 6 in whey permeate medium (5% or 8% (w/w) WP) supplemented with 1% (w/w) yeast extract, 0.5 g/L MgSO₄·7H₂O, 0.05 g/L MnSO₄·H₂O and 1 ml/L Tween-80. For free cell batch cultures in 8% WP medium, maximum cell counts (1.4·10¹⁰ CFU/ml) and EPS production (2374 mg/L) were measured after 20 and 32 h, respectively. This is one of the highest EPS productions reported in the literature for lactobacilli. For continuous cultures in 8% WP, maximum EPS production (1808 mg/L) and volumetric productivity (542.6 mg/L·h) were obtained for a low dilution rate of 0.3 h⁻¹. High immobilized biomass (2.6·10¹¹ CFU/ml support) and EPS concentrations (1800 mg/L) were measured during repeated immobilized cell cultures for incubation periods of 8 h in 5% WP. The high biomass in the system increased EPS volumetric productivity (225 mg/L·h) compared to free cell batch cultures, even though this fermentation was limited by the low carbon source concentration. Our study clearly shows the high potential of *Lb. rhamnosus* RW-9595M and ICT for production of EPS as functional and nutraceutical food ingredients.

Key Words: *Lactobacillus rhamnosus*, exopolysaccharides, immobilization

63 The effect of lactic acid bacteria and bifidobacteria on interleukin-6 and interleukin-8 production by Caco-2 cells. C. Wong*¹, J.J. Pestka¹, and Z. Ustunol¹, ¹Department of Food Science and Human Nutrition, Michigan State University.

Probiotics and the milk products produced using these microorganisms have been reported to stimulate both non-specific and specific immune responses. However, the number of studies using human cell lines has been limited in the past. The objective of this study was to examine the interleukin (IL)-6 and IL-8 production by Caco-2 cells stimulated with *Lactobacillus acidophilus* LA2, *Lactobacillus bulgaricus* NCK 231, *Lactobacillus casei* ATCC 39539, *Lactobacillus reuteri* ATCC 23272, *Streptococcus thermophilus* St 133, *Bifidobacterium* Bf-6 or *Bifidobacterium adolescentis* M101-4. Caco-2 cells resemble normal human intestinal epithelial cells, and thus were chosen for this study. Lactic acid bacteria or bifidobacteria were added to 10% non-fat dry milk (NFDM) at concentrations of 10⁶, 10⁷, and 10⁸ cfu/ml. Bacteria samples were either heat killed (95°C, 30 min) immediately after preparation or after fermentation (37°C, 4 hr). Cell numbers increased one log after fermentation. Bacterial samples were incubated with a monolayer of Caco-2 cells for 24 h. Uninoculated NFDM was used as the control. Cytokine, IL-1β, was used as the positive control for both IL-6 and IL-8 stimulation by Caco-2 cells. Supernatants of all treatments were collected and frozen at -80°C until assayed for IL-6, and IL-8 using ELISA. The complex effects of NFDM, probiotic cultures, probiotic dose, fermentation and their various interactions on the levels of IL-6 and IL-8 production will be presented. Since IL-6 and IL-8 are secreted by cells involved in inflammatory responses, their stimulation may or may not be desirable depending on the immune status of the individual.

Key Words: Lactic acid bacteria, Cytokine, Milk

64 Use of restriction fragment length polymorphism to isolate *Lactococcus lactis* strains producing novel EPS. Helene Deveau* and Sylvain Moineau, *Universite Laval*.

Restriction Fragment Length Polymorphism (RFLP) is a technique in which organisms may be differentiated by analysis of patterns derived from cleavage of their DNA. If two organisms differ in the distance between sites of cleavage of a particular restriction endonuclease, the length of the fragments produced will differ when the DNA is digested with a restriction enzyme. The similarity of the patterns generated can be used to differentiate strains from one another. Recently, van Krangelburg et al. (J. Bacteriol., 1999, 181:6347-6353) proposed a classification scheme to differentiate EPS-producing lactococcal strains based on RFLP of the *eps* operon. This grouping was based on the size of two *Sst*I fragments that hybridized with the *epsB* and *epsD* probe. Using this system, we were unable to classify three of the seven lactococcal *eps*⁺ strains available in our laboratory. This dilemma is likely due to the presence of a *Sst*I site outside the *eps* gene cluster, which is responsible for the variable size of the hybridizing fragments. Thus, the hybridization signals are reflecting the variability of the nucleotide sequence upstream of the operon rather than the variability of the operon itself. These findings led us to the modification of the classification procedure, where two endonucleases (*Acy*I and *Hind*II) and one probe (*epsD*) were used to classify the seven *eps*⁺ strains. The strains *L. lactis* MLT3, SMQ-419 and SMQ-575 belong to group I, H414 to group II, MLT2 and SMQ-420 to group III. The strain SMQ-461 belongs to a fourth and novel group and the EPS produced by this strain is currently under investigation. The availability of such rapid cataloging system is likely to benefit research aimed at identifying lactococcal strains that produce novel EPS.

Key Words: Exopolysaccharides (EPS), *Lactococcus lactis*, Classification

65 The detection of *Bacillus* endospores during low heat skim milk powder processing using nucleic acid technology. Amy Rife*, Dr. Rafael Jimenez-Flores, Dr. Chris Kitts, and Dr. Mark Kubinski, *California Polytechnic State University*.

Detection of endospores in milk powder could be obtained by direct PCR tests plus terminal restriction fragment patterns (TRFP) based on amplification of the 16s rDNA gene for bacterial community analysis. In the DPTC endospore library, we have detected five specific endospores that contribute to the lipolysis, casein hydrolysis, starch hydrolysis, and acid production in milk. Optimal quality powder has to be free of specific detrimental endospores. The objectives of this work were to evaluate TRFPs for the efficient detection of the five detrimental *Bacillus* endospores during a low heat skim milk powder processing run using a pilot plant model, to perform an ecological study of the microorganisms during the processing run, and to evaluate endospore specific gene amplification using PCR as a detection method. In addition to being used as a detection system, TRFP allows knowledge of the composition of communities and the dynamics of individual populations within that community. By using standard peaks and the Ribosomal Database Project (RDP), we are able to identify the specific microorganisms present during the powder processing stages. Our results indicate that TRFPs have proven to be a sensitive endospore detection method during low heat milk powder processing when endospores are present in the range of 103 to 105 CFU/g of milk. TRFPs also prove to be effective in classifying specific microorganisms present throughout each processing step as well as observing community transformations occurring during normal milk powder production in a pilot plant. This can lead to microbial ecology studies dealing with contamination parameters during powder production at an industrial level. TRFP analysis allowed to observe how adding a high concentration of endospores altered the microbial community and the interactions that took place within each sample. Using this technique in place of current ecological study methods, culturing biases such as temperature, nutrients and oxygen concentration are not encountered. In addition, using PCR with a selected gene found only in endospores, we are able to specifically detect those endospore-formers associated with milk powder production.

Key Words: Endospore, Milk Powder, Terminal Restriction Fragment Pattern

66 Comparison of three media used to estimate psychrotrophic bacteria in milk. A.A. Glueck-Chaloupka* and C.H. White, *Mississippi State University, Mississippi State, Ms./USA*.

This study was designed to evaluate the ability of violet red bile agar without an overlay (VRBA/WO) to accurately and rapidly enumerate psychrotrophs in milk. A survey of 36 commercially produced reduced-fat milk samples was conducted. Samples were plated and evaluated the day they were collected from the retail outlet and the day following a preliminary incubation (PI) of 18h at 21C. Psychrotrophic bacteria counts were determined at 32C and 21C on violet red bile agar without an overlay, standard plate count agar, and crystal violet tetrazolium agar. Bacterial enumerations were compared among the three media and two temperatures. A correlation ($r^2=0.73$) was noted between violet red bile agar counts without an overlay and standard plate counts for samples incubated prior to testing. In addition, a strong correlation ($r^2=0.87$) was found between the violet red bile agar counts without an overlay and crystal violet tetrazolium counts incubated prior to testing. Violet red bile agar without an overlay (VRBA/WO) is a viable alternative method when enumerating psychrotrophic bacteria in fluid milk.

Key Words: Psychrotroph, Milk quality, Pasteurized milk

67 Sensory and instrumental measurements of the sensory properties of powdered buttermilk. M. Spill*¹, J.-X. Guinard¹, and R. Jimenez-Flores², ¹*Department of Food Science and Technology, University of California, Davis*, ²*Dairy Products Technology Center, California Polytechnic University, San Luis Obispo*.

Buttermilk is the by-product of butter production. Over 40% of buttermilk is lost each year due to deterioration of quality, particularly sensory quality, yet sensory properties of buttermilk are not fully understood. To improve the knowledge of the sensory properties of buttermilk a descriptive language was developed. A panel of 10 judges developed a lexicon of sensory properties of reconstituted powdered buttermilk using industry samples. Thirty-three descriptors were defined including, for appearance: yellow and blue; for aroma: wheat, rice, grain, goat's milk, wet dog, cooked milk, powdered milk, cardboard, soy, butter, mac-n-cheese, white cheese, caramel, and egg; flavor attributes include: wheat, rice, grain, goat's milk, milk sugar, cooked milk, powdered milk, cardboard, soy, butter, mac-n-cheese, white cheese, caramel, and egg; and textural attributes include: thickness, mouthcoating, and astringency. References for each attribute were used to train panelists on these terms. This lexicon was validated by carrying out evaluations of 20 industry buttermilk samples. Sensory profiles were developed for the buttermilk samples using descriptive analysis techniques. Oxidation of the samples was examined using gas chromatography headspace analysis of hexanal after one and two weeks of storage at 30C. Susceptibility to oxidation and sensory attributes were compared. Preliminary work showed a positive correlation between susceptibility to oxidation and the following attributes: rice aroma, goat's milk aroma, wet dog aroma, egg aroma, egg flavor, grain flavor, soy flavor, and astringent/drying texture. A negative correlation was found between susceptibility to oxidation and caramel aroma and flavor. Having a standard sensory language for buttermilk will assist with training of sensory panels and communication between different industry and research groups.

Key Words: Buttermilk, Sensory, Descriptive analysis

68 Presence of an active phosphoenolpyruvate: glucose/mannose phosphotransferase system in *Streptococcus thermophilus* ATCC 19258. Armelle Cochu*, Christian Vadeboncoeur, Sylvain Moineau, and Michel Frenette, *Groupe de Recherche en Ecologie Buccale, Universite Laval, Quebec, Canada*.

Streptococcus thermophilus, which belongs to the lactic acid bacteria (LAB) family, is widely used in the dairy industry to produce fermented products. In most LAB, including streptococci, glucose is transported within the cell via the phosphoenolpyruvate:sugar phosphotransferase system (PTS). However, previous studies failed to detect any glucose-PTS activity in *S. thermophilus*. This is surprising considering that in *Streptococcus salivarius*, a species phylogenetically closely related to *S. thermophilus*, glucose is transported by the glucose/mannose-PTS and that a specific component for this PTS has been detected in *S. thermophilus*. We undertook this study with the goal of isolating and characterizing genes involved in the transport of glucose by the PTS in *S.*

thermophilus. The *ptsH* and *ptsI* genes, which code respectively for the PTS general proteins HPr and Enzyme I (EI), form the *pts* operon. An analysis of the amino acid sequence of these proteins in *S. thermophilus* showed that they shared a high level of identity with orthologues in other bacteria. Interestingly, unlike HPrs from other Gram-positive bacteria, the *S. thermophilus* HPr possessed a proline residue at position 68 that might interfere with HPr functions. Analysis of the transcription of the *pts* operon by Northern blot revealed the presence of a 0.6 kb transcript specific for *ptsH* and a 2.3 kb transcript covering the *ptsH* and *ptsI* genes. The *man* operon was composed of the *manL*, *M*, *N*, and *O* genes that coded for the IAB^{Man}, IIC^{Man}, IID^{Man}, and ManO proteins respectively. The first three proteins shared significant levels of identity with members of the mannose-PTS family, while no function could be assigned to ManO. Quantification of the 3.5 kb transcript of the *man* operon showed that levels increased by 30% when cells were grown in the presence of glucose rather than lactose. PTS assays using purified recombinant *S. thermophilus* HPr, EI, and IAB^{Man} proteins and *S. thermophilus* membranes as sources of IIC^{Man} and IID^{Man} showed that glucose, 2-deoxyglucose, mannose, and fructose were phosphorylated by the glucose/mannose PTS. Our results indicated the presence of an active glucose/mannose-PTS in *S. thermophilus*.

Key Words: Lactic Acid Bacteria, Glucose transport, Gene transcription

69 Properties and substrate selectivities of esterases from *Lactobacillus casei* LILA, *Lactobacillus helveticus* CNRZ32, and *Lactococcus lactis* MG1363. K.M. Fenster*, K.L. Parkin, and J.L. Steele, *University of Wisconsin-Madison, Madison, WI*.

Two esterases genes (*estB* and *estC*) were identified from a genomic library of *Lactobacillus casei* LILA. The *estB* and *estC* genes had open reading frames of 954-bp and 777-bp which could encode putative peptides of 35.7 kDa and 28.9 kDa, respectively. Recombinant EstB and EstC fusion proteins containing C-terminal six-histidine tags were constructed and purified to electrophoretic homogeneity using one step affinity chromatography. For comparison purposes, recombinant EstA (*Lactobacillus helveticus* CNRZ32) and tributyrin esterase (*Lactococcus lactis* MG1363) fusion proteins containing C-terminal and N-terminal six-histidine tags, respectively, were constructed and purified to electrophoretic homogeneity. Gel filtration of EstB and EstC suggest that they are hexameric and dimeric enzymes with native molecular masses of 219 kDa and 63.0 kDa, respectively. Characterization of EstB and EstC with various active-site inhibitors revealed that they are serine-dependent enzymes. Optimum temperature, NaCl concentration, and pH for EstB and EstC activities were determined to be 55 °C and 35 °C, 15% and 1%, and 6.5-7.0 and 5.5-6.0, respectively. EstB and EstC had significant activity under conditions simulating those of ripening cheese (10 °C, 4% NaCl, pH 5.1). Michaelis-Menten values (K_m and V_{max}) were obtained for EstA, EstB, EstC, and the tributyrin esterase for a variety of ethyl esters and ester compounds consisting of substituted phenyl alcohol and short-chain fatty acids.

Key Words: Esterase, Substrate selectivity, Ethyl ester

70 Construction and evaluation of food-grade vectors for *Lactococcus lactis* using aspartate aminotransferase and α -galactosidase as selectable markers. V. R. Sridhar*, V. V. Smeianov, and J. L. Steele, *University of Wisconsin-Madison, Madison, WI*.

Advances in genetic engineering have opened potential avenues for improving starter cultures; provided, that the genetic modifications are food-grade. Two food-grade vectors, pSUW611 and pSUW711, were developed for application in *Lactococcus lactis*. The vector, pSUW611 (4.0 kb), consists of a lactococcal Gram⁺ theta replicon derived from pJW563 of *Lc. lactis* subsp. *cremoris* W56, a multiple cloning site, and utilizes a lactococcal aspartate aminotransferase gene (*aspC*) as a selectable marker. Selection for pSUW611 transformants is based on complementation of the *aspC* mutation present in *Lc. lactis* JLS400; this strain cannot grow or significantly acidify milk unless supplemented with aspartic acid or asparagine. A milk based medium containing bromocresol purple was developed for selection of pSUW611 transformants. The entire pSUW611 was re-sequenced to exclude appearance of any *de novo* mutations. The vector was found to be stable during 100 generations of growth in non-selective rich medium (0.2% loss per generation). The second vector, pSUW711 (5.0 kb), was constructed

by replacing *aspC* with α -galactosidase (*aglL*) gene of *Bifidobacterium longum* VMKB44 under control of the Usp45 promoter of *Lc. lactis* MG1363. Transformants carrying pSUW711 utilized α -galactoside-containing carbohydrate such as melibiose and produced blue colonies on a melibiose-based medium with X- α -gal. Unlike complementation markers, dominant markers based on atypical sugar fermentation, such as the *aglL* gene are not dependent on specific vector-host combinations. Research is ongoing to determine the host range of pSUW711, compare transformation efficiencies of pSUW611 and pSUW711, and to determine their usefulness by over-expressing a peptidase gene of interest. Development of such food-grade starter systems will provide industry with the necessary tools for genetic-modification of industrially relevant *Lc. lactis* strains.

Key Words: food-grade vector and selectable markers, aspartate aminotransferase, α -galactosidase

71 Electrostatic effects on the yield stress of whey protein isolate foams. J. P. Davis* and E. A. Foegeding, *North Carolina State University, Raleigh, NC/U.S.A.*

The foaming properties of whey protein ingredients are important in many of their functional applications. Structurally robust foams are often desirable, therefore, the vane method was used to characterize the yield stress (τ) of whey protein isolate foams (10% w/v) at three different levels of pH (3.0, 5.0 and 7.0) while in the presence of either NaCl or CaCl₂ (0 to 400 mM). While electrostatic forces are known to significantly affect other functional properties of whey protein ingredients, the relationship between τ of whey protein isolate foams and electrostatic variables had not been investigated. In the absence of salt, τ was approximately 20% greater (50 to 60 Pa) at pH 5.0 or 7.0 as compared to the pH 3.0 controls. No concentration of either NaCl or CaCl₂ significantly affected τ at pH 3.0. However, at pH 7.0, increasing concentrations of up to 400 mM NaCl or CaCl₂ progressively increased τ , with equivalent concentrations of CaCl₂, as compared to NaCl, increasing τ to greater magnitudes. For example, at pH 7.0, the addition of 400 mM NaCl increased τ by approximately 70% as compared to the control, while the addition of 400 mM CaCl₂ increased τ almost 100%. This suggested that specific divalent cationic effects were important to the mechanisms responsible for generating τ . At pH 5.0, which is near the isoelectric point (pI) of the major whey protein β -lactoglobulin, the addition of NaCl up to 400 mM did not significantly change τ , while higher concentrations of CaCl₂ (100 and 400 mM) slightly increased τ . Measurements of foam overrun as well as dynamic surface tension measurements of the diluted foaming solutions were included to aid the data interpretation. A previously described theoretical model predicted that τ would increase with increasing overrun and τ would decrease with decreasing surface tension; however, these relationships did not hold. Dynamic surface tension measurements supported the importance of specific divalent cation effects to τ at pH 7.0.

Key Words: yield stress, foam, whey protein

72 Characterization of interactions involved in the gelation of hydrolyzed whey proteins. D. Doucet*¹, S.F. Gauthier², and E.A. Foegeding¹, ¹North Carolina State University, ²Universite Laval.

Previous work (Doucet et al., 2001, J. Food Sci., 66(5): 711-715) has shown that gelation occurs during extensive hydrolysis (DH >18%) of whey protein isolate (WPI) with Alcalase 2.4L[®]. This phenomenon is unexpected and creates a hurdle for the industrial production of whey protein hydrolysate, where high protein concentration is required to reduce the cost of drying. The objective of this study was to investigate the gelation mechanism and the type of interactions involved in this gelation process.

The enzyme-induced gel product obtained after 5 h of hydrolysis was studied by turbidity measurements at different pH, ionic strength and in the presence of various dissociating reagents. Electrophoresis (native and SDS-PAGE) and chromatography (HPSEC) were used to determine the size of the peptides causing aggregation. The enzyme-induced gel was stable over a wide range of pH (2.5-8.0) and therefore shows some similarities with plastein reaction products. Addition of NaCl, which is able to break weak ionic bonding, did not lead to the dissociation of the aggregates and did not salted-out the peptides suggesting that electrostatic interactions are not the main forces involved in aggregation. Chaotropic reagents such as urea, guanidine-hydrochloride and

SDS were effective at different levels to solubilize aggregates indicating that hydrogen bonds and hydrophobic interactions are involved in the gel network. The decrease in turbidity of enzyme-induced gels when the dielectric constant of the solvent was decreased also showed the importance of hydrophobic interactions. Reducing reagents such as β -mercaptoethanol and DTT did not break aggregates and suggests that disulfide bonds do not play a major role in the aggregation process. Analysis by native-PAGE and SDS-PAGE also demonstrated that most of the aggregates could be disrupted. HPSEC results have determined that 80% of the peptides present were < 2000 Da. Therefore, physical aggregation via hydrogen bonds and hydrophobic interactions, with ionic bonding playing a minor role are the most probable type of interactions involved in the gelation process.

Key Words: Enzymatic hydrolysis, Gelation, Interactions

73 Process analysis of skim milk microfiltration for selective concentration of casein. M Singh*, G Solakni, and S.S.H. Rizvi, *Institute of Food Science, Cornell University, Ithaca NY 14853.*

Cheese making from concentrated cheese milk has been of interest to the food industry for well over the past two decades. As more and more cheese plants incorporate membrane processing in cheese manufacture to standardize cheese milk and increase total solids, the need to analyze this process becomes more critical. In this study we report

the effects of concentration factor (CF), cross flow velocity (CFV), and uniform trans-membrane pressure (UTMP) on energy requirements for selectively concentrating skim milk upto 8 times using cross flow microfiltration (CFM). CFM (0.2 μ m) of pasteurized skim milk was carried out at 50°C at three CFVs and three UTMPs. Volumetric CF of 8x was achieved at each combination of CFV and TMP, permeate flux and longitudinal pressure drop were recorded at each CF, and power consumption was calculated. Power consumption increased upto 1398% with CF (23.6 to 353.5 kJ/kg at 8x). A transition from turbulent to laminar flow was observed at 6x and retentate behavior became shear thinning. Increase in CFV from 5.3 to 6.3 m/s at 8x increased flux and reduced power consumption by 25% (353.1 to 263.1 kJ/kg). Although, increasing the UTMP (68.9 to 137.9 kPa) enhanced the starting flux (51.1 to 62.2 kgm⁻²h⁻¹) and lowered the corresponding power consumption by 18% (28.8 to 23.6 kJ/kg), above 6x, higher UTMP caused excessive fouling, lowered the flux from 14.0 to 8.0 kgm⁻²h⁻¹ and the power consumption increased from 179.9 to 353.1 kJ/kg. Overall power consumption is always lower due to shorter CFM process when skim milk is microfiltered to 8x at higher CFV (6.3m/s) as compared to 5.3m/s. Overall power consumption increased only marginally when UTMP was increased (68.9 to 137.9kPa). However at higher UTMP and above 6x, the permeate flux dropped precipitously below the minimally acceptable rate, which limited the performance of the CFM system.

Key Words: Microfiltration, Skim milk, Process Analysis

Graduate Paper Competition ADSA Production Division and ADSA Southern Branch

74 Effects high wheat bran rations and different sources of protein on the milk constituents and production. Moslem Bashtani*, Abbasali Naserian, and Reza Valizadeh, *Ferdowsi University Of Mashhad, Mashhad, khorasan, Iran.*

The effect of including an increased amount of wheat bran on performance of Holstein dairy cows was investigated using a change over design with four treatment periods. Eight multiparous Holstein cow weighting 56319 kg and average days in milk of 48.5 \pm 26 and mean milk production of 30 \pm 1.94 kg/day were adapted to the experimental rations for 14 days and then entered into a collection period of 7 days. The proportion of concentrate and roughages in the total mixed ration were 60% and 40%. The treatments were 1) 25% wheat bran supplemented with cottonseed meal 2,3,4) 40% wheat bran supplemented with cottonseed meal, fish meal and urea respectively. The animals were individually kept indoors and had free access to fresh water and salt blocks. The daily feed intake was recorded and milk yield, blood, feces, and rumen liquor were sampled on a regular basis for analysis. There were no treatment effects on average daily dry matter and nutrient intakes. Dry matter, organic matter and crude protein digestibility were significantly increased with 40% level of wheat bran while NDF and ADF digestibility were similar in the different treatments. The digestibility values, which were calculated by AIA marker, were similar to the in vivo results. Feces, urine and ruminal pH were not affected by the different treatments. Changing the level of wheat bran did not significantly increase rumen ammonia-N, but urine utilization led to significant increases in rumen ammonia-N contents. A significant increase in blood glucose was observed in the supplemented fish meal diet. Daily milk production, percentage and daily yield of protein, lactose, casein, NPN and SNF milk were not significantly affected by different diets. It appeared that the level of wheat bran in dairy diets can be increased up to 40% with any adverse effects.

Key Words: Dairy cows, Wheat bran, Milk production and composition

75 Effect of lauric acid on ruminal fermentation, nutrient digestibility and milk yield of dairy cows. K. L. Grandeen*, A. N. Hristov, and J. K. Ropp, *Department of Animal and Veterinary Science, University of Idaho, Moscow, ID 83844-2330.*

Medium-chain saturated fatty acids have been shown to inhibit ruminal protozoa and ammonia production in the rumen in vitro. A cross-over design trial with four ruminally and duodenally cannulated lactating dairy cows (268 \pm 30.5 DIM; 768 \pm 36.9 kg BW) was conducted to study the effect of lauric acid-Na (LA) on ruminal fermentation, nutrient digestibility, and milk yield and composition. Cows were fed (DM basis) a 46% concentrate (barley, corn, cottonseed, soybean meal):52% forage

(alfalfa hay, triticale silage) diet, twice a day (0600 and 1800). The daily dose of LA (0, Control or 240 g/cow, LA) was divided into two equal portions and introduced directly into the rumen through the cannula before the two feedings. Cows were treated with LA for 14 days before sampling and rumens were inoculated with ruminal contents (20% on weight basis) from donor cows fed on the same diet on day 1 of each study period. Ruminal samples (28 in 5 days) were analyzed for fermentation variables and protozoal counts. Digestibility was determined using acid insoluble ash as a marker. LA had no effect ($P > 0.05$) on ruminal pH (6.0 and 6.1), ammonia (12.0 and 11.8 mM), and VFA concentration (128.0 and 121.4 mM) and composition (Control and LA, respectively). Compared to Control, protozoal counts were reduced ($P < 0.05$) by LA (11.14 vs 0.98 $\times 10^5$ /ml, respectively). Carboxymethyl-cellulase and xylanase activities of ruminal fluid were lowered (by 40 and 36%, respectively; $P < 0.05$) and amylase activity was not affected ($P > 0.05$) by LA compared to Control. DM intake and DM, OM, CP, NDF, and ADF digestibility were not different ($P > 0.05$) between the two treatments. Milk yield (28.8 and 29.6 kg/d), FCM yield, milk fat (3.43 and 3.38%) and protein (2.92 and 2.79%) concentrations and yields and milk urea N content (24.6 and 21.1 mg/dl; Control and LA, respectively) were not affected ($P > 0.05$) by treatment. In conclusion, compared to untreated Control, lauric acid introduced into the rumen daily at approximately 0.3% of the rumen weight reduced protozoal numbers and fibrolytic activities of ruminal fluid but had no other effects on ruminal fermentation, total tract digestion of nutrients, or milk yield and composition.

Key Words: Lauric acid, Protozoa, Dairy cows

76 Production and metabolic responses to dietary conjugated linoleic acid (CLA) and trans-octadecenoic acid isomers in periparturient Holstein cows. KT Selberg*, CR Staples, and L Badinga, *University of Florida, Gainesville, FL.*

Thirty-nine multiparous Holstein cows were utilized in a completely randomized design to examine the effects of feeding ruminally protected CLA and trans-octadecenoic acid isomers on animal productivity and metabolism during the transition to lactation. Dietary treatments were initiated approximately 28 days (D) prior to expected calving date and continued through D 49 postpartum (PP). Treatments consisted of 1) a basal TMR diet (CON), 2) basal diet + 150 g/d CLA mix (CLAM), and 3) basal diet + 150 g/d trans-octadecenoic acid mix (TRANS). The amounts of CLA and trans-octadecenoic acid mixes fed were adjusted to 225 g/d during the seven-week (wk) PP treatment period. Liver biopsies

were obtained at D 2, 14 and 28 PP to evaluate treatment effects on hepatic lipid accumulation. Dietary treatments had no detectable effects on pre- or PP dry matter intakes, body weights and body condition scores. Treatment x D interactions were detected for yield of milk ($P < 0.001$) and fat ($P < 0.001$). Milk yield increased and peaked earlier (by wk 3) in the TRANS group, compared to CON and CLAM groups. In contrast, dietary CLA stimulated milk production only after wk 4 of lactation. Milk fat percentage decreased sharply between wk 1 and 3, and did not change thereafter in the TRANS group. Dietary CLA caused a slower, but more drastic decrease in milk fat by wk 6 of lactation. Average milk fat yield (CON, 1.4 kg/d; CLAM, 1.2 kg/d; TRANS, 1.4 kg/d) and 3.5% fat-corrected milk production (CON, 40.0 kg/d; CLAM, 37.4 kg/d; TRANS, 40.0 kg/d) did not differ among diets. Feeding CLA or trans-octadecenoic acids had no detectable effect on milk protein percentage or somatic cell count. Liver fat and triacylglycerol (TAG) concentrations increased between D 2 and 14 PP, and then decreased by D 28 in CON and CLA groups. Total lipid and TAG concentrations in liver biopsies collected from cows in the TRANS group were similar across D. Differential kinetics of CLA and trans-octadecenoic acid-mediated effects on production and metabolic responses would indicate potential converging as well as distinct signaling mechanisms for these fatty acid isomers in the dairy cow.

Key Words: Conjugated linoleic acid, Trans-octadecenoic acids, Transition period

77 Intramammary infusion of IGF-I increases BrdU-labeling in mammary epithelial cells of prepubertal heifers. L.F.P. Silva*, M.J. VandeHaar, and M.S. Weber Nielsen, *Michigan State University, East Lansing MI.*

In vitro studies with bovine mammary tissue strongly suggest that insulin-like growth factor-I (IGF-I) stimulates mammary development in cattle before puberty. However, this effect has never been demonstrated *in vivo*. Our objective was to determine if intramammary infusions of IGF-I would stimulate mammary development in prepubertal heifers. Ten μ g of rhIGF-I diluted in 10 ml of sterile saline (1mg/ml albumin) was infused once per day, via the streak canal, into two quarters, one front and one rear, of six prepubertal dairy heifers (222 \pm 10 kg BW). Contralateral quarters received saline with albumin. This dose of IGF-I was calculated to increase the concentration of IGF-I in the parenchyma by 50 ng/ml. After seven days of treatment, bromodeoxyuridine (BrdU) was infused intravenously at 5 mg/kg BW, and heifers were slaughtered 3 h later. Samples from three regions of the mammary parenchyma (proximal, intermediate, and distal to the teat) were collected, fixed, sliced, and incubated with BrdU monoclonal antibody to identify cells in the S-phase of the cell cycle. Total number of epithelial cells and BrdU-labeled cells were quantified in three microscopic fields from each slide section. An average of 3,200 cells were counted in each quarter. Intramammary infusion of IGF-I increased ($P < 0.001$) the percentage of epithelial cells in the S-phase by 60% (6.4 vs. 4.0%, $\pm 0.6\%$). Proliferation was similar ($P > 0.35$) in all three parenchymal regions, and the response to IGF-I was similar in each region. This similar response indicates that IGF-I translocated homogeneously throughout the parenchyma. The effects of IGF-I in front quarters was the same as in rear quarters. Also, infusion of IGF-I in diagonal quarters gave a response identical to that of infusion in quarters of the same side, suggesting that each quarter could serve as a separate experimental unit. Statistical power calculations showed that five animals would be required to detect a 30% difference in cell proliferation with 95% confidence. We conclude that local IGF-I increases proliferation of mammary parenchymal epithelial cells in prepubertal heifers. Moreover, combining intramammary infusion with the BrdU-labeling technique is a sensitive method for measuring effects of metabolic compounds on mammary development.

Key Words: Bovine, Proliferation, Mammary gland

78 Use of insulin-like growth factor-1 in culture and administration of GnRH to recipients to improve pregnancy rates following timed embryo transfer of in vitro-produced embryos to lactating dairy cows. J. Block*, M. Drost¹, R.L. Monson², J.J. Rutledge², R.M. Rivera¹, F.F. Paula-Lopes¹, O.M. Ocon¹, and P.J. Hansen¹, ¹University of Florida, Gainesville, FL, ²University of Wisconsin, Madison, WI.

Studies have reported the positive effect of insulin-like growth factor-1 (IGF-1) on embryonic development *in vitro*. In addition, there are reports that administration of GnRH on d 11 improves pregnancy rates following artificial insemination. Objectives of this study were to determine if pregnancy rate following timed embryo transfer would be improved by 1) culturing embryos in the presence of IGF-1 and 2) treating recipients with GnRH on d 11 after putative estrus. The experiment was conducted between June and September, 2001. Embryos were produced from Holstein oocytes collected from ovaries from a Wisconsin abattoir. Oocytes were shipped overnight to Gainesville where fertilization took place. Following fertilization, oocytes were cultured in the presence or absence of 100 ng/ml IGF-1. A total of 210 primiparous and multiparous lactating Holstein cows were synchronized using the OvSynch protocol and used as recipients in 13 replicates (6 to 24 recipients/replicate). Fair to excellent quality blastocysts and morulae were collected at d 8 after fertilization and randomly transferred to day 7 (d 0 = the day following the 2nd GnRH injection) recipients. For the first 3 replicates (n = 46), recipients received no additional treatment. For the remaining 10 replicates (n = 164), recipients randomly received either GnRH (Cystorelin[®], 100 μ g) or placebo on d 11. Pregnancy was diagnosed 45 d after embryo transfer. Recipients which received IGF-1 treated embryos had higher pregnancy rates than controls ($p < 0.05$, 29/124 = 23.4% vs. 10/86 = 11.6%). Among cows receiving GnRH or placebo at d 11, pregnancy rate was higher ($p < 0.05$) for those receiving GnRH (22/93 = 23.7%) than for those receiving placebo (8/71 = 11.3%). Results indicate that addition of IGF-1 to embryo culture and administration of GnRH on day 11 can improve pregnancy rates to timed embryo transfer in lactating dairy cows. Support: USDA IFAFS 2001-52101-11318 and USDA TSTAR 2001-34135-11150, Florida Milk Checkoff Program, and the Babcock Institute for International Dairy Research and Development, UW-Madison.

Key Words: Embryo Transfer, IGF-1, GnRH

79 Expression of fibronectin, laminin and type IV collagen in mammary tissue from ovariectomized and intact prepubertal heifers. S. D. Berry*, R. D. Howard², and R. M. Akers¹, ¹Virginia Tech, ²Virginia Maryland Regional College of Veterinary Medicine, Blacksburg, VA 24061.

The objective of this experiment was to investigate the potential role of the extracellular matrix proteins fibronectin, laminin and collagen in regulating prepubertal heifer mammary development. Mammary parenchyma and fat pad tissue was collected from fourteen six-month old heifers, eight of which were ovariectomized between one and three months of age, and six which served as intact controls. Distribution of total collagen was assessed by sirius red staining of tissue sections and fibronectin, laminin and type IV collagen were assessed by immunohistochemistry. Abundance of fibronectin and laminin was also analyzed by western blotting. Total mammary mass was dramatically reduced in ovariectomized animals (130 \pm 21 g vs. 304 \pm 25g, $p < 0.001$). Histological structure also differed: while parenchyma from intact animals contained abundant branching epithelial structures (TDU), TDU from ovariectomized animals essentially consisted of major ductal structures with little or no branching. Collagen fibers were abundant and densely packed throughout inter-lobular stroma and were less abundant and more diffuse within intra-lobular stroma. Type IV collagen was present primarily in the basal lamina of capillaries, whereas fibronectin and laminin staining was present throughout parenchymal stroma, in both intact and ovariectomized animals. Western blotting showed that fibronectin was more abundant within parenchyma than the mammary fat pad (182 vs. 21 densitometric units/mg tissue; $p < 0.0001$). Laminin was more abundant in parenchyma from intact than ovariectomized animals (30 vs. 17 densitometric units/mg tissue; $p < 0.05$), but laminin abundance did not differ between parenchyma and fat pad tissues. These results provide initial evidence that fibronectin, laminin and collagen participate in regulation of prepubertal mammary development in heifers.

Key Words: Mammary, Bovine, Extracellular matrix

80 Comparison of high-molecular weight glycoproteins, MUC1 and MUCX, in porcine and bovine milks. C. Liu*, A.K. Erickson, D.R. Henning, and D.H. Francis, *South Dakota State University, Brookings, SD.*

Using periodic acid Schiff's (PAS) reagents, a modified silver staining method, and wheat germ agglutinin (WGA) blot assay, two polymorphic high-molecular weight glycoproteins in porcine milk samples were resolved and detected on SDS-PAGE. Both proteins showed polymorphism in band number (one or two) and band mobility. Based on this observation and the data obtained from other species, these two glycoproteins were expected to be porcine homologues of milk MUC1 and MUCX. Porcine MUC1 was resolved in 6% running gel and had an estimated molecular weight varying from 300,000 to 400,000. Porcine MUC1 was detected in both milk fat globule membrane (MFGM) and skim milk (whey protein portion) preparations, while porcine MUCX, resolved in 3% stacking gel, was only found in the skim milk phase. With similar methods, polymorphic MUC1 was found in both MFGM and skim milk phases of bovine milk but exhibited a much lower molecular mass (usually <250,000), which agrees with earlier studies on bovine MUC1. However, in contrast to porcine MUCX, bovine MUCX was present only in skim milk, appearing as a nonpolymorphic single band on 3% stacking gel and has a relatively higher molecular weight than porcine MUCX. Regardless of species, PAS staining of MUC1 bands was much stronger than that of MUCX bands within each individual sample, suggesting either much less glycosylation or much lower concentration of MUCX in the skim milk.

Key Words: Porcine milk mucins, Bovine milk musins, Milk glycoproteins

81 Short day photoperiod enhances lymphocyte proliferation in dairy cattle. T.L. Auchtung*, J.L. Salak-Johnson, and G.E. Dahl, *University of Illinois, Urbana, IL.*

The periparturient period is a time of increased immunosuppression and risk of mastitis in cows. Cows on short day photoperiod (SDPP) during the dry period have higher milk production in the subsequent lactation than cows on long day photoperiod (LDPP) when dry. Of interest, rodents treated with SDPP have increased immune cell function relative to LDPP animals. The objective of this study was to determine whether immune cell function could be improved in dairy cattle treated with SDPP as compared to LDPP. Holstein steers ($n = 12$) were used as the model. Treatments were LDPP (16 h light:8 h darkness) and SDPP (8 h light:16 h darkness). After 9 wk on treatment, animals were switched to the opposite photoperiod treatment. Blood (20 mL) was collected on heparin via jugular venipuncture at Weeks 4 and 13. The buffy coat was mixed with RPMI-1640 cell growth media and was centrifuged through Histopaque-1077 density gradient. Lymphocytes were then washed with RPMI and brought to a final concentration of 5×10^6 cells/mL in RPMI supplemented with 10% FBS and gentamicin. Lymphocytes were stimulated by each of three mitogens: Concanavalin A (20 μ g/mL), phytohemagglutinin (10 μ g/mL), and pokeweed mitogen (10 μ g/mL). After incubation for 48 h at 37°C and 5% CO₂, thiazolyl blue (MTT) was added to quantify lymphocyte proliferation. At Week 4, mitogen-stimulated lymphocyte proliferation was greater ($P < 0.05$) in animals treated with SDPP than those treated with LDPP for all three mitogens. Results were similar at Week 13, with animals treated with LDPP through Week 9 but then switched to SDPP having greater ($P < 0.05$) lymphocyte proliferation for all three mitogens as compared with the animals that were switched from SDPP to LDPP. In conclusion, SDPP significantly improves immune function, as measured by lymphocyte proliferation, compared with LDPP in dairy cattle.

Key Words: Cattle, Photoperiod, Lymphocytes

82 Prevention of fatty liver in transition dairy cows by glucagon. R. A. Nafikov*, B. N. Ametaj², G. Bobe¹, J. W. Young¹, and D. C. Beitz¹, ¹Iowa State University, Ames, IA, ²Purdue University, West Lafayette, IN.

The objective of this study was to determine whether administration of glucagon at day two postpartum would prevent the development of fatty liver (hepatic lipidosis) in dairy cows. Twenty-four multiparous Holstein cows were used. During the dry period, cows were fed cracked corn in addition to their normal diet for the last 30 days before calving to induce pathological fatty liver. Then, they were assigned randomly to one of three different treatment groups of eight cows in each and

injected subcutaneously with either saline, 7.5 mg/day, or 15 mg/day of glucagon for 14 days starting at day two postpartum. Liver samples were obtained on -4, 2, 6, 9, 16, 20, 27, 34, and 41 days postpartum by puncture biopsy. Blood samples were taken from the coccygeal vein every day starting 4 days prepartum until the day after the last injection of glucagon and then every time before liver biopsies. Liver samples were analyzed for lipid composition. Blood samples were analyzed for concentrations of glucose, nonesterified fatty acids, β -hydroxybutyrate, and other blood constituents. We found that glucagon administered at day two postpartum prevented the accumulation of total lipids in cows/liver during the first two weeks after calving. Glucagon at both dosages increased blood glucose concentration but did not alter nonesterified fatty acid concentration in blood. This experiment demonstrates that glucagon given during the early postpartal period will prevent fatty liver in dairy cows. (supported in part by USDA grant 99-35204-8576)

Key Words: Fatty liver, Glucagon, NEFA

83 Oxytetracycline resistant gram-negative bacteria in dairy cattle: risk factors and implications on food safety. A. A. Sawant, N. V. Hegde, B. C. Love, and B. M. Jayarao, *The Pennsylvania State University, University Park, PA, USA.*

Over the last decade, scientists, food animal producers, medical and veterinary clinicians and the general public have become increasingly concerned about the development of antibiotic resistant microorganisms and its subsequent transmission from the animal to human populations. This issue is perceived as a significant public health concern, particularly in terms of food safety. A study conducted in our laboratory showed that 104 of 344 (30%) lactating cows on 23 of 33 (69%) dairy farms were positive for oxytetracycline-resistant gram-negative bacteria (OXY-GNB) in feces. The OXY-GNB accounted for 0.2 to 99% of the total fecal flora in the feces. *Escherichia coli* accounted for 96% of the oxytetracycline-resistant isolates. Isolates resistant to oxytetracycline were also observed to be resistant to clindamycin (100%), florfenicol (99%), penicillin (100%), tiamulin (100%), tilimicosin (97%), tylosin (100%), and sulpha drugs (88-95%). The isolates were able to grow at high concentration (32 μ g/mL) of oxytetracycline than the cutoff level for MIC₉₀ (16 μ g/mL). Resistance to oxytetracycline persisted even on removal of "selection pressure" (culture on antibiotic free medium); suggestive of resistance being regulated by genetic element(s). It was observed that dairy producers who fed milk replacers with oxytetracycline to calves were 12-fold more likely to have lactating cows shedding OXY-GNB as compared to dairy producers who did not feed milk replacers containing oxytetracycline. Further, bulk tank milk (BTM) from 3 of the 33 dairy herds had *Escherichia coli* that were resistant to oxytetracycline. The findings are compelling and strongly suggest that oxytetracycline-resistant gram-negative bacteria could be an important food safety issue.

Key Words: antimicrobial resistance, gram negative bacteria, milk replacer

84 Antimicrobial resistance patterns of bacteria cultured from milk samples in Wisconsin from 1994 - 2001. J. A. Makovec* and P. L. Ruegg, *University of Wisconsin, Madison.*

Concern about antimicrobial resistance exists throughout the world. The objective of this study was to determine antimicrobial resistance of bacteria cultured from milk samples submitted to the WI Veterinary Diagnostic Laboratory from Jan 1994 - June 2001. Clinical case records from milk samples were retrieved for analysis. Antimicrobial susceptibility tests were performed on 8,905 of 83,650 samples. Bacteria were tested for susceptibility using Kirby-Bauer disk diffusion and classified as sensitive, intermediate or resistant based on NCCLS standards. For analysis, intermediate results were classified as resistant. Antimicrobial resistance was examined for *Staph aureus*, *Staph sp.*, *Strep sp.* and *E. coli*. Year was significantly associated with proportion of *Staph aureus* resistant to ampicillin, erythromycin, lincomycin and penicillin ($P < 0.0001$) as well as pirlimycin ($P = 0.0078$) and sulfa ($P = 0.0076$). There was no significant relationship between year and proportion of *Staph sp.* resistant to tetracycline ($P = 0.58$). Year was significantly associated with proportion of *Staph sp.* resistant to erythromycin ($P = 0.03$), lincomycin, pirlimycin, sulfa ($P < 0.0001$) and SXT ($P = 0.0004$). There was no significant association between year and proportion of *Staph sp.* resistant to cloxacillin ($P = 0.12$), penicillin ($P = 0.74$) and tetracycline ($P = 0.23$). Year was significantly associated with proportion of *Strep sp.* resistant to cloxacillin

($P=0.0007$) and tetracycline ($P=0.0441$). There was no significant association between year and proportion of *Strep. sp.* resistant to ampicillin ($P=0.22$), cephalothin ($P=0.337$), erythromycin ($P=0.07$), lincomycin ($P=0.95$), penicillin ($P=0.21$), pirlimycin ($P=0.13$), sulfa ($P=0.37$) and SXT ($P=0.78$). Year was significantly associated with proportion of *E. coli* resistant to cephalothin and sulfa ($P=0.0006$). There was no significant association between year and proportion of *E. coli* resistant to ampicillin ($P=0.10$), SXT ($P=0.49$) and tetracycline ($P=0.10$). Some variation was noted in the antimicrobial resistance of these pathogens.

Key Words: Antibiotic, Antimicrobial resistance, Mastitis

85 Effects of storage time and thawing methods on the recovery of Mycoplasma in milk samples from cows with intramammary infections. M. Biddle*, L. Fox, M. Evans, and C. Gaskins, *Washington State University*.

This study was executed to determine the effects of storage and thawing on the viability of *Mycoplasma species* in cow's milk. The trial was designed using a control sample and seven treatments subjected to two methods. Treatments 1, 2, 3 and 4 were the same sample repeatedly frozen and thawed for 4 weeks starting on Week 1 after collection. Thawing, plating, and refreezing of this sample were repeated on Weeks 2, 3, and 4, after original collection. Treatments 5, 6, and 7 were three individual samples stored for varying lengths of time. Treatment 5 samples were stored for two weeks and a portion plated on Week 2. Treatment 6 samples were stored for three weeks and plated on Week 3. Treatment 7 samples were stored for four weeks and plated on Week 4. There was a significant treatment effect ($p < 0.0001$) on the recovery of colony forming units (CFU) in milk samples when comparing the control sample to Treatments 1 through 7. There was a linear decline in mean number of CFU in samples that were repeatedly frozen and thawed. Control sample CFU was 6.29, Treatment 1 CFU 4.64, Treatment 2 CFU 3.69, Treatment 3 CFU 3.01, and Treatment 4 CFU 1.86. A linear decline in mean number of CFU was also present for milk samples that were stored for varying lengths of time. Treatment 5 CFU was 4.41, Treatment 6 CFU 4.13, and Treatment 7 CFU 3.18 which are 2-3 fold log reductions in comparison to the control sample. To determine the best thawing method, Treatment 1 through 7 samples, previously split, were thawed using two methods. In Method 1, samples were thawed at ambient temperature for one-half hour. In Method 2, samples were thawed at 37°C in a water bath. More mycoplasma were recovered from milk samples thawed at ambient temperature than milk samples thawed in a 37°C water bath ($p < 0.0001$). In comparing mean numbers of CFU, Method 1 CFU was 4.04 and Method 2 CFU was 3.76. A final comparison was made between individual treatments. All treatments were significant ($p < 0.0001$), with the exception of the Treatment 5 to Treatment 6 pairwise comparison. The results of this study indicate that storage and thawing of milk samples is harmful to mycoplasma organisms.

86 Performance of lactating dairy cows fed gamagrass as hay or silage. J-S. Eun*, V. Fellner¹, J. C. Burns², and M. L. Gumpertz¹, ¹North Carolina State University, Raleigh, NC, USA, ²USDA-ARS, Raleigh, NC, USA.

Twenty lactating Holstein cows were used to determine feeding value of gamagrass as hay or silage and effect of supplemental corn on gamagrass silage utilization. Cows were grouped by DIM, milk yield, and parity into 5 groups. Each group was assigned to one of 5 dietary treatments: 1) gamagrass hay (GH), 2) gamagrass silage (GS), 3) GS + low corn (GSLC), 4) GS + medium corn (GSMC), and 5) GS + high corn (GSHC). A protein supplement mix was offered to all cows to keep crude protein levels similar across treatments. All silage diets were offered for 6 weeks and hay was offered for 3 weeks. Data were analyzed according to a completely randomized design using the proc GLM procedure

of SAS. Feeding gamagrass as hay or silage did not change milk yield. Compared to gamagrass silage, feeding supplemental corn increased milk yield but only at the medium and high levels of corn inclusion ($P < 0.05$). Milk fat, protein, and lactose contents were similar across all treatments; there was a tendency for milk protein to be higher with GSHC diet ($P < 0.07$). Yields of milk fat, protein, and lactose tended to be higher with GS compared with GH and corn supplementation supported higher yields when compared to gamagrass silage. Gamagrass fed as silage resulted in a higher feed conversion efficiency compared to gamagrass fed as hay ($P < 0.01$). Including corn with the silage resulted in a lower feed efficiency with GSHC being the lowest. Conversion of feed N to milk N was greater with gamagrass fed as silage compared to hay ($P < 0.01$) and supplementation of GS with corn failed to improve N efficiency. Milk urea nitrogen (MUN) was significantly higher ($P < 0.01$) for cows fed GH compared to all other treatments. Feeding GS significantly lowered MUN, and corn supplementation at the medium and high levels further reduced MUN ($P < 0.05$). Milk lipid profile was similar between GH and GS. Supplementing corn at the high level increased C_{18:0}, trans-C_{18:1}, and C_{18:2} contents. Gamagrass silage supported similar milk yield compared to gamagrass hay. Increased energy from supplemental corn increased milk yield and tended to increase conversion of feed N into milk protein. Gamagrass fed as silage without or with corn improved the N status of the cows as indicated by lower MUN concentrations.

Key Words: Gamagrass, Corn, Dairy cows

87 Dietary cation-anion difference and K:Na ratio effect on performance of lactating dairy cows during hot weather. C.D. Wildman*, J.W. West, and J.K. Bernard, *The University of Georgia, Tifton, GA*.

Forty-two lactating Holstein cows averaging 187.6 DIM (± 58.5 d) were used in an 8 wk trial to determine the response to dietary K:Na ratio and dietary cation-anion difference (DCAD) levels fed during hot weather. The study duration was June 6 through July 31. Mean maximum and minimum temperature, relative humidity, and temperature-humidity index (THI) were 31.2 and 22.6°C; 95.8 and 58.8%; and 85.9 and 75.3. Treatments were arranged as a 2x3 factorial within a randomized block design to provide 30 or 45 meq/100g DM (Na + K - Cl - S) and 2:1, 3.5:1, and 5:1 K:Na ratios using sodium bicarbonate and potassium carbonate to modify diets. Intake of DM, energy-corrected milk yield, fat percentage, and protein percentage for low and high DCAD and low, moderate, and high K:Na ratios were 22.8, 22.8, 22.7, 22.7, 22.9 kg/d; 27.7, 28.2, 28.2, 27.6, 28.0 kg/d; 3.9, 3.7, 3.8, 3.9, 3.8%. No significant main effects or interactions were detected ($P > .10$). A significant effect for K:Na ratio was observed in protein percentage ($P < .08$), with the highest ratio yielding the lowest protein percentage (2.9%) compared to the low and moderate ratios, which yielded 3.0 and 3.1%. Blood urea nitrogen (BUN), blood bicarbonate, urinary bicarbonate, blood Na and K, and urinary Na and K for low and high DCAD and low, moderate, and high K:Na ratios were 17.3, 14.8, 15.8, 15.2, 17.1 mg/dl; 22.1, 22.5, 22.1, 21.9, 22.8 mmol/L; 94.7, 106.1, 102.6, 100.6, 97.9 mmol/L; 147.8, 147.5, 147.5, 147.6, 147.8 mmol/L; 4.9, 4.8, 4.7, 4.8, 4.9 mmol/L; 99.5, 110.6, 141.9, 105.4, 67.9 mmol/L; 128.8, 153.7, 116.2, 148.2, 159.4 mmol/L. A significant effect of DCAD was seen for BUN ($P < .01$). A significant ratio effect was seen for urinary K and Na ($P < .10$). There was a tendency toward a DCAD effect for urinary bicarbonate ($P < .11$). No other main treatment effects were seen. Results suggest that sufficient blood buffering existed with the lower DCAD diet, with additional cation and bicarbonate being excreted in the urine.

Key Words: Dietary Cation-Anion Difference, Electrolytes, Heat stress

Graduate Paper Competition Northeast ASAS/ADSA Section

88 Potential mechanisms for increased milk yield due to increased milking frequency during early lactation. S. A. Hale*, A. V. Capuco², and R. A. Erdman¹, ¹University of Maryland, College Park, ²USDA-ARS, Beltsville, MD.

Increased milking frequency (IMF) at the beginning of lactation has been shown to increase milk yield not only during IMF but also after its cessation. This experiment evaluated the immediate effects of IMF

initiated during early lactation, on mammary growth and long-term effects on milk yield. Thirty-one cows were divided into three treatment groups: 1) controls: cows milked twice daily (2X) beginning at parturition (d 1), 2) IMF1: cows milked four times daily (4X) from d 1 to 21 postpartum (pp) and 3) IMF4: cows milked 2X d 1 to 3 and 4X d 4 to 21 pp. The 4X cows were milked immediately before 2X cows and again 3 h later, at the end of the normal milking routine. All cows were

milked 2x from d 21 to 305 pp. Milk yields were 33.7, 42.3 and 38.3 kg/d during wk 1 to 3 ($P < 0.02$) and 36.1, 39.0 and 38.8 kg/d during wk 4 to 40 ($P < 0.04$) for control, IMF1 and IMF4, respectively. Mammary biopsies from four cows per treatment were obtained on d 7 and 14 pp to evaluate mammary cell proliferation. Tritiated-thymidine incorporation tended to increase on d 7 in IMF1 cows ($P = 0.09$), and arithmetic means of the percentage of cells expressing Ki67 proliferation antigen ($P > 0.1$) were consistent with a proliferative response to IMF. Blood was sampled three times per wk during the first 2 wk and then once per wk during wk 3,4,5,6,8 and 10. Plasma IGF-1 averaged 20.1 ng/ml in IMF cows vs. 24.2 in controls ($P < 0.05$) but was not accompanied by a change in GH ($P > 0.50$). Prl was also not affected by treatment ($P > 0.50$). Neither milk yield nor a potential effect on mammary cell proliferation were correlated with systemic IGF-1. However changes in local IGF-1 and its binding proteins cannot be discounted. Increasing milking frequency for a short time during early lactation increased milk yield that persisted for most of lactation. Furthermore, increasing milking frequency during early lactation may have a proliferative effect on the mammary epithelium, which would account for the persistent increase in milk yield. Keywords: milking frequency, mammary growth, IGF-1

Key Words: Milking frequency, Mammary growth, IGF-1

89 Performance of dairy cows as affected by prepartum dietary carbohydrate source and supplementation with chromium throughout the periparturient period. K. L. Smith^{*1}, M. R. Waldron¹, T. R. Overton¹, J. K. Drackley², and M. T. Socha³, ¹*Cornell University, Ithaca NY*, ²*University of Illinois, Urbana*, ³*Zinpro Corporation, Eden Prairie, MN*.

Holstein cows (n=74) entering second or later lactation were used to determine whether production and DMI are affected by source of carbohydrate in the prepartum diet and chromium-L-methionine (CrMet) supplementation throughout the periparturient period. Cows were fed either a TMR with the concentrate portion based on starch-based cereals (NFC; 1.63 Mcal/kg NE_L, 14.5% CP, 41.3% NFC) or a TMR with the concentrate portion based on nonforage fiber sources (NFFS; 1.59 Mcal/kg NE_L, 14.3% CP, 34.5% NFC) from 21 d before expected parturition until parturition. After parturition all cows were fed a lactation TMR (1.74 Mcal/kg NE_L, 17.8% CP, 39.9% NFC). The CrMet was supplemented once daily via gelatin capsule at dosages of 0, 0.03, or 0.06 mg/kg BW^{0.75}. Thus, treatments were in a 2 (carbohydrate source) x 3 (CrMet) arrangement. Neither prepartum nor postpartum DMI was affected by treatment ($P > 0.15$). Milk yield tended ($P < 0.06$) to be increased linearly by CrMet supplementation. Percentages of fat ($P < 0.12$) and total solids ($P < 0.06$) in milk tended to be decreased for cows fed the NFFS diet prepartum. These data indicate that prepartum carbohydrate source has little influence on performance during the immediate peripartal period, and that trends for increased milk yield for cows supplemented with CrMet are independent of prepartum dietary carbohydrate source.

	NFC			NFFS			
Item	0 ¹	0.03 ¹	0.06 ¹	0 ¹	0.03 ¹	0.06 ¹	SEM
Prepartum DMI ²	13.7	13.5	13.4	13.5	14.3	13.9	0.44
Postpartum DMI ²	17.6	18.2	19.0	18.2	19.5	19.7	0.82
Milk ²	39.5	39.7	41.9	40.4	41.4	43.7	1.6
Fat, %	4.39	4.54	4.54	4.47	4.28	4.12	0.16
Fat ²	1.70	1.76	1.86	1.76	1.76	1.76	0.06
Protein, %	3.50	3.41	3.11	3.14	3.32	3.19	0.15
Protein ²	1.33	1.30	1.27	1.23	1.34	1.36	0.08
Solids, %	13.44	13.60	13.26	13.30	13.18	12.79	0.23
Solids ²	5.23	5.31	5.49	5.30	5.43	5.52	0.20

¹CrMet dose (g/kgBW^{0.75}) ²kg/d

Key Words: Periparturient Cow, Carbohydrate, Chromium

90 Evaluation of ruminally unprotected lysine as a source of metabolizable lysine for high producing cows. A. M. McLaughlin^{*1}, N. L. Whitehouse¹, E. D. Robblee¹, R. S. Ordway¹, C. G. Schwab¹, P. S. Erickson¹, and D. E. Putnam², ¹*University of New Hampshire, Durham, NH*, ²*Balchem Corporation, Slate Hill, NY*.

Lysine (Lys) is generally the first or second limiting amino acid (AA) in metabolizable protein (MP) for lactating dairy cows (NRC, 2001). This

experiment was conducted to compare the dose-response relationships between duodenally infused LysHCl and dietary LysHCl as a way to estimate the "Lys bioavailability" value (ruminal escape x intestinal absorption) for dietary Lys. Two primiparous and 3 multiparous Holstein cows (63 to 126 DIM) were assigned to each of two squares in a balanced split-plot 5 x 5 Latin square design. Cows were fed a Lys-deficient basal diet supplemented with ruminally protected methionine (Met) to ensure that Lys was first limiting. Evaluation of the basal diet with NRC 2001 indicated 5.1% Lys and 2.4% Met in MP. Dosage levels were selected assuming Lys bioavailabilities of 100% for infused Lys and 20% for fed Lys. The five dosage levels (g Lys per 25.1 kg DM intake) for the infusion and fed squares were: (1) 0, 0; (2) 16.5, 82.5; (3) 33, 165; (4) 49.5, 247.5; and (5) 66, 330; respectively. The highest dosage for each square was selected to provide for 7.2% Lys in MP. Experimental periods were 14 d with the last 7 d for measurements of feed intake, production, and plasma AA. Content and yield of milk true protein and plasma Lys concentrations (% of total plasma AA) were considered to be the primary response criteria and are reported below. Infusing incremental Lys increased milk protein content and yield, and plasma Lys concentrations, whereas feeding incremental Lys was without effect. Feeding Lys did not result in sufficient responses from which to estimate a "Lys bioavailability" value for ruminally unprotected Lys. These data indicate that the "Lys bioavailability" for ruminally unprotected Lys is considerably less than 20%.

	Dose					Linear	Quad	Cubic
Item	1	2	3	4	5	P=	P=	P=
Milk protein %								
Infused	2.72	2.86	3.03	3.09	2.98	0.006	0.038	0.472
Fed	2.93	2.89	2.95	2.99	2.89	0.978	0.552	0.261
Milk protein, g/d								
Infused	1213	1258	1383	1430	1390	0.001	0.013	0.056
Fed	1292	1302	1275	1293	1320	0.502	0.346	0.515
Plasma Lys, % of TAA								
Infused	2.77	3.20	3.81	4.22	4.39	0.001	0.518	0.567
Fed	2.46	2.54	2.74	2.61	2.96	0.184	0.809	0.649

Key Words: Cows, Amino acids, Lysine

91 Timing of embryonic mortality and its relationship to serum progesterone in dairy cattle. M. J. Starbuck^{*}, R. A. Dailey, and E. K. Inskeep, *West Virginia University, Morgantown, WV*.

Embryonic mortality, a significant problem in the dairy industry, may be associated with many variables. Several potential factors were studied as predictors of pregnancy maintenance in pregnant dairy cows (N = 211) on two farms. Beginning on d 28 to 36 of gestation, cows were examined by ultrasonography for presence of a viable embryo. Pregnant cows were re-examined every 3 d until d 60 or between d 45 to 51 and d 59 to 66 for presence of an embryo and diameter of the CL and follicles ≥ 5 mm. Blood samples for progesterone were taken at each examination. Breed, age, parity, service number, sire, synchronization, inseminator, and milk production were recorded. Overall embryonic mortality was 11% (13% Farm 1 and 7% Farm 2). Late embryonic (\leq d 45 of gestation) and early fetal ($>$ d 45 of gestation) losses accounted for 67% and 33%, respectively. Cows with two CL maintained fewer pregnancies ($p < 0.01$) than cows with one CL (73% vs. 91%). Two CL did not increase concentrations of progesterone. Because CL appeared functional (progesterone ≥ 1 ng/ml in the sample collected closest before embryo mortality), the embryo apparently died before CL regression. Embryonic loss, but not fetal loss was associated with concentrations of progesterone on d 28 to 37 ($p < 0.01$). Cows in higher body condition at d 28 to 36 maintained fewer pregnancies than cows in moderate or lower condition ($p < 0.05$). Older cows (≥ 5 yr) maintained fewer pregnancies than heifers ($p < 0.05$). Synchronization, inseminator, days postpartum, size of CL, size of largest follicle, number of large follicles, parity, and embryo size at 28 to 37 d or 45 to 51 d did not affect pregnancy retention. In conclusion, embryonic mortality after maternal recognition of pregnancy and during placentation, a significant problem in the dairy industry, is associated with luteal function during d 28 to 37.

Key Words: embryonic mortality, progesterone, dairy cattle

92 The effect of gastrointestinal parasitism on reproductive parameters in lactating dairy cows. J. Sanchez*¹, I. R. Dohoo¹, A. Nodtvedt², and L. DesCôteaux³, ¹Atlantic Veterinary College, University of Prince Edward Island, ²The Norwegian Zoonosis Centre, National Veterinary Institute, ³Faculté de médecine vétérinaire, Université de Montreal.

The effect of gastrointestinal parasitism in adult dairy cows was evaluated in a large clinical trial in two provinces of Canada. The impact of treatment on reproductive performance as measured by calving to conception interval, calving to first service interval and number of breedings was evaluated. Of the 28 dairy farms involved in the clinical trial, 20 of them kept computerized cow records on reproductive parameters. The lactating cows received either eprinomectin pour-on or placebo at calving. The effect of treatment on time to conception and time to first service were evaluated using cox proportional hazard models and a poisson model was used for the number of breedings to conception. A total of 610 cows were included in these analyses. No statistically significant effect for calving to conception interval (hazard ratio=1.16, P=0.20) or calving to first service interval (hazard ratio=1, P=0.53) was observed. There was, however, a 13% reduction in the number of breedings to conception for treated animals (count ratio=0.87, P<0.05). The ability of an indirect ELISA using a crude adult *Ostertagia ostertagi* antigen to discriminate animals that would benefit from treatment was evaluated using individual milk samples from a subset of 109 cows. The ELISA optical density (OD) values obtained between 120 days before calving and drying off were categorized as high OD (>=0.5) and low OD (< 0.5). Among untreated animals, the hazard of conception was lower (hazard ratio=0.38, 95% CI=[0.19,0.75]) for high OD cows compared to low OD cows suggesting that higher parasite burdens had an adverse effect on reproductive performance. Treated high OD cows had a hazard of conception equivalent to the hazard for all cows in the low OD group suggesting that treatment prevented the negative effect associated with these higher parasite burdens. Because of the small sample size in the current study, more works is needed to confirm both, the effect of eprinomectin treatment on reproduction and the ability of the ELISA to discriminate between groups of animals that would potentially benefit from anthelmintic treatment.

Key Words: Eprinomectin, *Ostertagia ostertagi* ELISA, reproduction performance

93 Management definition of alternative herd environments to investigate genotype by environment interaction. E Raffrenato*^{1,2}, R W Blake², P A Oltenacu², and J Carvalheira³, ¹Consorzio Ricerca Filiera Lattiero-Casearia, Ragusa, Italy, ²Cornell University, Ithaca, NY, ³Universidade do Porto, Vairao, Portugal.

Genotype by environment interaction (GEI) reduces and makes unequal the net economic benefits in alternative herd environments. Our objective was to utilize management practices to define herd environment and to investigate the potential GEI. A 2000 survey of 168 Friesian and 74 Brown Swiss herds in southeastern Sicily provided 17 milk yield-enhancing practices that were used to build distance matrices for each breed based on the coefficient of Jaccard. Herds were clustered into high and low opportunity environments based on this information using the Lance-Williams flexible beta method. Genetic parameters were estimated by multiple trait derivative free REML analysis of first-lactation standardized yields of milk, fat and protein, and weighted somatic cell score (WSCS) from 8897 Friesian and 1143 Brown Swiss cows. High opportunity herds outperformed low ones for yield traits. Sire variances for yields were consistently smaller in the low opportunity environments, which is evidence for GEI. Estimated correlated responses indicated substantial opportunity losses in poor environments, including WSCS (0.66 for Friesian and 0.61 for Brown Swiss). Results suggested that these GEI arose from differential use of these management practices. This method of herd clustering was not data dependent, so assumptions are preserved when using standard statistical theory for estimation and testing.

Key Words: genotype environment, genetic parameters, milk yield

94 A comparison of chemical and microbial anti-fungal additives and their effects on the fermentation and aerobic stability of corn silage. D. H. Kleinschmit*, J. M. Neylon, T. L. Ebling, J. M. Ladd, J. E. Lynch, and L. Kung, Jr., University of Delaware, Newark.

Whole plant corn (27%) was ensiled in laboratory silos to investigate the effects of anti-fungal additives on fermentation and aerobic stability. Treatments were: 1) untreated (C), 2) inoculated with *Lactobacillus buchneri* (100,000 cfu/g of fresh forage, Pioneer Hi-Bred, Intl., Des Moines, IA), (PLB), 3) *L. buchneri* (400,000 cfu/g, Biotol, Inc., Eden Prairie, MN), (BLB), 4) Biomax 5 (*L. plantarum* PA-28 and K-270, 100,000 cfu/g, Chr. Hansen Biosystems, Milwaukee, WI), (B5), 5) sodium benzoate, 0.1%, (SB), 6) 50% potassium sorbate and 50% EDTA, 0.1%, (PSE), 7) buffered propionic acid, (0.1%, Kemin Industries, Des Moines, IA), (Ki 112), and 8) Siloguard II (0.05%, International Stock Food Corp., Marietta, GA), (SG). After 122 d of ensiling, numbers of yeasts were lowest in BLB. Aerobic stability was similar among BLB, SB and PSE and were greater (P < 0.05) than all of the other treatments. The concentration of acetic acid was greatest in BLB when compared to other treatments. Silages treated with SB and PSE had lower concentrations of ethanol than did other silages. Only the microbial inoculant, BLB, and the chemical additives, SB and PSE, were able to improve the aerobic stability of corn silage in this study.

Treat- ment	C	PLB	BLB	B5	SB	PSE	Ki 112	SG	SE
Yeasts, log cfu/g	4.42 ^a	3.70 ^a	0.90 ^b	4.82 ^b	3.47 ^a	2.96 ^{ab}	4.25 ^a	4.61 ^a	0.46
Aerobic sta- bility, h	39.3 ^b	45.3 ^b	138.7 ^a	35.3 ^b	164.7 ^a	149.3 ^a	42.0 ^b	33.3 ^b	30.63
DM re- covery, %	93.0 ^b	98.0 ^{ab}	96.1 ^{ab}	94.3 ^b	100.0 ^a	100.0 ^a	95.0 ^{ab}	95.9 ^{ab}	1.24
Acetic acid, %	2.19 ^{bc}	2.47 ^b	2.83 ^a	2.13 ^{cd}	1.86 ^d	2.02 ^{cd}	1.99 ^{cd}	2.08 ^{cd}	0.06
Etha- nol, %	2.76 ^a	3.40 ^a	3.09 ^a	3.39 ^a	0.74 ^b	0.56 ^b	3.57 ^a	3.71 ^a	0.20

a,b,c,d Means in rows with unlike superscript differ (P < 0.05).

Key Words: Aerobic stability, Inoculants, Silage

95 Age-related response of somatotropic axis in Hereford calves from birth to one year of age treated with bovine (b) somatotropin (ST). K.E. Govoni*, T.A. Hoagland, E.F. Jones, D. Schrieber, and S.A. Zinn, University of Connecticut, Storrs, CT, USA.

To determine the effects of bST administration on the somatotropic axis from birth to one year of age in cattle, 10 male (M) and 10 female (F) Hereford calves were used. Within gender, 7 animals were injected with bST (500 mg; Posilac) and 3 were not injected (C). Blood samples were collected (3 samples every 30 min/d) for 7 d before (Pre) and 7 d after (Post) administration of bST on d 50, 100, 150 and 200. To determine response at birth, bST was administered immediately after the sample collection on d 0 (within 24 h of birth). BW were taken at each period. ST and Insulin-like Growth Factor-I (IGF) were analyzed by RIA. IGF Binding Protein (BP) -2 and -3 were quantified by Western Ligand Blot [expressed as arbitrary units (AU)]. Data were analyzed using the Proc Mixed model of SAS. BW were similar for M and F, however ADG was greater in M at 200 d (P < 0.05). In samples taken prior to bST administration, ST decreased from 0 to 200 d (P < 0.01; 34 to 15 ng/mL). However, ST decreased at 50 d in F but not until 150 d in M. In samples taken prior to bST administration, IGF increased over time in M (P < 0.05; 106 to 166 ng/mL), but not in F (P > 0.05; 105 to 116 ng/mL). From 0 to 200 d, BP-2 and -3 did not change and were not different between M and F. Administration of bST increased (P < 0.01) ST and IGF at each period measured from 0 to 200 d. Overall, in samples following bST administration, BP-3 increased (P < 0.05; 51 to 63 AU) while BP-2 decreased (P < 0.05; 51 to 44 AU) at each period from d 50 to 200. From birth to d 5, BP-3 decreased in C animals (P < 0.05; 70 to 33 AU), but no change was observed in bST treated animals

($P > 0.05$; 47 to 57 AU). At birth (d 0) BP-2 was less in bST treated calves than C ($P < 0.05$; 35 vs 61 AU), but BP-2 were similar on d 3 and 5 in bST treated and C animals. Thus, in terms of the somatotrophic axis, calves respond to bST administration, even at birth.

Key Words: Somatotrophic axis, Hereford calves, Bovine somatotropin

96 Differential effect of mammary inflammation on albumin and β -casein concentration in porcine milk. A. C. W. Kauf*, D. C. Pighetti, D. A. Pape, A. L. Magliaro, and R. S. Kensinger, *Penn State University, University Park.*

Mastitis in lactating sows reduces growth performance of the nursing litter (Curtis, 1974; Dyck et al., 1987). Mastitis in dairy cows reduces milk yield and changes milk composition (Carroll and Jain, 1969; Shuster et al., 1991), but less is known about the effects of mastitis on milk composition in the sow. Our objective was to quantify the changes in albumin and β -casein in sow milk in response to an intramammary endotoxin challenge (Kensinger et al., 1999). Nine parity-one Yorkshire sows received intramammary infusions of endotoxin (1.5 $\mu\text{g/gland/kg BW}$) at 0700 on alternating days from d 2-10 of lactation. Endotoxin (ET) was infused into two functional, previously non-infused mammary glands on a total of three days. Milk samples were collected from both ET-treated and control mammary glands between 0900-1200 by manual expression during one or more nursing episodes. Albumin concentrations were determined by ELISA, and β -casein concentrations by Western blot analysis against a standard amount of β -casein. Data were analyzed by the Proc GLM option of SAS. Albumin concentrations in milk were elevated in ET-treated versus control glands (2.12 vs. 1.31 mg/ml, respectively; $P < 0.01$) on d 5-10 of lactation. β -casein concentrations in milk were decreased in ET-treated versus control glands (22.5 vs. 34.2 ng/mg total milk protein, respectively; $P < 0.01$) on d 5-10 of lactation. In addition, SDS-PAGE analysis of milk samples revealed a protein that co-migrated with a bovine lactoferrin standard. Concentrations of this band were greater in early (\leq d 4) versus mature milk (\geq d 5). However, there was little evidence for an effect of endotoxin challenge on the concentration of this putative lactoferrin in milk samples collected 2 to 5 hours post-intramammary infusion. This study shows that albumin increases and β -casein decreases in sow milk in response to intramammary infusion of endotoxin, and probably reflects host defense mechanisms in the sow.

Key Words: Porcine mastitis, Albumin, β -casein

97 Novel birth-weaning feeder reduces time spent learning to drink from an open vessel. R.W. Quinn*, T.G. Hartsock¹, N.C. Whitley², and L.W. Douglass¹, ¹*University of Maryland College Park*, ²*University of Maryland Eastern Shore.*

Teat seeking is an innate behavior of newborn pigs, allowing them to locate teats and begin suckling soon after birth. This behavior has proven to be problematic in the adaptation of neonatal pigs to artificial feeding systems. Piglets weaned into conventional group pens with milk replacer in troughs or modified poultry waterers continue to exhibit teat-seeking behaviors directed toward pen mates and objects within the pen and appear to discover the milk replacer "by accident." Consequently, many take longer than 12 hours to learn to drink unless assisted. A trough-style birth-weaning feeder was designed to take advantage of the

piglets' natural searching behavior in order to reduce the time to learn to drink from an open vessel. Immediately after birth, treatments were randomly assigned to 115 crossbred pigs from 15 litters as a two-by-two factorial. The pen treatments consisted of a novel trough-style Individual Pen feeder (IP, $n=60$) or a commercially available Group Pen feeder (GP, $n=55$). The second treatment designated piglets as Suckled ($n=58$) or Unsuckled ($n=57$) prior to weaning. Each piglet was observed for 6 hours following placement in a weaning pen. Data on time to first drink, general activity, nosing, sucking and aggressive nosing were recorded for each piglet. More IP piglets learned to drink than did GP piglets (82% vs. 16%, $p<.01$). However, in those pigs that did learn, average time to drink was not different between pens (GP $2.6\pm.48\text{h}$, IP $3.1\pm.28\text{h}$, $p=.21$). Prior suckling did not affect success in either pen ($p=.41$). GP piglets had higher levels of activity ($p<.01$) but there was a time x treatment interaction with GP activity being high and declining and IP activity remaining low and constant. GP piglets had higher incidences of nosing ($p<.01$), sucking ($p<.01$) and aggressive nosing ($p<.01$). Suckling did not affect activity levels, nosing or aggressive nosing ($p=.74$, .27 and .54, respectively). Unsuckled piglets had a higher incidence of sucking behavior that approached significance at $p=.053$.

Key Words: Piglet, Behavior, Weaning feeder

98 Development of a new in vitro model for infant colonic fermentation with immobilized cells. C. Cinquin*, G. Le Blay¹, I. Fliss^{1,2}, and C. Lacroix^{1,2}, ¹*Dairy research institut STELA, Quebec, Qc, Canada*, ²*Institut sur les Nutraceutiques et les Aliments Fonctionnels (INAF), Quebec, Qc, Canada.*

Different in vitro models have been used to study human colonic microbiota. However, for many of these models, and particularly chemostats, bacterial concentrations (109 CFU/ml) were much lower than those measured in faeces (1010-1011 CFU/ml), and culture stability was limited. In this work a new colonic fermentation system with immobilized-cells was developed for infant colonic microbiota. Fecal bacteria samples from infant were immobilized in 1-2 mm diameter gel beads (2.5% gellan gum, 0.25% xanthan gum, 0.2% sodium citrate) using a double phase dispersion process. Continuous cultures were carried out in a single-stage chemostat inoculated with immobilized cells, and fed with a medium specially designed to simulate baby diet. Different fermentation conditions (pH and residence times) were tested with the objective to simulate conditions in different sections of the infant colon (proximal, transversal and distal colon). The composition and metabolic activities of the microflora were monitored during a 54-day continuous culture. High survival rates for the major bacterial groups of the fecal flora were measured after immobilization. Bacterial concentrations and metabolic activities measured at steady state in the reactor effluent were influenced by culture conditions. The total population measured in colonized beads after one-week culture was high (>1010 CFU/g), and remained stable afterwards. Cell concentrations for the major bacterial groups in beads were very similar to those measured in fresh feces used for immobilization. Our study showed that cell immobilization could provide an environment more akin to the infant gastrointestinal tract, compared to conventional liquid cultures. This new in vitro model could be used to test the effects of different factors, including probiotics and prebiotics, on the colonic microbiota.

Key Words: Immobilized-cells, Colonic fermentation, Continuous-flow culture

Animal Behavior and Well-Being Influence of Environment on Animal Well-Being

99 Environmental enrichment for neonatal pigs and its influence on post weaning aggression. E.S. Jolly, J.B. Gaughan*, and A.K. King, *The University of Queensland, Gatton, Australia.*

Aggression is a common behavioural reaction seen amongst pigs that are weaned and subsequently mixed with other pigs. Post weaning aggression is harmful in that it can give rise to behavioural vices, lead to decreased productive output, may cause injuries and infection and possibly death. Decreasing the incidence of post weaning aggression and encouraging the incidences of play behaviour may be beneficial. This study investigated the effects of environmental enrichment for neona-

tal pigs and its influence on the incidence of post weaning aggression (tail and ear biting, bites and mouth hits directed towards the head and shoulder). The four treatments used were (i) No enrichment (control), (ii) Toys (either a rubber ball, small rubber tire, PVC pipe, empty plastic drink bottle or ice cream container), (iii) Handling (picking up, patting and stroking piglets as soon as possible after birth, and then for 10 minutes/litter 4 times each week), (iv) Toy plus handling. Forty sows plus litters were used (10 per treatment). Toys were placed with the sow and litter from 5 d of age and rotated every three d. Following weaning (24 d of age) the pigs were allocated to weaner pens based on treatment and blocked for sex. Video surveillance was used to record piglet interactions throughout lactation and for the first 24 h post weaning. The pigs'

aggressive and play behaviours were quantified and analysed using SAS (Chi Square test). There was a significant association ($P < .05$) between treatment and play-aggressive behaviour. There was a positive association ($P < .05$) between the provision of toys and the behaviour displayed by the pigs post weaning (no toy = 821 aggressive bouts and 274 play bouts; toy = 514 aggressive bouts and 1476 play bouts). There was no difference ($P = .48$) in regard to piglet behaviour for either the control, handling or toy plus handling treatments. Environmental enrichment via the provision of toys appears to be a viable option for decreasing the incidences of post-weaning aggression and in turn decrease the occurrence of behavioural vices.

Key Words: Swine, Welfare

100 Heat stress in the outdoor lactating sow: Influence of shaded wallows on behavior, performance and physiology. A. K. Johnson^{*1}, F. M. Mitlöhner¹, J. L. Morrow², and J. J. McGlone, ¹*Pork Industry Institute*, ²*USDA-ARS*.

One hundred ten PIC USA sows and their litters were used to determine the effects of shaded (SH N=53) versus unshaded wallows (CO N=57) on sow behavior, performance and physiology. Sows ranged over five parities and were fed a completely balanced diet. Behavior data were collected by 15-min scan samples, over a 24 h period/wk for 15 wk. All sows were observed twice when litter age was 5 and 15 d respectively. Duration of standing, lying, walking, feeding, inactive, head down, drinking and location within the radial did not differ ($P > .05$) for wallow treatments. Performance parameters were collected from farrowing records but there were no ($P > .05$) differences for wallow treatments or temperature by wallow treatment interactions. Respiration rates (RR) breathes/min were collected on 49 sows over 7 wk when maximum air temperatures exceeded 32°C. Wallow treatments did not ($P > .05$) affect RR rates but there was a wallow treatment by temperature interaction for CO sows which had a higher ($P = .006$) RR compared to SH sows. Blood was collected from the sow on the d of weaning. Physiological parameters measured were total white blood cells (WBC) counts, differentials, acute phase proteins, neutrophil chemotaxis and chemokinesis, and packed cell volume. There were no ($P > .05$) differences for wallow treatments for most physiological measures. However, the treatment by air temperature interaction was significant in that WBC counts (103/L), neutrophil:lymphocyte ratio, and neutrophil chemokinesis decreased ($P < .05$) with warmer temperature, while % lymphocytes and eosinophils increased ($P < .05$) with warmer air temperatures. In conclusion, sows spent large percentages of their time budget inside the farrowing hut and little time at the wallow during warm weather. Shading wallows did not result in improved use or litter performance. While differences were seen in physiological measures all values were within normal physiological ranges for lactating sows indicating that these sows were adapting equally well to the shaded and unshaded wallows.

Key Words: Heat Stress, Sows, Outdoor

101 Effect of gestational stress on sow behavior and subsequent pig response to weaning. M.J. Toscano^{*1}, K.A. Scott¹, H.K. Smith¹, H.G. Kattesh², M.P. Roberts², and D.C. Lay¹, ¹*USDA-Agricultural Research Service -Livestock Behavior Research Unit*, ²*Department of Animal Science, The University of Tennessee*.

Exposing a pregnant sow to stress has been shown to have negative effects on resulting young. However, little knowledge exists regarding the mechanisms of this process or the effects due to specific stressful events. In this study, sows received i.v. injections of ACTH (1 IU/kg BW) (ACTH, n = 15), rough handling (RUF, n = 13), or no treatment (CONT, n = 15) once a wk during d 42 to 77 of gestation. To assess treatment effects, at approximately d 80, sows underwent either a modified open field test (O, n = 22) during which a person stood on one side of the test area or a startle test (S, n = 20) during which a hand was quickly placed directly in front of the sow and latency to touch recorded. Sow productivity data included: birth and weaning weights, litter size, weight gain, sex ratios, ratio of ano-genital to crown-rump (ag:cr) length at birth, viability of individual pigs, and number weaned. To assess the physiological effects of treatments on the pigs, blood was collected (one pig per litter, n = 35) immediately prior to weaning and then every other day for 10 d post-weaning and examined for cortisol and corticosteroid binding globulin (CBG). In the O test, latency to approach the human, number and duration of touches, inner and outer

squares entered, urination, and defecation were not affected by treatment. In the S test, ACTH sows had a greater latency to touch than CONT sows ($P < .04$), but not RUF sows ($P > .10$). Ag:cr in male CONT pigs was greater than ACTH or RUF pigs ($P < .0001$). At weaning CONT pigs had gained more weight than either ACTH ($P = .031$) or RUF ($P = .003$) pigs. Analysis for CBG revealed an effect due to repetitions ($P < .01$), thus repetitions were analyzed separately. In the first repetition, CBG concentrations in CONT pigs were greater than both stress treatments ($P < .003$) though were not different in the second repetition ($P > .46$). Pigs' cortisol concentrations were not affected by treatment ($P > .14$). Our results suggest that stress during the gestation period alters behavior of the sow and gender development, growth, and coping abilities of the offspring to weaning stress.

Key Words: Pre-natal stress, Swine, Welfare

102 The isolation of simulated udder elements to decrease danger to piglets due to crushing. H.K. Smith^{*1}, K.A. Scott¹, M.J. Toscano¹, K.J. Daniels², and D.C. Lay Jr.¹, ¹*Agricultural Research Service - USDA*, ²*Purdue University*.

Three d post-farrowing is the critical period in which sows are more likely to overlay or crush piglets. Crushing accounts for 4.8 to 18 % of piglet mortality. Previous studies found that a simulated udder (SU) decreased the danger of piglet crushing by drawing the piglets away from the dam. The current study was designed to compare the possible attractants of heat, odor, and tactile properties when used with the SU. In each of the 3 experiments, 20 crossbred commercial sows (n = 10 per treatment) and their litters (mean = 9.5) were utilized. All farrowing stalls were equipped with heat lamps and video data were obtained using continuous time-lapse photography (1 frame/.4 s) from 12 to 72 h post-farrowing while the sow was standing using 1-min scan samples and recording the number of piglets using the specific SU or the control treatment. The data were analyzed using generalized estimating equations. Experiment 1 tested the original SU without the odor component of the dam's smell on the cloth against only a heat lamp as the control. Experiment 2 compared the dam's odor on the cloth compared to the cloth alone. Finally, Experiment 3 tested the cloth alone against the heat lamp. Piglet mortality due to crushing was not different in any of the experiments ($P > .10$). The results of Experiment 1 showed no differences between the SU without the dam's odor and the control heat lamp ($P > .10$). In Experiment 2, the only treatment difference was found in the 12 to 24 h period with the cloth without odor, attracting a higher number of pigs than the cloth with odor (.81 and .63 respectively, $P = .005$). Data from Experiment 3 indicate that more piglets were attracted to the cloth without odor (estimated probability = .85) compared to the control of the heat lamp alone (.67, $P = .005$). Thus, pigs are attracted to several stimuli, of those tested in these experiments, tactile properties are substantially potent. These results provide encouraging data for further explorations to decrease the crushing danger to piglets.

Key Words: piglet, crushing, behavior

103 Effects on production, health and behavior of two types of housing for gestating gilts. M.J. Harris^{*1}, A.D. Sorrells^{1,2}, S.D. Eicher², B.T. Richert¹, and E.A. Pajor¹, ¹*Purdue University, West Lafayette, Indiana*, ²*USDA-ARS Livestock Behavior Research Unit, West Lafayette, Indiana*.

The effects on production, health and behavioral time budget of housing gestating gilts during one parity in either individual stalls (n=14) or groups of 4 (n=8; 27 gilts) with individual feeding stalls were evaluated. Animals were limit-fed once per day. Floors were fully slatted with no bedding. All conditions, except for housing type, were identical for the two systems. Gilts were weighed and their backfat measured on d 7, 35, 63 and 91 of gestation. Skin health was evaluated using a 6-point scoring scale every 2 wk. Lameness was scored using a 6-point gait scoring scale when gilts were transferred to the farrowing room. Behavior was videotaped for 24 h at wk 4, 6, 8/9 and 13 of gestation. Stall- and group-housed gilts did not differ in body weight or backfat during the study. Group-housed animals gained on average 20% more weight during pregnancy, but this difference was not significant. There were no differences in skin lesion scores between gilts in the two housing systems on d 7, but by d 91 skin health for several regions of the head, face, body, feet and legs was significantly poorer in group-housed than stall-housed animals ($P < .05$). Lameness scores at transfer to farrowing

tended to be higher in group-housed than stall-housed gilts ($P < .1$). As gestation progressed, gilts spent less time standing ($P < .0001$) and more time lying ($P < .05$), but behavioral time budgets (percentages of time spent standing, lying, sitting, eating and drinking) of stall and group occupants did not differ. When not eating or drinking, grouped gilts spent 24.5% of their time in the feeding stalls and 75.5% in the communal area. In summary, while gilts grouped for one gestation showed more skin injuries and lameness than stalled gilts there were no production or behavioral time budget differences. Housing effects may emerge after several parities, and effects of group systems will vary with design, space allowance and group size.

Key Words: Welfare, Swine, Gestation

104 Evaluation of housing stress on gestating gilts using immunological measures. A.D. Sorrells^{1,2}, S.D. Eicher¹, M.J. Harris², E.A. Pajor², and B.T. Richert², ¹USDA-ARS, West Lafayette, Indiana, ²Purdue University, West Lafayette, Indiana.

The use of gestation stalls in pork production remains a controversial topic in animal welfare. Immune and cortisol measures were determined for Landrace x Yorkshire gilts in groups of four ($n = 8$) compared to gilts housed in standard industry stalls ($n = 14$; 2.21 m x .61 m) to evaluate the stress effect of two housing systems. In an attempt to provide swine producers a practical alternative to controversial gestation stalls, the back gates of four stalls were removed to allow a group of four gilts to interact behind the feeder stalls (3.9 m x 2.4 m). Floors were fully slatted and substrate was not provided for either system. Acute phase proteins, including haptoglobin, α 1-acid glycoprotein (AGP), and fibrinogen, were determined along with granulocyte, lymphocyte and monocyte counts, and hematocrit percentages. Cortisol was determined from saliva 1 h after moving into farrowing crates (d 111), and 24 h and 7 d post-farrowing. Peripheral blood samples were obtained via jugular puncture on d 35, 63, and 91 of gestation and d 3 and 14 post-farrowing. Data analysis was performed using mixed models in SAS[®] as a repeated measures design. Cortisol was significantly higher for animals housed in groups 1 h after moving into farrowing crates and 24 h post-farrowing ($P = .038$). Cortisol concentrations decreased significantly over time for grouped and stalled gilts ($P = .0001$). A time effect also existed for the variables fibrinogen, hematocrit and granulocytes ($P < .0005$). Stalled gilts showed a trend for higher plasma AGP concentrations ($\mu\text{g/ml}$) over grouped animals at d 35 of gestation and d 14 post-farrowing ($P = .07$). Significant differences ($P < .05$) were not found between treatments at any time point for any of the immune measures we examined. These data provide little evidence that the group housing system used was a better or worse alternative to gestation stalls when utilizing acute phase proteins and leukocyte counts as an indicator of welfare.

Key Words: acute phase proteins, swine housing, gestation

105 Cooling during the dry period reduces stress and increases milk production in the next lactation. L. Avendaño-Reyes¹, D. Alvarez-Valenzuela¹, S. Saucedo-Quintero¹, A. Correa-Calderon¹, F. Rivera-Acuña¹, and P.H. Robinson², ¹Universidad Autonoma de Baja California, Mexicali, Mexico, ²UCCE, Dept. of Anim. Sci., UC Davis, Davis, CA.

Twenty four multiparous Holstein cows were blocked by body condition score and assigned to one of two treatments 60 d prior to their anticipated calving date. The treatments were: (1) no cooling system and (2) with a cooling system based on fans with water spray. The cooling system operated from 1000 to 1800 h daily during the entire dry period of the cows, which consisted of the hot summer months (extreme low and high temperatures of 19°C and 48°C). Cows were fed a totally mixed ration ad libitum twice daily at 700 and 1400 h consisting of alfalfa hay (60% of dry matter), wheat straw (18%), wheat grain (15%), wheat bran (5%), and a mineral/vitamin premix (2%). Rectal temperatures and respiration rates were recorded twice daily at 0930 and 1430 h on Tuesday and Friday of every week, and body condition was scored on the same days. Calf birth weights were recorded. After calving, all cows were moved to the same pen, which was provided with shades but had no fans or misters, and fed a ration appropriate for cows in early lactation. Cows were milked twice daily at 0500 and 1700 h. Milk yield was recorded weekly through week eight, and analyzed for fat and crude protein. Data were analyzed by a repeated measures design. During the dry period, when cows were cooled or not cooled, there were no treatment differences in respiration rates or rectal temperatures at 0930 h.

However, cooled cows had lower ($P < .01$) respiration rates (77.5 vs. 84.5 breaths/min) and lower rectal temperatures (39.1 vs. 39.3°C) at 1430 h. Body condition score was higher ($P < .01$) for cooled cows (4.03 vs. 3.93), but calf birth weights were only numerically ($P = .15$) higher (35.7 vs. 32.9 kg). Cooled cows had higher ($P = .03$) milk production (26.03 vs. 24.31 kg). Results show that cooling dry cows using fans with water spray reduced heat stress under these very hot conditions, as indicated by afternoon respiration rates and rectal temperatures, and resulted in higher milk production during the subsequent lactation when cows were treated identically and not cooled.

Key Words: Heat stress, Respiration rate, Rectal temperature

106 Effects of pre-haul management and transport distance on beef calf performance and welfare. M.E. Booth^{*1}, K.S. SchwartzkopfGenswein², T.A. McAllister¹, G.J. Mears¹, A.L. Schaefer³, N. Cook³, J.S. Church⁴, and D.H. Crews Jr.¹, ¹Agriculture and Agri-Food Canada, Lethbridge, AB, ²Alberta Agriculture, Food and Rural Development, Lethbridge, AB, ³Agriculture and Agri-Food Canada, Lacombe, AB, ⁴Alberta Agriculture, Food and Rural Development, Red Deer, AB.

Growth performance, morbidity rates, behavior and physiological indicators of stress were assessed in 174 steer calves (219.3 \pm SE 0.21 kg) for 30 d after transport from ranch to feedlot. Blocked by birth date, the calves were preconditioned (P) or not (N), and subjected to short- (3 h, S) or long hauling time (15 h, L), yielding treatments PS, PL, NS and NL. Upon arrival at the feedlot, they were blocked by weight and assigned to 16 pens (four pens per treatment, one of which was equipped with a radio frequency identification system (GrowSafe Systems) for continual monitoring of individual bunk attendance (15 calves). Steers were fed a barley silage/barley grain-based backgrounding ration and weighed every 7 d. In transit, PS steers recorded the lowest heart rate (HR, 67.4 bpm \pm SE 1.46; $P < 0.05$). During a mid-journey stop, a significant decrease in HR, as compared to in-transit HR, was observed in all PL and NL steers. During the first 24 h at the feedlot, PL calves drank 66% more often than NL calves; PS 46% more often than NS. A preconditioning \times hauling time interaction was observed on shrinkage ($P < 0.001$) and ADG ($P < 0.05$). Shrinkage was greater ($P < 0.001$) in PL than in NL steers, and in NL than in either PS or NS steers ($P < 0.001$). The lowest ($P < 0.005$) ADG was recorded for PL calves (0.986 \pm SE 0.073 kg), although their DM intake (6.75 kg/d \pm SE 0.13) was similar ($P > 0.05$) to calves in the other treatment groups. The PS calves had the highest ($P < 0.05$) DM intake, followed by PL which were not significantly larger than either NL or NS intakes. Morbidity rate was 5.17% with no treatment effect. For single source cattle, the effect of preconditioning was to increase intake and reduce in-transit HR. However, the interaction between preconditioning and long haul may impinge on short term performance.

Key Words: Cattle, Transport, Welfare

107 Cow distribution within two different types of free-stall barns at varying temperatures. K. A. Koudele^{*}, L. D. Birney, and L. H. Adams, *Andrews University, Berrien Springs, MI.*

The objective of this study was to determine if cows housed in the greenhouse-style barn exhibited greater comfort than those in a steel-frame barn as defined by their distribution within each barn during varying ambient temperatures. The greenhouse structure was manufactured by Solar Barn[®]. Both barns were 30 X 90 m with 4.2 m high roll-up curtain sidewalls. The greenhouse barn roof was covered with white polypropylene. No shade cloth was used. The interiors of the barns were identical in size including alley widths and freestall dimensions. The grooved cement flooring had a slope of 1.5%. Ventilation was provided by the rolled-up sidewalls and by 1 m diameter fans located 6 m apart at eave height. The herd of 550 head was milked 3 times d in a double-12 parallel parlor, and had a RHA of 11,000 kg. The distribution of the cows within each barn was recorded prior to the start of the 1100 h milking. Temperatures were measured at cow head height in the middle of each barn. At 30°C the cows in both barns showed significant ($p \leq .05$) crowding with more than 85% in the upper half of each barn. At 8°C the cows in both barns were distributed significantly ($p \leq .05$) more evenly throughout the length of the barn. A more uniform distribution pattern was also seen at -3°C, however, there was a tendency ($p \leq .10$) for the cows to avoid the more open ends of the barn with fewer than 1% within 10 m of each end in the steel-frame barn.

However, in the greenhouse barn the actual number of cows within 10 m of each end was not different from expected ($p \geq .05$). These results indicate that at 30°C and at 8°C there was no difference in cow comfort based on animal distribution between the two types of barns. However, at -3°C the cows in the greenhouse barn utilized more of the floor space thereby reducing crowding and increasing cow comfort. This could be due in part to the radiant heating that occurred within the greenhouse barn but not the steel-framed barn.

Key Words: Dairy Cattle Behavior, Greenhouse Barn, Temperature

108 Factors affecting cow preference for stalls with different freestall bases in pens with different stocking rates. A.M. Wagner-Storch and R.W. Palmer*, *University of Wisconsin-Madison*.

Stall use was monitored using a closed circuit television system in a 4-row, 104-stall freestall barn. Stall status was recorded four times each day, 1400, 2000, 0400, and 0900 h, for a 9-mo period, 5/9/01 to 2/9/02. Two measures of cow preference, stall with cow lying or stall occupied (cow lying or standing in stall). The objective was to compare percentages of cow preference measures for each factor affecting use of stalls with different freestall bases. Six factors were analyzed: freestall base, distance to closest water, stall located at the end of a stall type section (END vs. NotEND), row of stalls (INTERIOR vs. EXTERIOR (wall side)), inside barn temperature (TEMP), and length of time animals exposed to freestall bases (XPOS). One pen had a low stocking rate (LowSR, 66%), five different freestall bases [mattresses-MATR1 and MATR2, waterbeds (WATR), soft rubber mats (SRMAT), and concrete (CONC)], and cows were milked with a robotic milker. The other pen had a 100% stocking rate (100%SR), the same five freestall bases, plus a sand (SAND) freestall base, and cows were milked 2X in a herring-bone parlor. Each pen was analyzed separately because of different stocking rates and cow movement control. Freestall bases were grouped with 3 to 7 stalls/section and randomly placed in each row. Results show both sides of the barn having significant differences ($P < .05$) between all freestall bases for lying and occupied. Stall usage for the 100%SR side for lying was SAND (69%), MATR1 (65%), MATR2 (57%), WATR (45%), SRMAT (33%), and CONC (23%), whereas, occupied was MATR1 (88%), MATR2 (84%), SAND (79%), SRMAT (65%), WATR (62%), and CONC (39%). Stall usage for the LowSR side for lying was MATR1 (45%), MATR2 (39%), WATR (26%), SRMAT (12%), and CONC (10%), whereas, occupied was MATR1 (60%), MATR2 (55%), WATR (34%), SRMAT (19%), and CONC (16%). Lying and occupied was highest ($P < .05$) for stalls 1) the farthest distance from water, 2) NotEND, and 3) on EXTERIOR for both sides. Lying and occupied varied for XPOS and TEMP for each freestall base. Cows spent more time on mattress bases, but highest percentage lying was in sand bases. Cows may prefer to stand on mattress bases to concrete alleys. Location appears to impact lying in or occupying stalls.

Key Words: Freestall Base, Cow Preference, Stocking Rate

109 Rubber flooring affects behaviour of dairy cows, especially animals with hoof injuries. J Fregonesi, F Flower, T Vittie, C Tucker, and DM Weary*, *Animal Welfare Program, Faculty of Agricultural Sciences, University of British Columbia*.

Flooring surfaces can affect the comfort of animals housed indoors, such as dairy cows in free-stall barns. The impact of flooring features may be particularly important for animals with hoof injuries. In the current experiment, four groups (each of 12 cows) were alternately housed

in sections of a free-stall barn with either rubber flooring or grooved concrete covering the area in front of the feed alley. Each group was followed for a 3-wk period on each surface, and individual behavioral responses were scored using 24 h time-lapse video recordings. Cows on the concrete surface spent 12.9 % of the available time standing inactive. This value increased to 15.5 % when cows were on the rubber flooring (s.e. = 0.4 %, $P < 0.001$). The increased standing time on the rubber was due in part to reduced time lying in the free stall (52.1 vs. 53.7 % lying, s.e. = 0.4, $P < 0.05$). Cows spent 20% of their time feeding, regardless of the flooring. The presence and severity of hoof lesions was assessed after hoof trimming. Cows with more lesions spent less time lying in the stall ($r = -0.42$, $P < 0.01$), and more time standing with their front two feet in the free stall ($r = 0.64$, $P < 0.001$), particularly when on concrete flooring (floor * lesion interactions, $P < 0.05$). Cows with lesions also spent less time feeding ($r = -0.39$, $P < 0.01$), but there was no interaction between this effect and the flooring. In conclusion, flooring for dairy cattle can have important effects on their behavior, especially for those cows with injured feet.

Key Words: Flooring surface, Behavior, Welfare

110 Effects of stall surface on occupancy and postural changes in dairy cows. D. C. Lay Jr.*¹, L. L. Timms², and D. R. Thoreson², ¹ARS-USDA-Livestock Behavior Research Unit, West Lafayette, IN, ²Iowa State University, Ames, IA.

A great deal of concern is allotted toward dairy cow comfort in order to optimize both cow welfare and milk production. Toward this end, producers are utilizing various stall surfaces in order to optimize cow comfort, while at the same time decreasing health concerns. Experiment 1 was designed to determine which surface the cow preferred. We compared 6 different free-stall surfaces: A. 2" rubber mat-Dynamatrix[®]; B. Sand; C. Mattress - AgroMatic[®]; D. Mattress - Pasture Mat #1[®]; E. Sand with Sand Saver; F. Mattress - Pasture Mat #2[®]. Our goal was to allow the cows to choose the surface on which they preferred to lie. Therefore, a free stall barn was built to include 60 free-stalls that were randomly assigned to receive one of the six stall surface types. The barn was stocked at 95% capacity. The study was conducted between July and December, during which 7 d of observations were collected during each of three separate study periods. Data collected included whether the stall was occupied and the cows body position in the stall. Experiment 2 was conducted using tie stalls which were either bedded with sand or used a mattress (Pasture Mat[®]) for flooring ($n = 8/\text{trt}$). Data were collected for 17 d (Rep 1), when the flooring was new, and then again, two years later, for a 22 d period (Rep 2) to record cow position. During Rep 2, data were collected for 8 days, cows were moved to the alternate flooring, and data were again collected 6 d later for an 8 d duration. Data for Exp. 1 shows a distinct seasonal affect, with cows occupying stalls in treatment $B > E > C, D > F > A$ ($P < 0.0001$) during July, but this pattern changed to $D, E, F > A, B, C$ ($P < 0.0001$) by late September. A very similar pattern of usage was seen for late November. Data from Experiment 2, Rep 1, found that cows on mats were more likely to be found lying ($P < 0.001$), compared to cows on sand. However, by Rep 2, we found no differences in resting behavior between treatments ($P > 0.10$). Collectively, these data indicate that cows do have a preference for the type of surface on which they lie, and that these preferences can change during the season. However, behavior of cows in tie stalls may not be fully indicative of these preferences.

Key Words: dairy, stall, comfort

Animal Health Immunology and Management

111 Immunological and growth performance responses of finishing steers supplemented with menhaden fish oil. T. J. Wistuba*, E. B. Kegley, and M. E. Davis, *University of Arkansas, Fayetteville AR / USA*.

Inclusion of fish oil in ruminant diets may fortify the fatty acid composition of meat and modulate the immune system. Therefore, an experiment was conducted to determine the effects of supplemental menhaden fish oil on growth performance and immune function of beef calves. The 72-d study used 20 crossbred steers (438 ± 28 kg initial BW; 2

calves/pen; 5 pens/dietary treatment). Dietary treatments consisted of either a control (75% corn, 11% soybean meal, and 10% cottonseed hull) diet or the control diet with 2% fish oil. Steers were weighed on d 0, 1, 21, 42, 63, 72, and 73. On d 0, 21, 42, and 63 all calves were bled by jugular venipuncture, and *in vitro* blastogenic response of peripheral lymphocytes to phytohemagglutinin (PHA), concanavalin A (CONA) and pokeweed mitogen (PWM) was measured. Fish oil supplementation decreased ADFI (14.52 vs. 13.28 kg, $P < 0.05$, as-fed); conversely, it had no effect on ADG or gain/feed (2.08 vs. 1.89 and 0.14 vs. 0.14;

$P > 0.10$). There was no effect of fish oil on mitogen stimulation of isolated lymphocyte proliferation on d 0, 21, or 63. However there was a treatment \times time interaction ($P < 0.01$) because lymphocytes isolated on d 42 from calves fed the control diet with 2% fish oil had a smaller proliferation response to stimulation with CONA ($P < 0.01$) and PWM ($P < 0.01$) and tended to have a smaller response to stimulation with PHA ($P < 0.08$) than lymphocytes from calves fed the control diet. Since CONA predominantly stimulates T cells, PWM predominately stimulates B cells, and PHA stimulates both T and B cells, this change indicated that fish oil supplementation on d 42 limited the proliferation of both sets of lymphocytes. Skin-fold response to intradermal injection of PHA on d 71 did not differ among treatments. Fish oil supplementation in this trial had no negative effects on growth performance or feed efficiency. Results indicated that fish oil supplementation did modulate the immune system on d 42. More research may be required to document or elicit the exact immunological changes that occur at the cellular level.

Key Words: Menhaden fish oil, Finishing cattle, Immune response

112 *In vitro* cytotoxicity of aflatoxins B1, M1, ochratoxin A and protective effects of antioxidants. A. Baldi*, E. Fusi, R. Rebucci, L. Pinotti, F. Cheli, and V. Dell'Orto, Department VSA, University of Milan, Italy.

The aim of this work was to investigate the capability of different antioxidants to reduce the *in vitro* cytotoxicity of aflatoxin B1 (AFB1), M1 (AFM1) and ochratoxin A (OTA). Five cell lines were used: MDCK (Madin Darby Canine Kidney), LLC-PK1 (Pig Kidney), AML-12 (Mouse Liver Hepatocytes), SKNMC (Human Neuroblastoma) and BME-UV1 (Bovine Mammary Epithelial). Since mycotoxin biotransformation comprises cytochrome P-450 mediated reactions, the cells were preliminarily tested for their cytochrome P-450 activity evaluated by ethoxyresorufin O-deethylation (EROD) method. The effects of mycotoxins on cell viability were evaluated by the cellular methylthiazoltetrazolium (MTT)-cleavage activity. AFB1, AFM1 and OTA, were added to the culture medium at different concentrations (0.07, 0.15, 0.30, 0.60, 1.25, 2.5, 5, 10, 20, 40 $\mu\text{g/ml}$) and biological effects were evaluated at different incubation times (24, 48 and 72 h). The concentration of the toxin giving 50% cytotoxicity (LC_{50}) was determined. AFB1 LC_{50} after 24 hours was: BME-UV1 = $32.3\mu\text{g/ml}$, AML-12 = $89.8\mu\text{g/ml}$, SKNMC = $24.5\mu\text{g/ml}$. LC_{50} of AFM1 on BME-UV1 was $6\mu\text{g/ml}$. OTA cytotoxicity was: BME-UV1 = $8\mu\text{g/ml}$, AML-12 = $26.5\mu\text{g/ml}$, SKNMC = $26.8\mu\text{g/ml}$, LLC-PK1 = $26.7\mu\text{g/ml}$ and MDCK = $14.5\mu\text{g/ml}$. AFB1 treatment caused a time-dependent effect with a significant decrease in LC_{50} values within 72h. No significant time dependent effect was observed in AFM1 and OTA cytotoxicity. In order to evaluate inhibitory effects of antioxidants on cytotoxicity, BME-UV1 cells, the most sensitive, were cultured in combination with LC_{50} doses of mycotoxin in presence or absence of Retinol, α -Tocopherol and β -Carotene (0.01 mM and 0.001 μM). α -Tocopherol treatment induced a significant decrease in cytotoxicity at LC_{50} dose (51.5 ± 5.57 vs 39.2 ± 4.21 ; $P < 0.05$), no significant effects of Retinol and β -Carotene on *in vitro* cytotoxicity was found. To conclude α -Tocopherol was able to inhibit by 12% OTA, but not AFB1 and M1 cytotoxicity. Supported by MURST 2000 COFIN Baldi.

Key Words: Cytotoxicity, Mycotoxins, Antioxidants

113 *In vitro* evaluation of the oxidative damage induced by mycotoxins. E. Pavoni¹, B. Bertasi^{*1}, M.N. Losio¹, and A. Baldi², ¹IZS, Brescia - Italy, ²Department VSA, University of Milan - Italy.

The aim of this work was to evaluate the involvement of reactive oxigen species (ROS) in the Ochratoxin A (OTA) and Aflatoxin B1 (AFB1) cytotoxicity. Madin, Darby canine kidney (MDCK), pig kidney (LLC-PK1), mouse liver hepatocytes (AML-12) and human neuroblastoma (SKNMC) cell lines were used for OTA. SKNMC, AML 12 and bovine mammary epithelial (BME-UV1) cell lines were tested for AFB1. Cells were incubated with different concentrations of OTA (0, 5, 10 and 20 $\mu\text{g/ml}$) and AFB1 (0, 2.5, 5, 10, 20 and 40 $\mu\text{g/ml}$). ROS production was measured at different times (24, 48 and 72 h) by dichlorofluorescein (DCF) method. OTA-induced ROS production in MDCK and LLC-PK1 cells was significantly higher ($P < .05$) than the one induced in the nervous SKNMC cell line. ROS production by OTA was increased in a dose dependent manner in MDCK and SKNMC cells. A time dependent effect

was observed for OTA-treated cells, with a significant ($P < .05$) increase in ROS production within 48 h. No significative ($P > .05$) variation of ROS production was observed in OTA-AML 12 treated cells. Quantitative analysis of ROS production in OTA-treated (20 $\mu\text{g/ml}$) cells is summarized in table. No significant ($P > .05$) variation of ROS production was observed in AFB1-treated cell lines. To conclude, the results show that OTA cytotoxicity is strongly related to oxidative damage, mainly detected in renal cell lines, derived from the *in vivo* target tissue. Conversely, results suggest that AFB1-cytotoxicity does not appear to be directly associated to oxidative mechanism detected by ROS test. Supported by MURST Cofin 2000 - Baldi grant.

	ROS, fluorescence units \pm SE		
	24h	48h	72h
MDCK	6369 \pm 6.1 ^a	9658 \pm 6.4 ^b	9976 \pm 7.2
LLC-PK1	5187 \pm 17.4 ^a	8662 \pm 13.4 ^b	8995 \pm 17.6
SKNMC	4021 \pm 6.7 ^a	8124 \pm 4 ^b	9021 \pm 9.3
AML 12	1113 \pm 36	—	—

^{a,b} Means on the same row with different superscript are different ($P < .01$).

Key Words: mycotoxins, ROS, cytotoxicity

114 Effect of intravenous infusion of increasing amounts of lipopolysaccharide on plasma macro-mineral, vitamin D, and protein concentrations in lactating dairy cows. M. R. Waldron^{*1}, B. J. Nonnecke², T. Nishida¹, R. L. Horst², M. R. Foote³, and T. R. Overton¹, ¹Cornell University, Ithaca, NY, ²National Animal Disease Center (NADC), USDA ARS, Ames, IA, ³Iowa State University, Ames, IA.

Four multiparous lactating cows (175-220 DIM) were used in a 4x4 Latin square design to assess the effects of increasing doses (0.0, 0.5, 1.0, 1.5 $\mu\text{g/kg}$ BW) of lipopolysaccharide (LPS; *E. coli* 0111:B4) on plasma concentrations of macro-minerals, vitamin D, and protein. Treatments were dissolved in 100 ml of sterile saline and infused intravenously over a period of 100 min. Blood was sampled immediately before infusion (0 h), at 60-min intervals for 8 h, and at 24 and 48 h postinfusion. Vitamin D metabolites were analyzed in 0, 2, 6, 24, and 48 h samples only. Parallel response trends were observed for all doses of LPS administered; therefore, LPS response data were combined and analyzed as either 0 $\mu\text{g/kg}$ BW LPS (CTL) or all doses of LPS combined (TRT). Plasma calcium (9.52 vs. 8.57 mg/dl, SE=0.36) and phosphorus (5.81 vs. 4.26 mg/dl, SE=0.34) concentrations decreased after LPS infusion ($P < 0.05$ and $P < 0.005$, respectively), but differences in plasma magnesium concentrations were not significant (2.16 vs. 2.21 mg/dl, SE=0.04; $P > 0.20$). Plasma 25-OH vitamin D₃ (80.4 vs. 75.9 ng/ml, SE=3.5) was not different ($P > 0.20$), whereas 1,25-(OH)₂ vitamin D₃ (50.9 vs. 42.1 pg/ml, SE=3.8) tended to decrease ($P = 0.08$) after LPS infusion. Differences in plasma protein concentration (7.72 vs. 7.55 g/dl, SE=0.10) after LPS administration approached a trend ($P = 0.17$). These data suggest that the inflammatory response elicited by LPS alters plasma macro-mineral and vitamin D concentrations that are important for calcium homeostasis and metabolic health of lactating dairy cows.

Key Words: Lipopolysaccharide, Minerals, Vitamin D

115 Endotoxin (LPS) administration uncouples growth hormone (GH) regulation of insulin-like growth factor-1 (IGF-1): decreased signal transduction STAT-5b phosphorylation. T. H. Elsasser* and S. Kahl, USDA-ARS, Growth Biology Laboratory, Beltsville, MD.

We employed immunohistochemical assessment of phosphorylation of STAT-5b and the induction of an endogenous, proinflammatory cytokine-driven inhibitor of JAK-2 kinase, CIS-SOCS-3, to determine whether signal transduction processes are affected by LPS challenge (to mimic an immune stress) when in the host response to stress GH regulation of IGF-1 is lost. Liver tissue was obtained by transcutaneous biopsy 6 h after the administration of LPS (*E. coli* 055:B5, 3 $\mu\text{g/kg}$ BW, i.v. bolus) or saline to heifers (mean BW 334 ± 12 kg, synchronized to diestrus). The 6-h point was chosen based on previous data showing that this was the earliest time after LPS that plasma IGF-1 was consistently and significantly decreased. STAT-5b phosphorylation capacity was tested by administering recombinant bovine GH (Monsanto,

Co., Inc., 50 mg/heifer, i.v. bolus, n = 8) 5 to 8 min prior to obtaining the biopsy cores. Fixed and deparaffinized biopsy tissues were incubated with primary antibody for phosphorylated STAT-5b (pSTAT-5, Tyr-PO4-694, B-D Transduction Labs) and CIS-SOCS-3 (IBL Co., Ltd). Antigen visualization on slides was accomplished by avidin-biotin complex enhanced horseradish peroxidase deposition of diaminobenzidine. Plasma IGF-1 was measured by RIA. Plasma IGF-1 concentrations in LPS heifers were depressed 32% at 6 h ($P < 0.05$) compared to controls. The percentage of hepatocytes staining for pSTAT-5 increased 5-fold ($P < 0.05$) after GH challenge in heifers not receiving LPS. In contrast, pSTAT-5 was not detected in tissue from LPS-challenged heifers. CIS-SOCS-3, which inhibits the JAK-2 kinase phosphorylation of STAT-5b, was present in control heifers only in Kupffer cells and unaffected by GH challenge. LPS challenge resulted in intense increased staining in the Kupffer cells but also in hepatocytes. The data suggest that perturbed phosphorylations in the GH signal transduction pathway contribute to the uncoupling of GH control of IGF-1.

Key Words: Growth hormone, Signal transduction, Endotoxin

116 Growth, feed intake, and acute phase protein response of two genotypes and genders to an acute challenge with lipopolysaccharide (LPS). J. W. Frank^{*1}, R. W. Ratliff¹, G. L. Allee¹, R. D. Boyd², and M. A. Mellencamp², ¹University of Missouri - Columbia, ²PIC USA, Inc.

This study was conducted to evaluate the response of two genetic lines of pigs to increased levels of endotoxin challenge. In addition, C reactive protein was measured to determine its potential use as a biomarker of immune response. Thirty-six pigs (BW = 21.3 kg) were allotted by genotype (Line 1 and Line 2) and sex (B and G) to one of three LPS treatments. Lines 1 and 2 were generated by mating two dam lines to one sire line. Treatments were an i.m. injection of 0 (LPS-0), 25 (LPS-25), or 50 ug LPS/kg BW (LPS-50). Pigs were penned individually and weighed on d 0 and 7. Feeders were weighed daily to establish baseline feed intake (ADFI -48 to 0 h relative to injection). Acute feed intake response (AFIR) is ADFI 0 to 48 h after injection divided by baseline intake. Serum was harvested at time 0 and 48 h after injection to measure C reactive protein. LPS-0 pigs grew faster and consumed more feed than LPS-25 or LPS-50 pigs (0.79 vs. 0.51 and 1.15 vs. 0.93 kg/d, respectively; $P < 0.001$). There was also a sex x genotype x LPS interaction for ADG ($P < 0.04$). Line 1 B and Line 2 G had similar decreases in ADG at LPS-25 and LPS-50 compared to LPS-0, whereas Line 1 G and Line 2 B had decreased ADG with increased LPS dose. A sex x genotype x LPS interaction was also observed for AFIR ($P < 0.05$). Line 1 B and Line 2 G responded similarly to both LPS doses, while Line 1 G and Line 2 B had decreased AFIR with increased LPS dose. Three of twelve B and no G died following the LPS challenge ($P < 0.10$). Line 1 had higher baseline C reactive protein concentrations than Line 2 (171 vs. 83 ug/ml; $P < 0.05$). No differences were observed for C reactive protein 48 h after challenge. A net change in C reactive protein of #71 and 19 ug/ml resulted for Line 1 and 2, respectively ($P < 0.11$). Based on these data, C reactive protein may not be a good indicator of immune stimulation as a result of an LPS challenge. Additionally, barrows and gilts within genetic lines may respond differently to an endotoxin challenge.

Key Words: Pigs, LPS, Genotype

117 Effect of dexamethasone (DEX) and insulin-like growth factor-1 (IGF-1) on pokeweed mitogen (PWM)-induced lymphoproliferation and immunoglobulin production. A.L. Delgado^{*1}, T.H. Welsh, Jr.², and J.C. Laurenz¹, ¹Texas A&M University-Kingsville, ²Texas A&M University-College Station.

This study investigated the effect of IGF-1 and the synthetic glucocorticoid, DEX, on PWM-induced lymphoproliferation and immunoglobulin M (IgM) production in vitro. Blood was obtained from male, crossbred pigs (n=3 pigs/experiment; 35-45 days of age) and lymphocytes isolated by density gradient centrifugation. Lymphocytes were plated in 96-well plates at 1×10^5 cells/well in DME/F12 containing 10% fetal bovine serum, 2 mM L-glutamine, 10 uM 2-mercaptoethanol, PWM (0 to 1000 ng/mL), DEX (0 to 10^{-6} M) and/or IGF-1 (0 to 200 ng/mL). Cultures were incubated for 96 h and proliferation determined using the CellTiter proliferation assay (Promega, Madison, WI). In replicate cultures, supernatants were removed and IgM production determined using an ELISA. As expected, PWM induced dose-dependent increases

($P < 0.01$) in proliferation and IgM production with maximal effects occurring at 12.5 and 160 ng/ml, respectively. DEX dose-dependently inhibited ($P < 0.01$) PWM-induced (3.1 and 12.5 ng/mL) proliferation with 74 and 50% inhibition occurring at 1×10^{-7} M. Similarly, DEX dose-dependently inhibited ($P < 0.01$) PWM-induced (20 ng/mL) IgM production with maximal 50% reductions in IgM production occurring at 10^{-6} M. In contrast, in cultures treated with higher concentrations of PWM (>80 ng/mL) DEX (10^{-7} M) augmented IgM production. IGF-1 did not affect ($P = .21$) PWM-induced lymphoproliferation. Similarly, IGF-1 did not affect ($P > .05$) IgM production at higher levels of PWM (160 and 320 ng/mL), but did dose-dependently increase ($P < .05$) IgM production at lower concentrations of PWM (80 ng/mL) with maximal effects at 25 ng/mL IGF-1 (2837 ± 740 vs 4725 ± 907 ng/mL IgM, respectively). In addition, IGF-1 provided modest protection ($P < .05$) against DEX-mediated suppression of PWM-induced lymphocyte proliferation and IgM production and enhanced ($P < .05$) the DEX-mediated augmentation of IgM production at higher concentration of PWM (>80 ng/mL). Collectively, these results demonstrate that IGF-1 can enhance lymphocyte function and reduce the suppressive effects of glucocorticoids suggesting that IGF-1 may be useful to modulate immune function in young pigs.

118 Toxicity of ergovaline on Caco2 cells as assessed by MTT, alamarBlue, and DNA analysis. N.W. Shappell^{*}, ARS-USDA.

The exact mechanism of fescue toxicity has yet to be established, but it has been associated with an inability to thrive. Ergovaline has been identified as the major ergopeptine alkaloid associated with fungal infections of tall fescue. The gastrointestinal (G.I.) toxicity of ergovaline was evaluated in a Caco2 cell system which mimics the G.I. epithelium. Cells were plated at 1×10^5 cells per well (96 well plates) in DMEM, with 9.1% fetal bovine serum. Ergovaline in methanol was tested at 1×10^{-4} to 10^{-11} M beginning on da 1, 8, and 18 in culture. Acute and chronic toxicity was assessed after 24 and 72h of exposure to ergovaline. Treatment periods were chosen to study undifferentiated, semi-differentiated, and completely differentiated cells. Cell toxicity was assessed by MTT (thiazolyl blue) reduction (mitochondrial succinate dehydrogenase activity), alamarBlue assay (cytochrome oxidase activity), and total DNA. Undifferentiated cells were sensitive to 0.1 mM ergovaline after acute exposure (74%, 56%, and 53% of control values for MTT, alamarBlue, and DNA respectively, $P \leq 0.0001$) or chronic exposure (6%, 13%, and 0.3% as indicated above). By da 11 in culture, cell toxicity to ergovaline had decreased, and after 24h of exposure a ~12% increase in MTT was seen (1 nM, 10 nM, and 0.1 mM - $P \leq 0.02$, 0.01, and 0.0002, respectively). After 72h of exposure to 0.1 mM ergovaline, all three parameters were reduced ~20 to 30% (MTT 26%, $P \leq 0.0001$, alamarBlue 31%, $P \leq 0.0001$, and DNA 16 %, $P \leq 0.006$). Fully differentiated cells exhibited increased MTT activity (~20%) again, after 24h exposure at all concentrations except 0.1 nM, while alamarBlue activity was decreased at all concentrations (~15%). A ~15% elevation in MTT was found after 72h exposure from 1 nM to 10 μ M ergovaline, while both MTT and alamarBlue activity decreased ~13% with 0.1 mM ergovaline. No change in DNA was found until 72h of exposure, when DNA was reduced ~12% over most concentrations. These findings indicate variable sensitivity of G.I. cells to ergovaline, dependent on the state of differentiation. Ergovaline (0.1 mM) is toxic to undifferentiated cells, while differentiated cells are much more resistant to its toxic effects.

Key Words: ergovaline, toxicity, DNA

119 Effects of segregated early weaning on systemic and enteric T lymphocyte subpopulations in pigs. D. C. Brown^{*}, C. V. Maxwell, M. E. Davis, G. F. Erf, and S. Singh, University of Arkansas, Fayetteville.

Systemic and gut T lymphocyte subpopulations were compared between pigs reared in on-site and off-site facilities. Crossbred pigs were weaned at 19 ± 2 days of age and allotted to one of two facilities based on initial BW (5.94 ± 0.07 kg on-site; 5.87 ± 0.07 kg off-site). Pigs in each group were divided into four weight groups, allotted into equal subgroups (2 or 3 pigs/pen) and stratified based on sex and litter. All pigs received common diets and were managed similarly. On d 1, 3, 11, and 24 post-weaning, one pig from each weight group was randomly sacrificed (n=4 per facility) and blood mononuclear cells and intraepithelial lymphocytes (IEL) were isolated for single and double stain analysis using flow cytometry techniques. Compared to other days sampled the percentage

of blood T lymphocytes were greater ($P \leq 0.01$) on d 24 post-weaning, the percentage of CD4+ cells was higher ($P \leq 0.05$) on d 1 post-weaning, and double positive cells (CD4+CD8+) were lower ($P \leq 0.10$) on d 3 post-weaning in pigs from both facilities. On-site pigs had a higher ($P \leq 0.10$) percentage of CD4+ IEL at d 1 post-weaning compared to off-site pigs on d 1, 3, 11 and 24 post-weaning. After d 1 post-weaning, the percentage of CD4+ IEL decreased ($P \leq 0.05$) in on-site pigs and the percentage of CD8+ IEL in the off-site pigs increased ($P \leq 0.05$). The percentage of CD8+ IEL then decreased ($P \leq 0.05$) on d 24 postweaning for off-site pigs. The percentage of CD8+ IEL was higher ($P \leq 0.05$) for the off-site pigs on d 3 and 11 postweaning than on-site pigs on d 3 post-weaning. Off-site pigs had a higher ($P \leq 0.05$) percentage of IEL positive for the gamma/delta T cell receptor on d 1 post-weaning compared to on-site pigs on d 1, 11 and 24 post-weaning and off-site pigs on d 3 and 11 post-weaning. Double positive and CD8+CD4- IEL were lower ($P \leq 0.05$) on d 1 and 3 post-weaning than d 11 and 24 post-weaning. These data suggest that the differing nursery environment alters systemic and enteric T cell subpopulations.

Key Words: T cell subpopulations, Intraepithelial lymphocytes, Nursery pigs

120 Bacterial colonization of the neonatal pig gut is altered by enteral versus parenteral feeding. R. B. Harvey^{*1}, K. Andrews¹, R. E. Droleskey¹, K. V. Kansagra², B. Stoll², D. G. Burrin², K. J. Genovese¹, T. S. Edrington¹, R. C. Anderson¹, and D. J. Nisbet¹, ¹Food and Feed Safety Research Unit, USDA-ARS, College Station, TX USA, ²USDA-ARS-Children's Nutrition Research Center, Baylor College of Medicine, Houston, TX USA.

Sepsis in preterm human infants has been associated with total parenteral nutrition (TPN), and it has been suggested that sepsis may occur due to translocation of gut luminal bacteria. In this study, we compared the effects of TPN versus enteral (ENT) feeding on intestinal bacteria translocation. Newborn, colostrum-deprived pigs (<24 h old) were fitted with intravenous catheters and divided into two groups. One group (n = 13) received TPN through intravenous feeding and the second group (n = 14) was orally fed a commercial pig milk-replacer (ENT); the nutrient intake did not differ between groups. After 7 d of treatment, pigs were euthanized and jejunum (J), ileum (I), cecum (C), liver, spleen, mesenteric lymph node, and blood were evaluated using restrictive media and serial dilutions to determine the presence and concentrations of enteric bacteria. ENT pigs had increased bacterial concentration and diversity of intestinal tract enterics compared to TPN pigs. The majority of positive samples in the TPN group were cultured from the C, with infrequent isolation from the J or I. Bacterial genera commonly isolated from the intestinal tract included *Enterococci*, *Pediococci*, *Enterobacter*, *Staphylococci*, *Klebsiella*, *Citrobacter*, and *Clostridia*. The ENT group had 1/14 positive for *Clostridium difficile* toxin A compared to 5/13 for the TPN group. Translocation of bacteria from the intestinal tract to tissues or blood was similar (8/14 ENT, 6/13 TPN) between groups. We conclude that ENT pigs have increased concentrations and diversity of intestinal bacteria compared to TPN pigs. TPN pigs may be at higher risk for colonization by *C. difficile*.

Key Words: Enteric bacteria, Colonization, Parenteral feeding

121 Development of a novel paradigm for the real-time monitoring of bacterial pathogenicity in swine. S. Willard^{*1}, P. Ryan¹, R. Bailey², M. Lawrence², C. Estill², S. Gandy¹, and D. Lay³, ¹Dept. of Animal and Dairy Science, Mississippi State University, Mississippi State, MS, ²College of Veterinary Medicine, Mississippi State University, Mississippi State, MS, ³USDA-ARS, West Lafayette, IN.

The objective of this study was to evaluate whether photonic reporters (e.g., luciferase) incorporated into relevant *Salmonella* strains could be used as indicators of bacterial infection (both in incidence and severity) within the living pig. To develop this paradigm, neonatal pigs (n = 12) were removed from the sow between 1 and 7 days of age, and placed on an antibiotic-free milk replacer for the duration of the trial. Pigs were anaesthetized for whole body imaging using a Telazol-xylazine-ketamine cocktail, placed in dorsal recumbency and the ventral surface of non-infected pigs imaged (10 min) using a photon counting camera (background image). Following this, one of two experiments were conducted. In Experiment 1, a dose response study was conducted in which pigs were challenged via esophageal intubation with increasing doses of a

Salmonella anatum bacterial isolate engineered to express the luciferase protein (*Salmonella-lux*; 1.5, 4.5 and 7.5 billion CFU). This was done to determine the level of photonic activity (relative units; RU) detectable through the stomach and ventral surfaces of the living pig. In Experiment 2, pigs were imaged (10 min accumulation of photons) pre- and post-challenge (Time 0: *Salmonella-lux* at 2 billion CFU), the pigs were then recovered and re-imaged at 24, 48 and 72 h post-*Salmonella-lux* challenge. A 17.7-fold increase ($P < .05$) in photonic emissions from the addition of 1.5 billion CFU ($14,882.7 \pm 3,965.5$ RU) to 7.5 billion CFU ($263,596.8 \pm 95,905.6$ RU) of *Salmonella-lux* was noted in the dose response study. Detectable photonic emissions in the stomach were highest ($P < .05$) immediately post-infusion (2.5-fold above pre-challenge), while photonic emission from the lower gastrointestinal tract were highest ($P < .05$) at 24 h (43.7-fold above pre-challenge). By 72 h post-challenge, no difference ($P > .10$) between the 24 h post-challenge and pre-challenge (background) photonic emissions were noted from infected pigs. In summary, photon-emitting bacteria can be detected through the ventral surfaces of the neonatal pig, providing a unique model from which to assess bacterial pathogenesis in the living pig.

Key Words: *Salmonella*, Swine, Biophotonics

122 Effect of ketoprofen, local anesthesia, and caudal epidural anesthesia during castration of beef cattle. S. T. L. Ting^{*1,2}, B. Earley¹, J. M. L. Hughes², and M. A. Crowe², ¹Teagasc, Grange Research Centre, Dunsany, Co. Meath, ²Faculty of Veterinary Medicine, University College Dublin, Ballsbridge, Dublin 4, Ireland.

The effect of burdizzo castration alone or in combination with ketoprofen (**K**), local anesthesia (**LA**), or caudal epidural anesthesia (**EPI**) on cortisol, acute phase proteins, immune function, and performance of beef bulls was determined. Fifty Holstein x Friesian bulls (13 mo of age; BW = 307 5.3 kg) were assigned to one of five treatments: 1) untreated control (**C**); 2) burdizzo castration (**BUR**); 3) BUR following K (3 mg/kg BW i.v.; **BUR + K**); 4) BUR following LA (8 mL into each testis followed with 3 mL s.c. along the incision line of 2% lidocaine HCl; **BUR + LA**); and 5) BUR following EPI (0.05 mg/kg xylazine HCl and 0.4 mg/kg lidocaine HCl as caudal epidural; **BUR + EPI**). The area under the plasma cortisol against time curve was lower ($P < .05$) in BUR + K than in BUR, BUR + LA and BUR + EPI animals. On d 1 post treatment, plasma haptoglobin (**HAP**) levels were higher ($P < .05$) in the castration groups except in BUR + K. On d 3 and 7, HAP levels were higher ($P < .05$) in BUR + LA and BUR + EPI than in C. Plasma fibrinogen (**FIB**) levels were higher ($P < .05$) on d 3 in all castration groups than in C. On d 7, FIB levels remained elevated ($P < .05$) in BUR + LA compared with C and other castrated groups. On d 1 and 3, Con A-induced interferon- γ production was lower ($P < .05$) in BUR + LA than in C, but was not different ($P > .05$) to BUR and BUR + EPI. ADG from d -1 to 35 was lower ($P < .05$) in BUR, BUR + LA and BUR + EPI, but not in BUR + K compared with C. In conclusion, burdizzo castration increased plasma cortisol and acute phase proteins, suppressed immune function and reduced growth rates. LA prolonged the increase in acute phase proteins and suppression of cell-mediated immunity. K was more effective in reducing cortisol than LA or EPI. Systemic analgesia with a non-steroidal anti-inflammatory drug was more effective in minimising inflammatory responses associated with castration than local or epidural anesthesia.

Key Words: Cattle, Castration, Epidural Anesthesia

123 Effect of forage condensed tannins on gastrointestinal parasite infection in grazing wether goats. B.R. Min^{*1}, W. Pomroy², S.P. Hart¹, and T. Sahl¹, ¹E (Kika) dela Garza Institute for Goat Research, Langston University, OK 73050, USA, ²Veterinary and Biomedical Science, Massey University, Palm/N, NZ.

The objective of this study was to evaluate effects of dietary condensed tannins (CT) in *Serica lespedeza* (SL; *Lespedeza cuneata*; 4.6% extractable CT/kg DM) on total fecal egg output (TFEO; eggs/d) and stage of larvae development compared with non-CT-containing forage (rye/crabgrass (RC); 0.6 g extractable CT/kg DM) in grazing wether goats. A grazing trial (cross over) involving 11 naturally parasite-infected (>1,200 eggs/g) goats (47 ± 3.3 BW) were randomly selected 1 mo after Ivermectin treatment (0.2 mg/kg BW) failure. Larval culture of pre-treatment feces showed that 86-97% of larvae were *Haemoncus*, with the remainder being *Trichostrongylus* and *Ostertagia*. Periods lasted

15 d, with fecal samples taken on d 0, 5, and 15. The number of eggs/g feces were determined by a modification of the McMaster technique. Larvae were cultured for 10 d at 27°C by placing 20 g of fresh feces inside a small glass container within a larger container holding free water (20 ml) to maximize humidity. Larvae were collected using a modified Baermann's procedure and counted. Mean fecal egg counts (2,722 *vs* 1,162 eggs/g) and TFE0 (173 *vs* 45 x 104 eggs/d) were lower ($P < 0.01$) for RC *vs* SL. Larvae development from eggs to infective stage of larvae (L3) by 15 d was 88% (3,432 *vs* 421 larvae/20 g feces; $P < 0.001$) lower for RC *vs* SL. In conclusions that CT in forages such as SL may reduce pasture contamination with infective larvae and be a valuable tool for parasite control.

Key Words: condensed tannins, gastrointestinal parasite

124 Minimally invasive diagnostic procedures and measures of test performance in BVD infected cattle. N Cook^{*1}, A Schaefer¹, S Tessaro², D Deregt², G Desroche³, and P Dubeski⁴, ¹Agriculture and AgriFood Canada, ²Animal Disease Research Institute, ³Public Works, Edmonton, ⁴Alberta Agriculture Food and Rural Development.

The objective was to compare minimally invasive measures for diagnosis of bovine viral diarrhoea (BVD). Heifers ($n = 10$) were infected with 2 * 10⁷ TCID type 2 strain 24515A BVD virus, with 5 seronegative animals as controls. Infrared thermographic (IRT) images of the eye

were recorded each day for 21 days. Saliva samples were collected every third day. Clinical assessment was conducted every day and utilized a 4-symptom classification system, each on a scale of 0 # 4. Scores for clinical assessment identified infected animals from Day 9 post-infection. Infrared images of the maximum eye temperature were statistically higher for infected animals by Day 7 post-infection ($p < 0.001$) and remained statistically different from control levels up to Day 11 ($p < 0.05$). Salivary cortisol levels were elevated in infected animals by Day 7 post-infection ($p < 0.004$) and remained so until Day 14 ($p < 0.02$). Comparisons between tests were made using measures of test performance. Clinical assessment score = 2 had a maximum test efficiency of 50%. Maximum test efficiency for IRT eye temperature was 60.3% at 32.4°C and for salivary cortisol was 83% at 8 nmol/L. Diagnostic tests were compared at referent levels giving maximum test efficiency. IRT eye temperature provided a test sensitivity of 98.5%, compared to 87.8% for salivary cortisol and 19.7% for clinical assessment. However, IRT test specificity was 10% compared to 100% for clinical assessment and 47.2% for salivary cortisol. Risk factor (RF) was represented as the ratio of false negative to true negative test results. Clinical assessment RF = 1.05 was higher than for salivary cortisol (RF = 0.35) and IRT eye temperature (RF = 0.2). Minimally invasive diagnostic tests are capable of earlier diagnosis of BVD infection than clinical assessment. Additionally, measures of test performance *vs.* test referents can be used to objectively manage risk associated with diagnostic testing.

Key Words: Bovine Viral Diarrhoea, Infrared Thermography, Salivary Cortisol

Breeding and Genetics Genetic Prediction and Selection in Cattle

125 Detection and adjustment of abnormal test day yields. G. R. Wiggans^{*}, P. M. VanRaden, and J. C. Philpot, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

Milk, fat, and protein yields on test-day (TD) were investigated to develop a method to detect abnormal yields for exclusion from calculation of lactation yields as an alternative to using producer-reported sick code. A TD yield was considered to be abnormal if it was < 60 or $> 150\%$ of predicted TD yield. These limits were selected to identify the low and high 1% of the distribution. The new cow specific upper limit replaced the previous limit of 123 kg milk. Predicted TD yield was calculated from previous TD yield adjusted by a daily change (slope) based on days in milk (DIM), DIM², previous TD yield, and interaction between DIM and previous TD yield. To accommodate changes in slope at peak yield, separate coefficients were estimated for ≤ 50 and > 50 DIM. Because yield from more than one TD may be abnormal, the last previous normal TD yield was retained for assessing subsequent TD yield. To be identified as abnormal, TD yields that were abnormal based on the previous TD yield also were required to be abnormal when checked against a prediction based on last previous normal TD yield and subsequent TD yield. Herd mean was used when fewer than three TD were recorded and to determine an acceptable range for component percentages. The procedure was applied in reverse for the first test with the predicted yield calculated from the second TD. When the outlier detection method was applied to > 93 million TD records of cows that calved in 1997 or later, 1.8% of milk, 3.4% of fat, and 1.9% of protein TD yields were identified as abnormal. The higher percentage of outliers for fat reflects its greater variability. Lactation yields were calculated after replacing abnormal TD yields with a floor or ceiling of 60 or 150%, respectively, of yield predicted from the last previous normal TD. For cows that had lactation records with one abnormal TD yield or more and a subsequent lactation record, the correlation between consecutive lactations increased from 0.692 to 0.693 for milk (561,063 lactations), from 0.653 to 0.660 for fat (951,387 lactations), and from 0.686 to 0.694 for protein (488,653 lactations). The outlier detection method identifies both high and low abnormal TD yield and improves the correlation between consecutive lactation yields.

Key Words: Test-day yield, Abnormal yield, Outlier detection

126 Examination of methods to correct for preferential treatment among AI bull dams. N.R. Zwald^{*} and K.A. Weigel, *University of Wisconsin - Madison, Madison, WI.*

The objective of this study was to quantify the magnitude of preferential treatment among dams of AI sires, and to identify methods that can be used to reduce selection errors. Accurate selection of the most elite animals from the population is essential in maximizing genetic progress. Preferential treatment in some dairy herds has made this selection increasingly complex. To examine this problem, test-day data from dams of 1,972 AI bulls born between 9/1/94 and 9/1/97 and their herd-mates were obtained. These data included 641 herds, 188,031 cows, and 1,634,441 test-day records from cows calving between 1/1/90 and 12/31/97. Data were analyzed using a standard sire model, sire-maternal grandsire model, animal models with various assignment of management group classes, and test-day models. Breeding values of bull dams for milk, fat, and protein were regressed on daughter yield deviations of their sons to determine the magnitude of preferential treatment, and to determine which model best corrects for preferential treatment in bull dam herds. Correlations between initial sire PTA and pedigree values were calculated for AI sires receiving their first evaluation during 1998. Correlation between initial PTA was calculated for the following pedigree information at bull birth date: parent average (0.37), sire PTA milk (0.42), dam PTA milk (0.29), maternal grandsire PTA milk (0.36), sire-MGS PTA milk (0.44). This research shows that considerable preferential treatment occurs in many herds, which can lead to incorrect selection of bull dams and inflated parent averages on many young sires.

Key Words: Preferential treatment, Test-day model

127 Data sub-setting and assessment of bias in estimation of genetic correlations among countries. H. Jorjani^{*}, *Interbull Centre, Dept. of Anim. Breed. and Genet., Swedish University of Agricultural Sciences.*

The objective of this study was to assess the effects of different data sub-settings for simultaneous estimation of genetic correlations among a large number of countries. For this purpose dairy cattle populations in 6 countries, with heritability values of 0.15-0.40 and genetic correlations between 0.50 and 0.90, were simulated. Exchange of selected young bulls among countries started at generation 2 and continued until the end of experiment at generation 10. Two different population structures, small and mixed, with 20 bulls and 2000 cows, and 20-640 bulls and 2000-64000 cows per generation, respectively, were simulated. For estimation

of genetic correlations either all bulls or only a sub-set of bulls were used. There were two different sub-setting criteria: only bulls with at least 2 proofs and bulls with an effective number of proofs larger than 2.0 (approximately equivalent to 2-4 proofs). Estimated correlations for country combinations with high genetic correlations (0.90) were in good agreement with the simulated values and only occasionally differed by more than 3%. For country combinations with low genetic correlations (0.50) there was almost always a noticeable difference between simulated and estimated values. In the small population structure, simulated correlations were generally overestimated (by up to 35%), irrespective of the sub-setting criteria. In the mixed population structure, simulated correlations were both over and underestimated (by up to 20%). However, the results from the two sub-setting criteria in the mixed population structure were generally in very good agreement with each other and only in few cases differed by more than 3%. The main conclusion of this study was that a shift from current sub-setting criterion (use of common bulls only) to a situation where bulls with high effective number of proofs are used is not the source of any increase in bias and can be adopted for routine international estimation of genetic correlations in the future to reduce the time and computational burden of estimating genetic correlations.

Key Words: Data sub-setting, Genetic correlation, International evaluation

128 Selection differentials from national Holstein bull progeny test programs estimated from international data. R. L. Powell^{*1}, H. D. Norman¹, and A. H. Sanders¹, ¹*Animal Improvement Programs Laboratory, Agricultural Research Service, USDA.*

Genetic progress in dairy cattle is largely determined by the merit of bulls used to sire the next generation, which is influenced by merit of parents, progeny-test (PT) accuracy, and intensity of subsequent selection. For 10 national Holstein bull populations, percentage of PT bulls returned to artificial-insemination service and selection differentials for yield traits were computed. All PT bulls were <7 yr old. Selection of PT bulls was assumed to have taken place based on a bull's second evaluation. Where earlier data were not available to identify an evaluation as the second, additional age limits were applied. Data for PT selection evaluations were from the routine genetic evaluation files for Holstein bulls from the International Bull Evaluation Service (Interbull) for 1995 through 1996. A bull was considered to have been returned to service based on the addition of 200 or more daughters in the interval between evaluations 3 and 5 yr after the PT selection evaluation. Selection differentials were computed as differences between mean evaluations of PT bulls returned to service and all PT bulls, divided by sire standard deviations from Interbull. Percentages of PT bulls returned to service were 3 to 17% (mean of 8%). However, some PT bulls that actually were returned to service may not have had 200 additional daughters. Alternative criteria for determining return to service (100, 500, or 1000 additional daughters) impacted proportion selected considerably (up to 10%) for some countries but little (<2%) for others. Selection pressure was highest for protein yield. Selection differentials for estimated breeding value, in standard deviation units, ranged from 0.53 to 1.47 for milk yield, 0.37 to 1.15 for fat yield, and 0.58 to 1.61 for protein yield. For the US, results were 1.02, 0.64, and 1.05. Selection differentials for yield are affected by selection for other traits. Differences in percentage of PT bulls returned to service may be due to the intensity of parental selection, number of PT bulls and PT accuracy, and semen importation policies and export opportunities. These results document the intensity of genetic selection for yield, the differences in trait emphasis across countries, and the US position relative to other countries.

Key Words: Selection differential, Progeny testing, International evaluation

129 Improvements in dystocia national genetic evaluation system and data processing. C. P. Van Tassel^{*1}, G. R. Wiggins¹, J. C. Philpot¹, and I. Misztal², ¹*Animal Improvement Programs Laboratory, ARS, USDA, Beltsville, MD,* ²*University of Georgia, Athens, GA.*

The Animal Improvement Programs Laboratory (AIPL) of USDA assumed responsibility for conducting the national genetic evaluation for dystocia and maintaining the associated database in 1999. Current evaluations use a sire model. Adding a maternal grandsire (MGS) effect

to the model is expected to improve accuracy by partially accounting for merit of mates and differences in maternal ability of the dams. Dystocia data were migrated to a relational database integrated with the AIPL production database. This database design was implemented to allow more rigorous data edits by comparing with the production data and to improve MGS identification (ID) rate by utilizing pedigree records from production records with dam ID sufficiently unique to match production pedigrees. Improvements in MGS ID rate are important for implementation of a sire-MGS model. Processing information for 8,861,363 records is available: 568,396 were duplicates or updates of existing records; 33,378 records were rejected; and, the remaining 8,259,589 records (>93%) were accepted. MGS ID increased from 57.2% to 73.1% by integrating the dystocia and production data. Sire and sire-MGS models were compared using data from the August 2001 national genetic evaluation. These data included over 5 million birth score records after requiring sire and MGS ID, dam and sire breed of Holstein or Red and White, single birth, and birth 1980 or later. The sire model included herd-year, year-season, sex of calf, parity of dam, birth year group of sire, and sire. MGS and birth year group of MGS were added to the sire-MGS model. Herd-year, sire and MGS were random effects. Variance for herd-year was set to 10% of residual variance, residual variance was set to 1, heritability to .16, maternal variance to 40% of the direct genetic variance, and correlation between direct and maternal effects to -.3. Correlation between sire solution from the two models was .93. For the sire-MGS model, the range of solutions for sire effects was 1.36 and for MGS solutions the range was .42. Integration of dystocia data with production data resulted in substantial increase in MGS ID rate. A sire-MGS model is feasible for the dystocia data set and provides similar sire evaluations to a sire model.

Key Words: Dystocia, Threshold model, Genetic evaluation

130 A mixed effects heteroskedastic threshold model analysis of calving ease in Italian Piedmontese cattle. K. Kizilkaya¹, P. Carnier², A. Albera³, G. Bittante², and R.J. Tempelman^{*1}, ¹*Michigan State University, East Lansing MI, USA,* ²*University of Padova, Agripolis, Italy,* ³*Associazione Nazionale Allevatori Bovini di Razza Piemontese, Italy.*

Genetic evaluations of calving ease scores based on threshold models typically invoke the assumption of homogeneous residual variances on the underlying liability scale. Nevertheless, residual heteroskedasticity across sexes or herds has been firmly established for many production traits. Ignoring residual heteroskedasticity may lead to biased breeding values predictions. Heteroskedastic threshold models have been recently proposed for the analysis of ordinal categorical data; however, the proposed procedures invoke analytical approximations that may be somewhat tenuous. We define a multiplicative structural model for residual variances as a function of "fixed" (e.g. sex of calf) and "random" (e.g. herd) effects using Markov Chain Monte Carlo (MCMC) methods. After validating our procedure in a simulation study, we applied a sire and maternal grandsire model version to the analysis of calving ease records on 8,847 first Italian Piedmontese cows from 66 herds, each with at least 100 records. Using the Deviance Information Criterion (DIC), a residual heteroskedastic threshold model (DIC = 16753) was deemed to be better fitting than a regular homoskedastic threshold model (DIC = 17349) to the data. The 95% equal-tailed posterior probability intervals (PPI) of the residual variances for males and females were 0.9268-1.2898, and 0.6061-0.8392, respectively, with the corresponding 95% PPI for the difference being 0.2822-0.4915, thereby confirming significant residual heteroskedasticity across sexes. This difference further translated to small differences in both direct and maternal heritabilities between calf sexes. The inferred degree of residual heteroskedasticity across the 66 herds was such that the 95% PPI of the standard deviation of residual variances across herds was 0.5351-1.0732, with posterior means of individual herd residual variances ranging from 0.34 to 2.97 times the mean herd residual variance. Nevertheless, the Pearson and rank correlations between posterior means of breeding values and between their standard deviations using homogeneous versus heterogeneous models always exceeded 0.98. We have therefore established that both sex of calf and herds are significant sources of residual heteroskedasticity for calving ease scores in Italian Piedmontese cattle.

Key Words: Heterogeneity, Threshold model, MCMC

131 Investigating the value of birth weight as a predictor of perinatal mortality and dystocia. J.M. Johanson*¹ and P.J. Berger¹, ¹Iowa State University.

Birth weights of Holstein cattle are rarely recorded, so the effect of birth weight on perinatal mortality (alive or dead) and dystocia (assisted or unassisted) has been difficult to determine. This research explores the effect of birth weight and other factors on mortality and dystocia. The Iowa State University dairy research farm in Ankeny, IA, collected 5166 records of births between 1968 and 1999. The frequencies of mortality and dystocia were 9.8% and 26.0%, respectively. Due to the binary nature of the observations, the logistic regression was used to predict both perinatal mortality and dystocia. The model including birth weight was a better predictor of **perinatal mortality** than without birth weight. Linear and quadratic effects of birth weight were significant. Probabilities of mortality for birth weights of 27, 33, 40, 46, and 52 kg were 5.0, 2.9, 2.6, 3.5, and 7.0%, respectively. Other significant factors were year of birth, season, dystocia, parity and gestation length (quadratic). The model including birth weight was a better predictor of **dystocia** than without birth weight. The model included a significant quadratic effect of birth weight (P=0.058), but not a significant linear effect. Probabilities of dystocia for birth weights of 27, 33, 40, 46, and 52 kg were 5.0, 7.4, 11.6, 19.2, and 31.7%, respectively. Other significant factors were year of birth, sex of calf, parity, and perinatal mortality. Birth weight was necessary to predict the outcome of both perinatal mortality and dystocia. Fewer factors were necessary to predict dystocia than to predict perinatal mortality.

Key Words: Birth weight, Dystocia, Perinatal mortality

132 Repeatability of birth weight of calves in Holstein dams of Southern Nigeria. O.T.F. Abanikannda*¹, A.O. Leigh¹, O. Olutogun², and M. Orunmuyi³, ¹Department of Zoology, Lagos State University, Nigeria, ²Department of Animal Science, University of Ibadan, Nigeria, ³Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria.

One of the methods by which repeatability of a trait on an individual animal can be estimated is through the variance components method, where repeatability $R = \sigma^2_D / \sigma^2_D + \sigma^2_W$. The General Linear Model of SPSS was used for both the Analysis of Variance and variance components estimation. Factors studied included the season of birth, year of birth, sex of calf and parity of dam as fixed factors, while the dam was used as a random factor. A total of 229 birth weight records from 47 Holstein dams (with minimum of 4 calves per dam) covering a period of 12 years, recorded at Ibadan, Oyo State, Nigeria, were analyzed in this study. All year round calving occurred at the farm across the four climatic seasons. The late dry period (January - March) had 29.7 percent of the births recorded; the early wet period (April - June) had 25.3 percent; the late wet period (July - September) had 17.0 percent, and the early dry period (October - December) had 27.9 percent of the births. The observed differences in the number of births recorded significantly deviated from the expected distribution of births across the seasons ($\chi^2 = 8.642$). However, the sex ratio was not significantly different from expectation; males calves accounted for about 47.2 percent of the births. Of the factors studied, only season of birth (P<0.05) and dam (P<0.01) exerted significant influence on the birth weights of Holstein calves. The mean birth weight of Holstein calves on the farm was 33.49 ± 0.29 kg. The heaviest calves were born during the late wet season (34.33 ± 0.70 kg), while the lightest were born during the late dry season (32.38 ± 0.53 kg). Repeatability of calves' birth weight was 0.22 ± 0.07 . The low estimate may be due to the large number of dams with relatively small number of offspring. This estimate can be used to select dams for future breeding on the farm.

Source	Degree of Freedom	Mean Square
Season of Birth	3	58.388*
Year of Birth	11	18.607 ^{ns}
Sex of Calf	1	1.585 ^{ns}
Parity of Dam	7	21.933 ^{ns}
Dam	46	42.280**
Error	160	

* = P<0.05, ** = P<0.01, ns = not significant

Key Words: Repeatability, Holstein dam, Nigeria

133 Additional evaluation of the parameters of the glucose tolerance test (GTT) in connection with pedigree performance (PBV) in growing young bulls. L. Panicke*¹, R. Staufenbiel², and E. Fischer³, ¹Research Institute for the Biology of Farm Animals, Dummerstorf, Germany, ²Free University Berlin, Clinic of cattle and pigs, Germany, ³University Rostock, Faculty of Agricultural and Environmental Sciences, Germany.

Breeders are interested in early information for the estimation of genetic merit of young bulls. High milk performance connected with sound health regarding metabolism and sufficient fertility in dairy cows depends on a well balanced distribution of energy in the body. Glucose concentration in the blood stays almost constant. Insulin plays an important role based on its central position in energy metabolism. The function of insulin was recorded by means of the intravenous glucose tolerance test (GTT) on 329 breeding bulls. They were injected with 1 g of glucose per kg^{0.75} metabolic body weight. The aim was an additional contribution to the assessment of breeding bulls before the start of the offspring's test. The parameter estimates for the glucose tolerance test were a variation of s-%=9, a h²=0.20±0.12, and a mean correlation between the physiological indicator and estimated breeding value of 0.40 to 0.50. These relationships were affected by factors such as experimental conditions, age and nutritional state of animals. In the age group 6 to 18 mo (n = 52 bulls), the glucose half-life (GHWZ) and glucose area (GA) were superior to insulin concentration for the estimation of the predicted protein yield. On the basis of multiple linear and nonlinear regression between pedigree- (PBV), as well as GTT-information, and the estimated breeding value of the offspring (EBV), an additional recommendation can be given before the start of the offspring's test by the use of the GTT-parameters. The correlation between the offspring's estimated breeding value (EBV) and the regression calculated breeding value (CBV) for protein-kg of the bulls increased by r = 0.6 to 0.7. The pedigree- and GTT-information alone reached a correlation of r = 0.3 to 0.4 with similar certainty. The correlations between pedigree breeding value (PBV) and GTT-parameters were less than 0.1. Therefore, we can expect additional information about the genetic evaluation of breeding bulls from the use of GTT.

Traits	EBV Milk yield	EBV Fat yield	EBV Prot. yield	EBV Fat-%	EBV Pro-% tein-%	EBV RZM
ln GA	-0.33*	-0.30*	-0.26	+0.10	+0.25	-0.29*
ln GHWZ	-0.37**	-0.33*	-0.36**	+0.10	+0.17	-0.38**
ln GA +GHWZ	+0.48**	+0.31*	+0.45**	-0.23	-0.24	+0.44**
PBV	+0.70**	+0.38**	+0.48**	+0.52**	+0.54**	+0.35*
CBV	+0.83**	+0.65**	+0.70**	+0.73**	+0.67	+0.67**

n = natural logarithm; GA = glucose area equivalent; GHWZ = glucose half-life; PBV = pedigree breeding value; CBV = regression calculated breeding value; EBV = offspring's breeding value; RZM = selection index combining the total breeding values of fat and protein yield using relative economic weights of 1:4

Key Words: Cattle, Glucose, Breeding value

134 Global trends in international selection strategies of Holstein bulls. F. Miglior*^{1,2} and B.J. Van Doormaal², ¹Agriculture and Agri-Food Canada, ²Canadian Dairy Network.

Interbull production files were analyzed to assess trends in international selection strategies of Holstein bulls. The 27 populations included in the Interbull evaluations were divided into 4 groups: a) North America (Canada and United States), b) Europe (all European countries that sample more than 200 Holstein bulls per year: Denmark, France, Germany, Italy and The Netherlands), c) Oceania (Australia and New Zealand), and d) Other (the remaining European countries, Israel and South Africa). A total of 6,215 Holstein bulls were first proven worldwide in 2001. In spite of major efforts of AI organizations, average number of daughters at the bull's first proof was relatively low (49). Partly due to seasonal calving, Australia and New Zealand had the highest average number of daughters at bull's first proof (60) and the youngest average age at first proof (55 months). Of bulls born in 1984, 60% had a sire that already had a second crop proof. This figure dropped to less than 5% for bulls born in 1997 reflecting an increased usage of newly proven bulls as sires of sons. Consequently, generation interval in the sire of son pathway had drastically reduced over time, from almost 10 years in 1984 born bulls to 6.5 years in 1997 born bulls. Within a year

from the bull's first proof, all major selection decisions are already made. Average number of sons per sire has been quite constant over time for North America (15 sons per sire), while Europe has slowly increased from 9-10 in the 1980s to 13-14 sons per sire in recent years. Selection intensity has been increasingly higher over time also in the dam of sons pathway. Genetic level of most recent bulls was highest for milk and protein yield in North America, and for fat yield in Oceania. Genetic progress in the last 5 years was strongest for milk in North America, for fat in Oceania, and for protein yield in Other countries. Fast development of Interbull evaluations has allowed a rapid evolution from local to global selection. Superior genetics expressed on local scales is widely available and the best bulls have been chosen as sires of sons independent of their origin, thus providing strong genetic progress, even in countries with small breeding programs.

Key Words: Dairy bulls, International evaluations, Breeding strategies

135 The effect of producer goals on sire selection.
P. R. Tozer*¹ and J. R. Stokes¹, ¹*The Pennsylvania State University.*

Information from an on-line survey of dairy producers was used to determine how important producers perceived three different objectives in the breeding problem. The objectives were: maximizing expected net merit of the progeny; minimizing the expected progeny inbreeding coefficient; and minimizing semen expenditure. Producers were asked to rank the three objectives and then weight the importance of each objective relative to the others. This information was then used to determine weights to be used in a multiple-objective integer program designed to select individual mates for a herd of 76 Jersey cows with known genetic background and cow net merit. The results of the multiple-objective models show that rank and relative importance of producer objectives can affect the portfolio of sires selected. Producers whose primary objective was to maximize expected net merit had a range of average expected progeny net merit of \$306 to \$310, but the level of expected progeny inbreeding was from 6.99% to 10.45% and a semen cost per conception of \$35 to \$41. Similar results occurred for producers who selected minimizing progeny inbreeding or minimizing total expenditure on semen as their primary goal in their breeding programs. The results of this research suggest that producer information and goals have a substantial impact on the portfolio of sires selected by that producer to attain these goals.

Key Words: Sire selection, Producer objectives, Mathematical programming

Dairy Foods Micro

137 Production of Exopolysaccharides from *Streptococcus thermophilus* strains in Batch, Continuous and Fed-batch culture. F. Vaningelgem*¹, T. Adriany¹, M. Zamfir², and L. De Vuyst, ¹*Vrije Universiteit Brussel (VUB), Brussels, Belgium,* ²*Institute of Biology Bucharest (IBB), Bucharest, Romania.*

Compared to dextran-producing lactic acid bacteria (LAB) or Gram-negative exopolysaccharide (EPS) producers, the low EPS production by thermophilic LAB is a constraint for both its use as additives (*ex situ*) and the *in situ* production of EPS during yoghurt fermentation. Both approaches implicate the optimisation of physical and chemical factors to enhance bacterial growth and EPS production during fermentation. Secondly, technological factors, like the use of (semi)-continuous fermentations, need to be considered for a higher EPS production. Two high-molecular-mass (MM > 1000 kDa) EPS-producing *S. thermophilus* strains were used to optimise bacterial growth and EPS production during batch, continuous and fed-batch fermentations. Besides the production of high-molecular-mass EPS, also low-molecular-mass EPS material was found in the fermentation broth, possibly degradation products. Physical (pH, T) and chemical (nitrogen source) optimisation of the milk medium resulted in an eleven-fold increase in maximum EPS yields. The influence of combined energy sources on the kinetics of bacterial growth and EPS production was investigated using this optimised milk medium. The EPS yield was clearly dependent on the energy source. Whereas the monomer composition of the EPS was not dependent on the type of monomer used, there was evidence that the molecular mass might be influenced. During batch and continuous fermentations it was further observed that EPS production by *S. thermophilus* followed the bacterial

136 Effect of fitting dominance effects on the prediction of genetic values for beef cattle. K. A. Donoghue*, J. K. Bertrand, and I. Misztal, *The University of Georgia, Athens, GA, USA.*

The purpose of this study was to examine differences in direct and maternal breeding values under dominance and additive models using field data. The data consisted of 253,072 and 382,895 adjusted weaning weight records from the American Charolais and American Gelbvieh populations, respectively. In these data sets 10% and 9% of all animals had at least one full-sib, with the largest full-sib family consisting of 16 and 31 animals in the Charolais and Gelbvieh populations, respectively. The dominance model fit to both data sets accounted for dominance covariances, and included contemporary group, animal additive, animal maternal, maternal permanent environment and parental dominance (one-quarter of dominance variance) effects. In addition, a regression coefficient for inbreeding percentage was included. A reduced model was also fit, in which the parental dominance effect was removed. The correlations between direct and maternal breeding values in the two models were >0.99. However, changes were observed for parents whose proportion of total progeny that were full-sibs was large. Direct breeding values under the reduced model (ignoring dominance effects) were inflated for sires and deflated for dams as the proportion of total progeny that were full-sibs increased. For Charolais sires with a large proportion of full-sib progeny (>50%), direct breeding values were 0.65 kg higher and maternal breeding values were 0.35 kg lower under the reduced model, while changes observed for Gelbvieh sires were very small. For dams with a large proportion of full-sib progeny (>50%), direct breeding values were 0.13 and 0.06 kg lower under the reduced model, whereas maternal breeding values were 0.07 and 0.13 kg higher under the reduced model, for Charolais and Gelbvieh dams, respectively. The largest changes in direct (and maternal) breeding values in both breeds were 6.85 (3.98) and 2.53 (1.24) kg for Charolais and Gelbvieh populations, respectively, and were observed for sires with no individual records and many full-sib progeny or relatives. Ignoring dominance effects has the greatest impact on animals with little individual information who rely heavily on pedigree records from large full-sib progeny groups.

Key Words: Dominance, Mating system, Beef cattle

growth. The carbon/nitrogen ratio influenced the biomass formation, the EPS production and the relative concentrations of high-molecular-mass and low-molecular-mass EPS. Fed-batch fermentations using two different feeding strategies (constant feeding and acidification-controlled feeding) did not result in higher maximum EPS concentrations compared to batch fermentations. However, it was shown that a high (constant) lactose concentration was necessary to yield high concentrations (1130 ± 226 mg polymer dry mass per litre) of high-molecular-mass EPS and to prevent their degradation upon prolonged fermentation. Fed-batch fermentations can in this respect be interesting, not only to obtain high concentrations of high-molecular-mass EPS but also to improve their stability.

Key Words: Exopolysaccharides, Thermophilic Lactic Acid Bacteria, Fermentation

138 Effect of milk salts on autolytic behavior of lactococcal starter and wild *Lactobacillus paracasei* strains under cheese conditions. M.A. Bjurlin, A. Au-Yeung, K. Bies, and K.M. Polzin*, *Land O'Lakes, Inc.*

The autolysis of starter and, potentially non-starter bacteria, during the ripening process of cheese results in the release of intracellular enzymes into the curd matrix, consequently leading to enhanced flavor development. Previous research defining the autolytic behavior of cheese bacteria has focused on the effect of pH and NaCl concentration by assaying autolysis in various NaCl-adjusted buffer systems. This does not take into account, however, the ionic component of the cheese moisture

phase. In this study 4 commercial lactococcal starter strains, including reference strain AM2, and 8 wild *Lactobacillus paracasei* strains were examined for their autolytic behavior in a cheese milk salts (CMS) buffer and a sodium acetate (NaAc) buffer system. Autolysis was monitored by a decrease in cell suspension turbidity as measured by absorbance at 600/650nm. Viability was determined by colony enumeration on M17 or MRS plates. Cell plasma membrane permeability was monitored by fluorescent microscopy using the LIVE/DEAD BacLight® Bacterial Viability kit. Lactococcal starter strains displayed similar autolytic, viability and cell membrane permeability trends in either NaAc or CMS buffer. Conversely, wild *Lb. paracasei* strains displayed significant differences in viability and permeability trends in NaAc and CMS buffer, while autolysis was unaffected. Both starter lactococcal and wild *Lb. paracasei* strains entered a viable but non-culturable (VBNC) state when suspended in either buffer. The majority of the cells of the 4 starter strains and 5 of the 8 *Lb. paracasei* were VBNC by the end of the 28 day study. Our results suggest that the ionic environment may have a greater effect on the autolytic behavior of NSLAB than on lactococcal starters, that the viable but non-culturable state may account for a significant proportion of the cell population during cheese ripening, and that strains can vary greatly in the relative proportion of cells in the different autolytic stages.

Key Words: *Lactococcus lactis*, *Lactobacillus paracasei*, Autolysis

139 Survival and antimicrobial effect of bifidobacteria and yoghurt bacteria during refrigerated storage of yoghurt made from lactose hydrolysed milk. Ehab Kheadr¹, Abd El-Rah Abd El-Rahman^{*2}, and Tarek El-Nemr¹, ¹Alexandria University, Alexandria, Egypt, ²El-Minia University, El-Minia, Egypt, ¹Alexandria University, Alexandria, Egypt.

The viability of yoghurt bacteria (*Lactobacillus delbrueckii* ssp. *bulgaricus* LX and *Streptococcus thermophilus* S3) and four strains of bifidobacteria (*Bifidobacterium bifidum* DSM 20456, *B. bifidum* DSM BB12, *B. longum* DSM 20097 and *B. infantis* DSM 20090) during 15 days of refrigerated storage was assessed in yoghurt made from lactose hydrolysed or unhydrolysed milk. A reduction in milk lactose of 42.3% was achieved using Maxilact, 20000. For all trials, milk was inoculated at a level of 2% (v/v) with a bacterial mixture of *Bifidobacterium* spp. : *Str. thermophilus* : *L. delbrueckii* ssp. *bulgaricus* using a ratio of 2:1:1 (v/v/v). Lactose hydrolysis resulted in a significant (P<0.05) reduction in fermentation time taken by such starter mixtures to reach pH 4.5. The production of organic acids is significantly (P<0.05) higher in standard yoghurt and lactose hydrolysed yoghurt compared to bifidobacteria containing yoghurt and unhydrolysed yoghurt, respectively. At one day storage, the viability of yoghurt bacteria and bifidobacteria was significantly (P<0.05) higher in lactose hydrolysed than in unhydrolysed yoghurt. However, the decay in the viable counts of bifidobacteria between 3 and 15 days of storage period was faster in hydrolysed compared to unhydrolysed samples. Among tested strains of bifidobacteria, *B. longum* exhibited the highest rate of viability in both types of yoghurt during storage. Yoghurt samples with added bifidobacteria showed considerably variable antimicrobial activities. The neutralised supernatants prepared from lactose hydrolysed yoghurt had higher inhibition (P<0.05) than unhydrolysed samples. Yoghurt samples with added *B. bifidum* 20456 exhibited an inhibitory effect against *E. coli*, *Staph. aureus*, *P. aeruginosa* and *B. subtilis*. Samples with added *B. bifidum* BB12 or *B. longum* showed antimicrobial activities against *Staph. aureus* and *B. subtilis*, while those with *B. infantis* were active only against *Staph. aureus*. However, no inhibitory effect was found against *B. cereus*, *S. typhimurium* and *C. albicans*. In conclusion, the bifidobacteria used in this study had dietetic criteria for fermented dairy products.

Key Words: Antimicrobial, Bifidobacteria, Yoghurt

140 Analysis of the early promoter P1 of *Streptococcus thermophilus* bacteriophage DT1. Genevieve Lamothe*, Céline Levesque, Denise Tremblay, Frederic Bissonnette, Armelle Cochu, Michel Frenette, and Sylvain Moineau, Université Laval.

The lytic bacteriophage DT1, a member of the group with cohesive genome extremities (*cos*-type), was isolated from a mozzarella whey sample obtained from a Canadian dairy factory using the strain *Streptococcus thermophilus* SMQ-301. The genome of phage DT1 contains 34,820 bp and 46 ORFs of more than 40 codons. In silico analysis of

the nucleotide sequence revealed the presence of a putative early promoter that possess the -35 and -10 consensus sequences. This promoter, called P1, is positioned upstream from the predicted start codon of *orf29*. Primer extension analysis located the transcriptional start point at 6 nucleotides downstream from the last nucleotide of the inferred -10 box. Five minutes after infection of SMQ-301 with phage DT1, a transcript of approximately 6 kb was detected by Northern blot using an *orf36*-specific probe. In order to determine its relative strength, P1 was cloned upstream of the promoter-less chloramphenicol acetyltransferase-encoding gene (*cat*) of plasmid pBV5030. Its activity was then compared with that of the strong constitutive promoter of the phosphoenolpyruvate: sugar phosphotransferase system (PTS) operon of *S. thermophilus*. The activity of both promoters were measured by their ability to confer chloramphenicol resistance in *S. thermophilus* SMQ-301 and in *Lactococcus lactis* MG1363. The minimum inhibitory concentrations (MIC) of chloramphenicol require to prevent the growth of a standardized inoculum of *S. thermophilus* and of *L. lactis* harboring pFB1 (P1 promoter cloned into pBV5030) were determined at 60 g/mL and 20 g/mL, respectively. The MIC of chloramphenicol was slightly lower for *S. thermophilus* containing pGA1 (PTS promoter cloned into pBV5030) whereas it was almost double for *L. lactis* (pGA1). These results indicate that P1 is a strong constitutive promoter in these two lactic acid bacteria and that it may be used for the development of expression vectors.

Key Words: Bacteriophage, *Streptococcus thermophilus*, Promoter

141 Identification of the melibiose carrier in *Lactococcus lactis* subsp. *cremoris* MG1363. I. Boucher*, C. Vadeboncoeur, and S. Moineau, Université Laval, Quebec, Canada.

Sugar metabolism by lactic acid bacteria plays a key role in dairy fermentations. Production of organic acids from sugar metabolism is initiated by the transport of mono- and disaccharides across the cytoplasmic membrane through substrate-specific transporters. In *Lactococcus lactis*, lactose is transported into the cell by the phosphoenolpyruvate:sugar phosphotransferase system (PTS) via a cascade of phosphotransfer proteins. Melibiose, a galactoside analogous to lactose, is not a common fermentation substrate for *L. lactis*. However, melibiose fermentation is a distinctive characteristic of the non-dairy lactococcal species *Lactococcus raffinolactis*. We previously showed that the *L. raffinolactis* *aga* gene encoding alpha-galactosidase activity can confer the ability to metabolize melibiose to various *L. lactis* strains. Here, we report that melibiose is transported in *L. lactis* MG1363 through *galA*, the permease encoded in the galactose operon. Inactivation of the gene encoding *galA* effectively resulted in a loss of the Mel-positive phenotype conferred by *aga*. This altered phenotype could be complemented and restored by transformation with a plasmid encoding *galA*. Interestingly, the inactivation of *galA* did not affect the capacity of the cells to produce acid from galactose indicating that galactose may enter the cell through an alternative route. Accordingly, *galA* can be regarded as the melibiose transporter in *L. lactis* MG1363 and its exact role in the galactose fermentation phenotype remains to be elucidated.

Key Words: *Lactococcus lactis*, Food-grade cloning vector, Alpha-galactosidase

142 Phage ul36 gene expression in sensitive and resistant *Lactococcus lactis* hosts. J. D. Bouchard* and S. Moineau, Université Laval.

The lactococcal bacteriophage ul36 has been used repeatedly as a reference lytic phage of the P335 species in a number of studies on the characterization of antiphage systems such as abortive infection mechanisms (Abi). The complete genomic sequence of this phage was also recently determined in our laboratory. Here, we investigated the gene expression of this phage in infected *AbiK*⁻ and *AbiK*⁺ cells by Northern blot analysis. Using probes located within the putative early region, a large transcript of over 10 kb, as well as several shorter mRNAs were detected 5 minutes after the infection of sensitive host cells (*AbiK*⁻). An abundant 3.8-kb transcript indicated that the origin of phage DNA replication may act as a terminator. Interestingly, this virulent phage possesses a complete lysogeny module that was transcribed 30 minutes after the beginning of the lytic cycle. The late expression of these genes could explain the absence of chromosome integration events in this host. Transcripts of the late region were first detected 30 minutes after the adsorption step. A large mRNA that covered this region and the lysis module was only expressed after 45 minutes. During the ul36 infection

of AbiK⁺ cells, expression of the early genes was normal but no late transcript was detected at any time. Together with previous results on phage DNA replication and late protein production, these results confirm that AbiK rapidly blocks macromolecule synthesis during ul36 infection.

Key Words: Bacteriophage, Gene expression, *Lactococcus lactis*

143 Monitoring endospores and endospore-forming bacteria populations in commercial skim milk powder production plants. C. Murillo* and Rafael Jimenez-Flores, *California Polytechnic State University, San Luis Obispo, CA.*

The microflora of milk powder consists of a wide array of microorganisms of which special attention is given to *Bacillus* endospores. *Bacillus* endospores survive pasteurization and spray drying and inhabit the final powder product in the dormant state indefinitely. Once the powder is reconstituted, endospores may germinate, and through their enzymatic activity become detrimental to quality. The objectives of this study are to 1) enumerate mesophilic and thermophilic endospore populations during commercial, low-heat skim milk powder production, and 2) characterize the microbial ecology of this process using Terminal Restriction Fragment Patterns (TRFPs) in conjunction with the Ribosomal Data Base, and 3) compare the changes in bacteria populations during processing of low-heat, skim milk powder. Our approach is to observe these changes in commercial operations and to use the DPTC pilot plant as a model system. Fluid and powder skim milk samples were collected from two commercial milk powder facilities. Sampling points included the raw milk silo, separator, evaporator, and spray dryer. Microbial evaluation was normalized based on total solids. Every sample was evaluated for total aerobic plate count and mesophilic and thermophilic endospore counts. For TRFPs community DNA was extracted, amplified by PCR using 16S rDNA probes, and digested with *Hae*III and *Dpn*II. Endospore formers are predominant in condensed and powdered milk, and tend to increase in the powder with increasing processing time. In raw milk mesophilic and thermophilic endospores ranged from <25CFU/g to 70CFU/g and <25CFU/g to 10² CFU/g, respectively. In powder they ranged from <25CFU/g to 10³ CFU/g and <25CFU/g to 10⁵ CFU/g, respectively. Both endospore counts from skim milk showed an increasing trend with run time and rendered the powder out of the 10³ CFU/g limit. In commercial samples TRF patterns successfully described microbial populations and a drastic change was observed between raw and powder milk for most runs.

Key Words: Endospore, Milk Powder, Production

144 Influence of lactococcal cell envelope proteinases on accelerated Cheddar cheese ripening. S. I. Myaka*, L. E. Metzger, and L. L. McKay, *MN-SD Dairy Food Research Center, University of Minnesota, St. Paul, MN.*

The proteolytic enzymes produced by lactococcal starters have an essential role in cheese ripening. Secondary proteolysis is initiated by the cell envelope proteinase (CEP) and cheese quality has been linked to particular CEPs. Additionally, Cheddar cheese ripening can be accelerated through the use of a "quick lysis" strain of *L. lactis*. Previously, thermolytic, isogenic strains of *L. lactis* subsp. *lactis* were constructed to possess different lactococcal CEPs. The objective of this research was to investigate the influence of lactococcal CEPs type a, c, d, e, and g from five isogenic, thermolytic strains on Cheddar cheese ripening. Three replicates of stirred curd Cheddar cheese were produced

using these strains. Since the cultures undergo lysis during cheese manufacture, the cheeses were acidified with Glucono-delta-lactone after the cooking step. Additionally a control cheese was produced at each time with a commercial direct vat set starter culture using a conventional stirred-curd Cheddar cheese making procedure. There were no significant differences ($p \geq .05$) in cheese composition among the treatments and the mean moisture, fat on a dry basis, salt to moisture ratio, and pH ranged from 36.6 to 38.1%, 50.5 to 51.6%, 4.9 to 5.1%, and 5.2 to 5.3 respectively. Proteolysis was determined at 3 weeks, 2 months, and 4 months of ripening whereas descriptive sensory analysis (15 judges) was performed at 2 and 4 months of ripening. As expected the level of pH 4.6 soluble nitrogen, 70% ethanol soluble nitrogen, and free amino acids increased in all treatments during ripening and at 4 months the level of free amino acids was 1.68, 1.30, 1.89, 1.56, 1.20, and .97 mg Leu/g cheese respectively for type a, c, d, e, g, and control. There were no significant ($p \geq .05$) differences in overall flavor among the cheeses. However, bitterness was significantly higher ($p \leq .05$) in the control cheese. These results indicate that the level of free amino acids produced during ripening can be increased using a thermolytic culture, but the different CEPs investigated had no significant ($p \geq .05$) effect on overall cheese flavor after 4 months of ripening.

Key Words: Accelerated ripening, Cell envelope proteinase

145 Exopolysaccharides from lactic acid bacteria: microbial physiology and fermentation kinetics. L DE VUYST*¹ and F VANINGELGEM¹, ¹*Vrije Universiteit Brussel.*

Exopolysaccharides (EPS) from lactic acid bacteria (LAB) can be subdivided into two groups, namely homopolysaccharides (HoPS) and heteropolysaccharides (HePS). Recently, HePS receive renewed interest, since they play an important role in the rheology, texture, and mouth-feel of fermented milk drinks. For instance, the creamy, smooth texture is one of the aspects of the quality of yoghurt that seems to be improved by the ability of the yoghurt bacteria to produce HePS, even though only small amounts of HePS are being synthesized in milk. Many different types of HePS are secreted by LAB strains with respect to sugar composition and molecular size. HoPS are polymerised extracellularly from sucrose as donor molecule and supplier of energy. HePS are made by the polymerization of repeating unit precursors formed in the cytoplasm. The repeating units are assembled at the membrane by specific glycosyltransferases (GTF) through the sequential addition of activated sugars (sugar nucleotides), followed by export and polymerisation into a final HePS. Several enzymes and/or proteins are involved in the biosynthesis and secretion of HePS; some of them are unique to HePS formation. Glucose-1-phosphate and fructose-6-phosphate are the precursor molecules for HePS biosynthesis. A major difference between cells and strains grown on different carbohydrate sources is the capacity to synthesize sugar nucleotides. Instability of HePS production and variability of polymer yields are well-documented problems in the dairy industry. Therefore, a well-understood optimal carbon flux and supply of sugar nucleotides in stable, EPS-producing, industrial strains is a key issue for their economical exploitation. Whereas mesophilic LAB strains seem to produce maximum amounts of HePS under conditions not optimal for growth, for instance low temperatures, HePS production from thermophilic LAB strains appears to be growth-associated, i.e. maximum production during growth and under conditions optimal for growth. HePS degradation often takes place upon prolonged incubation of HePS-producing LAB strains due to glycolylase activity.

Key Words: Eps, Lactic acid bacteria, Physiology

Nonruminant Nutrition Nutritional Values of Phytase and Other Enzymes

146 Impacts of site-directed mutations and expression systems on efficacy of *Escherichia coli* phytases in diets for weanling pigs. C. H. Stahl*, J. M. Gentile, T. W. Kim, K. R. Roneker, and X. G. Lei, *Cornell University.*

Our laboratory has previously expressed an *E. coli* phytase (ECAP) and its two variants (Mutant U and AppA2) in *Pichia pastoris* using an inducible promoter. To reduce the fermentation cost, we expressed AppA2 in a constitutive expression system and characterized the biochemical properties of the produced enzyme. The objective of this study

was to compare the efficacy of these three enzymes produced from the two systems in a corn-soybean meal diet for young pigs. Thirty pigs (9.45 ± .95 kg BW) were fed the diet plus ECAP, Mutant U, and AppA2 produced by the inducible system, AppA2 produced by the constitutive system, or .16% inorganic P. All phytases were included at 500 U/kg diet. Growth performance, and plasma inorganic P concentrations were assessed weekly. At wk 1, pigs fed inorganic P had higher ($P < .05$) plasma inorganic P levels than all other groups, with the exception of the group receiving mutant U phytase. This difference disappeared by wk 2. There were no significant differences in overall ADG, ADFI, or gain:feed

among the five treatment groups. In conclusion, all of the phytases examined were comparatively efficacious in improving the bioavailability of phytate-P from a corn-soybean meal diet to young pigs. Mutant U may be slightly more efficacious than the wild type (ECAP) or AppA2 under the conditions of this study.

Key Words: Phytase expression, Pigs, Phosphorus

147 Relative effectiveness of an experimental consensus phytase to inorganic phosphorus and an *Escherichia coli* phytase in diets for weanling pigs. J. M. Gentile*, K. R. Roneker, S. E. Crowe, W. G. Pond, and X. G. Lei, *Cornell University*.

Consensus phytase is a stable biosynthetic enzyme derived from the sequences of multiple homologous phytases. Two experiments were conducted to compare its effectiveness with inorganic P (P_i) and an *E. coli* phytase Mutant U in improving phytate-P availability to pigs. In Experiment 1, 36 pigs (3 wk old) were fed a corn-soybean meal basal diet (BD) plus consensus phytase at 0, 250, 500, 750, 1000, or 1250 U/kg for 5 wk. In Experiment 2, 36 pigs (4 wk old) were fed BD supplemented with .1% P_i , .2% P_i , 750 U consensus, 450 U consensus, 450 U Mutant U, or 225 U consensus + 225 U Mutant U/kg. In Experiment 1, plasma inorganic P concentration, plasma alkaline phosphatase activity, bone strength, and growth performance of pigs were improved ($P < .05$) by supplemental consensus phytase. Pigs fed 750 U/kg displayed the best overall responses of all measures. In Experiment 2, pigs fed 450 U consensus/kg had similar plasma phosphorus concentrations and bone strengths to those fed .1% P_i . Pigs fed 450 U Mutant U and 750 U consensus/kg were not significantly different from those fed .2% P_i in plasma inorganic P concentration or bone strength. In conclusion, experimental consensus phytase is effective in releasing phytate-P from the corn-soy diet for weanling pigs, and 750 U/kg seems to be an appropriate dosage. In addition, Mutant U may be more effective than consensus phytase at 450 U/kg, but no synergistic effect was seen by combining these two enzymes.

Key Words: Consensus phytase, *E. coli* phytase, Phosphorus

148 True phosphorus digestibility is improved with little change in the endogenous phosphorus outputs associated with soybean meal in the transgenic phytase weanling enviro-pigTM. A. Ajakaiye*, M. Z. Fan, C. W. Forsberg, J. P. Phillips, R. G. Meidinger, M. Z. Weiderkehr, T. Archbold, S. P. Golovan, R. R. Hacker, and D. Barney, *University of Guelph, Guelph, Ontario, Canada*.

The objectives of this study were to compare true phosphorus (P) digestibility and the endogenous P outputs between the transgenic phytase weanling enviro-pigTM and the non-transgenic weanling pig by regression analysis technique using soybean meal (SBM) as a "model" test ingredient. Four transgenic G₁ phytase pigs, with an average initial BW of 6.1 kg, were fitted with a simple T-cannula at the distal ileum and fed four diets according to a 4 x 4 Latin square design. The diets were cornstarch-based and contained four levels of P (0.99, 1.95, 2.94 and 3.96 g/kg DMI) from SBM. Chromic oxide (0.35%) was used as a digestibility marker. Each experimental period consisted of 8 d with 4-d adaptation and 4-d collection of salivary juice, ileal digesta, and fecal samples. There were no effects ($P > 0.05$) of diets, animals and periods as well as circadian rhythm (am vs pm) on salivary phytase activity ($144.2 \pm 42.8 - 152.4 \pm 57.22 \mu\text{mol/mg protein/min}$). Compared with the results of the non-transgenic weanling pig reported in our previous studies (Fan *et al.*, 2001, J. Nutr. 131:2388-2396), there were differences ($P < 0.05$) in the true ileal (93.3 ± 5.4 vs $50.7 \pm 7.1\%$) and fecal 88.2 ± 3.3 vs $48.5 \pm 5.4\%$) P digestibility values in SBM. However, there were no differences ($P > 0.05$) in the ileal (0.54 ± 0.13 vs $0.86 \pm 0.09\text{g/kg DMI}$) and the fecal (0.30 ± 0.09 vs $0.31 \pm 0.06\text{g/kg DMI}$) endogenous P outputs associated with SBM between the transgenic and the non-transgenic weanling pigs. In conclusion, the transgenic phytase weanling enviro-pigTM is efficient in utilizing P associated with plant feed ingredients with little change in the metabolism of gastrointestinal endogenous P.

Key Words: Phosphorus, True digestibility, Weanling transgenic phytase pig

149 Effect of microbial phytase on energy availability as assessed by protein and fat deposition in pigs. J. L. Shelton*, L. L. Southern¹, T. D. Bidner¹, M. Persica¹, J. Braun², B. Cousins³, and F. McKnight³, ¹LSU Agricultural Center, ²BASF AG, Ludwigshafen, Germany, ³BASF Corporation, Mount Olive, NJ.

A comparative slaughter experiment (EXP) was conducted to determine the effect of phytase (Natuphos[®]) on energy availability as assessed by protein and fat deposition in pigs. Crossbred barrows (initial and final BW of 26 and 52 kg) were allotted to four treatments: 1) corn-soybean meal (C-SBM) diet fed at 2.9 x maintenance (M), 2) C-SBM fed at 3.2 x M, 3) Diet 1 + 500 FTU phytase, or 4) Diet 2 + 500 FTU phytase. The diets contained 1.15% total Lys and all other AA met or exceeded 115% of the requirement. Calcium and available P were fed at 115% of the requirement in diets with no added phytase and decreased by 0.10% in diets with added phytase. Pigs were penned individually and fed at 0600 and 1700 hr daily, and water was available constantly. Eight pigs were slaughtered and ground at the beginning of the EXP to determine initial energy, protein, fat, and ash content using chemical analyses. At the end of the EXP, all 48 pigs were killed for determination of carcass traits and protein and fat content by TOBEC analysis. Six pigs per treatment were ground for chemical determination of energy, protein, fat, and ash content. Pigs fed at 3.2 x M had an increase ($P < 0.10$) in ADG, fat deposition, retained energy (RE) in the carcass and in the carcass + viscera, and kilograms of protein in the carcass. Phytase increased ($P < 0.05$) tenth-rib backfat thickness at both energy levels. No other response variables were significantly ($P > 0.10$) affected by phytase as determined by univariate statistical analysis, but phytase in the diet of pigs fed at 2.9 x M increased every response variable measured. Multivariate analysis (MANOVA) that included the response variables ADG, gain:feed, loin muscle area, tenth-rib backfat thickness, protein deposition, fat deposition, and RE, showed that phytase increased ($P < 0.07$) energy availability in pigs fed at 2.9 x M. The results of this EXP show that phytase increases energy availability in diets for pigs.

Key Words: Energy, Phytase, Pigs

150 The effect of citric acid alone or in combination with microbial phytase on gastric pH, and P and DM ileal and fecal digestibilities. J.P. Rice*, J.S. Radcliffe¹, and R.S. Pleasant², ¹Purdue University, West Lafayette, IN, ²Virginia-Maryland Regional College of Veterinary Medicine, Blacksburg, VA.

Eight crossbred barrows fitted with steered ileo-cecal valve cannulas and percutaneous endoscopic gastrostomy (PEG) tubes were used in a 4X4 Latin square design to test the effects of citric acid alone or in combination with microbial phytase on gastric pH and P and DM apparent ileal (AID) and apparent fecal (ATTD) digestibility. Pigs were individually housed, allowed ad libitum access to water, and fed at 9% of metabolic BW (BW^{.75}). Water intake was measured daily. Diets were corn-soybean meal based and contained Cr₂O₃ as an indigestible marker. Dietary treatments were: 1) negative control, 0.53% Ca, 0.39% aP; 2) Diet 1 + 3.0% citric acid; 3) Diet 1 + 750 U/kg phytase, and 4) Diet 2 + 750 U/kg phytase. Each period consisted of a 7d adjustment, a 3d total collection, a 12h ileal collection, and a 3d adjustment followed by a second 12h ileal collection. Samples from the second collection were pooled by pig, freeze-dried and, along with fecal samples, analyzed for Cr, P, and DM content. Gastric pH was monitored continuously via an endogastric pH probe that was introduced into the gastric lumen through the PEG tube. Data were analyzed using the GLM procedures of SAS. Water intake was unaffected by diet ($P < 0.10$). Citric acid addition to the diet decreased stomach pH by 11.4% ($P < 0.001$) while phytase addition increased stomach pH ($P < 0.001$) by 12.5%. A phytase x acid interaction was observed for gastric pH ($P < 0.001$) with the combination of citric acid and phytase causing a greater decrease (14.3%) in stomach pH than acid alone. Phytase increased P AID by 15.5% ($P < 0.001$) and ATTD by 7.2% ($P < 0.001$), but had no effect ($P > 0.10$) on DM digestibility. The addition of citric acid did not effect ($P > 0.10$) the AID or ATTD of P, but did improve DM ATTD ($P < 0.001$) and AID ($P < 0.001$). Phytase x acid interactions were observed for P and DM ATTD ($P < 0.001$) and AID ($P < 0.001$). For all interactions, the combination of phytase and acid caused a greater increase in digestibility than an additive effect of phytase and acid. Feeding pigs citric acid and phytase in combination has the potential to increase nutrient digestibilities to a greater extent than citric acid or phytase alone.

Key Words: Pig, Citric acid, Phytase

151 Phytase supplementation in soybean meal-based practical diets improves apparent digestibility coefficients of nutrients for rainbow trout (*Oncorhynchus mykiss*). Zongjia Cheng^{*1}, R.W. Hardy¹, V. Verlhac², and J. Gabaudan², ¹*University of Idaho, Hagerman Fish Culture Experiment Station*, ²*Research Center for Animal Nutrition and Health, STE Chimique Roche, Ltd, France*.

Fishmeal is formulated into carnivorous fish feeds at 30-50% by weight. Fishmeal production is not growing worldwide but the demand for fish is increasing. Therefore, plant protein source such as soybean meal (SBM) will be used to replace portions of fishmeal. However, the availability of phosphorus (P) and zinc (Zn) in SBM are very low. Phytase supplementation may have an effect on improving availability of P and Zn, and other nutrients. In this study, SBM (50% of the diet) was formulated into a fishmeal (15%) diet and supplemented with 5 dosages of phytase (Ronozyme P (L), Roche Vitamins France). Duplicate tanks were assigned randomly to each diet. Three hundred rainbow trout, mean BW of 100.1 ± 7.4 g, were stocked in ten 40-L tanks. Experimental diets were fed once daily at 1300 h to apparent satiation for one week before fecal collection began. Feces were collected at 0800 h the next day by stripping all fish. Collection of feces was repeated three days until sufficient amount was obtained. Average apparent digestibility coefficients (%) of SBM-based practical diets supplemented with 0, 500, 1000, 2000, and 4000 FTU/kg diet were: dry matter, 77.4, 82.7, 81.9, 82.9, 84.2, respectively ($P < 0.05$); crude protein, 97.0, 97.9, 98.1, 98.1, 98.1, respectively ($P < 0.05$); lysine, 98.3, 98.9, 98.9, 98.9, 99.0, respectively ($P < 0.005$); total-P, 31.5, 70.1, 78.7, 78.9, 85.2, respectively ($P < 0.0001$); phytate-P, -0.13, 42.1, 60.9, 71.4, 61.3, respectively ($P < 0.005$); and Zn, 28.4, 41.1, 43.4, 51.6, 63.7, respectively ($P < 0.0001$).

Key Words: Soybean meal, Phytase, Rainbow trout

152 Effect of α -1,6-galactosidase, β -1,4-mannosidase, and β -1,4-mannanase on intestinal morphology and the removal of dietary antinutritional factors in young pigs. S. W. Kim^{*}, *Texas Tech University*.

Ninety nursery pigs, weaned at d 21 of age, were used to determine the effect of an enzyme complex (EasyBio System, Inc) on the growth performance, intestinal morphology and the removal of dietary antinutritional factor. Main enzymes in the complex were α -1,6-galactosidase, β -1,4-mannosidase, and β -1,4-mannanase. Pigs were allotted to one of two dietary treatments, i.e., control and enzyme supplementation (0.1%). Each treatment had nine replicates and five pigs per pen-replicate. Pigs were fed based on the three-phase feeding program (phase-1, 1 wk; phase-2, 2 wk; and phase-3, 3 wk). All pigs fed the same diet during phase-1 and -2, and fed one of two treatment diets during phase-3 period. Previously, supplementing this enzyme to nursery diet with low soybean meal did not show any beneficial to the pigs. Thus, the enzyme

was supplemented only to the phase-3 diet that contains 34% soybean meal. All pigs had free access to the diet and water. Body weight and feed intake were measured weekly. Four pigs were randomly selected from each treatment totaling eight pigs. Selected pigs were killed to obtain tissue and digesta samples. Stomach, small intestine, cecum, and large intestine were separated, emptied, and weighed. Small intestine was separated to proximal, middle, and distal sections. Tissue samples were obtained from three different sections of small intestines. Digesta from stomach, cecum, and proximal and distal section of small intestines were collected. Collected tissue samples were fixed for histological evaluation to measure the length of villus. Digesta samples were measured for the content of antinutritional factor. Pigs in the enzyme treatment had a greater ($P < 0.05$) ADG during the third week of phase-3 period. Average daily feed intake was not different between treatment groups. Gain/feed was greater ($P < 0.05$) in pigs of the enzyme treatment during the whole phase-3 period. Villus heights from proximal and middle portion of small intestines were not different between treatments. However, pigs in the enzyme treatment had a longer ($P < 0.05$) villus height than control pigs at distal portion of small intestine. This study also demonstrates that the enzyme degraded antinutritional factors at proximal site of small intestine.

Key Words: Pigs, Enzyme, Antinutritional factor

153 Effects of increasing xylanase supplementation of medium quality wheat based diets on the growth performance of entire males between 24 and 56 kg live weight. D. J. Cadogan^{*1}, H. Simmins², G. Partridge², and C. Argent¹, ¹*Bunge Meat Industries*, ²*Finnfeeds International Ltd*.

The recommended xylanase dose rate (Porzyme 9300) to maximise growth performance was 1000 g/t, however lower levels enzyme levels maybe more cost effective. To establish the cost optimum xylanase dose rate, 144 four entire males (Bunge genotype) were blocked by weight (24.2 kg) and allocated to wheat based diets with 5 increasing levels (0, 250, 500, 750, 1000 and 1400 g/t) of enzyme. Pigs were housed in individual pens and offered ad libitum feed and water throughout the 35 d study. The basal diet was formulated to contain 65% of a medium quality wheat, pre-characterized in an earlier growth study, 14.0 MJ DE/kg (3,350 kcal DE/kg) and 1.15% total lysine (0.70 g/MJ DE available lysine). There was a linear ($P < 0.05$) effect of Porzyme 9300 on average daily gain, average daily intake and ultra-sound P2 backfat. There was also a quadratic ($P < 0.05$) effect on daily gain. The xylanase significantly improved daily gain and F:G when increased from 0 to 250 g/t and 0 to 500 g/t respectively. The improvement in FCR, and the linear effect on P2 backfat, suggests enzyme may increase the energy availability of the wheat. The results indicate that the most cost effective dose rate of Porzyme 9300 is between 250 and 500 g/t.

Key Words: Pigs, Wheat, Xylanase

Nonruminant Nutrition

Antimicrobial Agents and Plant Extracts on Immunity, Health, and Performance

154 Introduction of antibiotics in animal production. Virgil W. Hays, *University of Kentucky*.

The discovery of the growth promotional benefits of chlortetracycline (aureomycin) came largely as a bonus from Animal Protein Factor (APF) research. Like many significant findings, a number of researchers and teams of researchers were involved in the steps leading up to the discovery of APF (also known as Anti-Pernicious Factor), the identification and isolation of Vitamin B₁₂, the discovery of antibiotics for treatment of diseases and the observations of the growth-promotional or growth-permitting effects of chlortetracycline and subsequently other antibacterial agents. A team of researchers (Tom Jukes, Bob Stockstad and others in the Lederle Laboratories) were searching for organisms that would produce APF. Their screening procedures involved the growth of chicks fed an all plant diet with a liver extract as the APF standard. At the same time another team of researchers (Dr. Benjamin Duggar and collaborators) was searching for organisms that would produce antibacterial agents. This team found that the soil microorganism *streptomyces aureofaciens* produced chlortetracycline. After this finding, Jukes and his collaborators included this organism in their APF screen tests. They found that products from this organism resulted in

growth rates greater than did the liver extract used as the standard. Because of the great medical need of these substances, some time passed before the pure antibiotic was available for addition to animal feeds to confirm the antibiotic effect. Once available, the acceptance was rapid. Soon the other antibiotics and combinations of antibiotics were tested and found to be beneficial. During the 1950's many papers (peaking about 1953) on benefits and modes of action were published. The use of antibiotics has contributed to many changes in the way pigs and poultry are housed and managed.

Key Words: Antibiotics

155 Protection of piglets against Salmonella infection with dried bacterial cells. Z. Mroz^{*1} and Y. Toride², ¹*Institute for Animal Science and Health, Lelystad, The Netherlands*, ²*Ajinomoto Co., Inc., Tokyo, Japan*.

Dried bacterial cells (DBC) from *Brevibacterium lactofermentum* (BL) and *Escherichia coli* K-12 (EC) were fed as immunomodulators to 40 piglets challenged with *Salmonella typhimurium* (ST). After weaning at 24 d of age, they were kept over 14 d in individual pens and allotted to

five cereal-soybean based diets: 1) Negative control (C); 2) C + 0.5% TMS (Trimethoprim sulfadiazine); 3) C + 0.05% BL; 4) C + 0.05% EC; 5) C + 0.5% EC. These diets (20% CP, 0.98% lysine, and 8.79 MJ NE/kg) and water were offered ad libitum. On d 2 postweaning, the animals were challenged orally with ST (5×10^5 CFU). Based on the performance, blood indices, gut histology, and ST shedding in feces of weaned piglets challenged with ST (Table 1) it can be concluded that adding DBC from EC was more effective than DBC from BL, and the differences in ST shedding in feces of piglets fed TMS and DBC were merely numerical.

Response	Diet					P	
	1	2	3	4	5	SED	value
ADFI, g	305 ^b	304 ^b	250 ^a	302 ^{ab}	322 ^b	20	0.076
ADG, g	194	208	143	201	227	28	0.134
WBC, $\times 10^3$ /mL	25.5 ^c	17.0 ^a	23.1 ^{bc}	20.5 ^{ab}	18.7 ^{ab}	2.3	0.007
Lymphocytes, % WBC	32.3 ^a	52.3 ^b	37.0 ^a	36.3 ^a	37.6 ^a	4.9	0.004
T-cell subpopul., CD4:CD8 ratio	0.62 ^a	0.58 ^a	0.59 ^a	0.73 ^{ab}	0.86 ^b	0.10	0.035
Villus: crypt ratio, prox. jejunum	5.06 ^{ab}	5.46 ^b	3.96 ^a	5.17 ^b	5.88 ^b	0.48	0.038
Villus: crypt ratio, mid jejunum	4.94 ^{ab}	5.03 ^{ab}	4.32 ^a	5.10 ^{ab}	5.66 ^b	0.28	0.035
ST in feces, log ₁₀ CFU/g	2.00	1.68	2.07	2.62	2.29	0.56	0.426

^{ab}Within a row, means without a common superscript letter differ at $P < 0.05$.

Key Words: Piglets, Dried bacterial cells, Salmonella

156 Studies on the blood cholesterol lowering effect of specific lactic acid bacteria in growing pigs. Y. H. Park^{*1}, K. M. Lee¹, J. G. Kim¹, Y. W. Shin¹, H. S. Kim², S. H. Kim¹, and K. Y. Whang, ¹*Korea University, Seoul, Korea,* ²*Culture Systems, Inc., Mishawaka, IN.*

An experiment was conducted to examine the effect of specific lactic acid bacteria (LAB, *Lactobacillus casei* and *Lactobacillus longum* mixture) on blood cholesterol level in growing pigs. Twenty-four crossbred (Yorkshire \times Landrace \times Duroc) growing pigs (50.0 ± 2.5 kg) were assigned to six treatments to evaluate plasma cholesterol level-lowering effects of the specific LAB. Animals were individually penned. Hypercholesterolemia in pigs was induced by feeding a diet containing 0.5% cholesterol (HCD) for 15 days (period I) after a 4-day adaptation period. Serum cholesterol levels were measured every 5 days during period I. Pigs fed the HCD diet had a higher ($P < .01$) cholesterol level in serum than pigs fed the normal diet (ND). During period II, total cholesterol, triglyceride (TG), and high-density lipoprotein (HDL) cholesterol levels in serum were measured every 5 days. The treatments and the changes of serum total cholesterol level (mg/dL) during period II were shown in Table. A significant level of serum cholesterol was reduced in hypercholesterolemia-induced pigs fed LAB for 20 days of experimental period. But there was no significant effect of LAB in ND fed groups. There was no significant difference among treatments in TG and HDL levels. This experiment demonstrates that abnormally high cholesterol level in blood can be reduced by feeding a diet containing LAB in growing pigs.

Treatment ¹	Day 0	Day 5	Day 10	Day 15	Day 20
ND-ND	112.37 ^c	108.19	120.34 ^c	105.19 ^b	102.21 ^c
HCD-HCD	159.48 ^{ab}	140.67	157.78 ^{de}	156.29 ^a	173.79 ^a
HCD-HCDL	182.36 ^a	150.60	158.47 ^{de}	135.37 ^a	144.52 ^b
HCDL-HCDL	153.79 ^b	144.91	168.62 ^d	156.18 ^a	157.09 ^{ab}
HCD-NDL	159.26 ^{ab}	149.80	187.73 ^d	101.64 ^b	105.52 ^c
HCD-ND	182.82 ^a	162.38	178.24 ^d	96.50 ^b	98.10 ^c

¹ND, normal diet; HCD, hypercholesterolemic diet; HCDL, hypercholesterolemic diet with LAB; NDL, normal diet with LAB. ^{a,b,c} $P < .01$ ^{d,e} $P < .05$ within the same column.

Key Words: Pigs, Lactic acid bacteria, Hypercholesterolemia

157 Growth performance and immune parameters of weanling pigs fed mannan oligosaccharides. M. E. Davis^{*}, C. V. Maxwell, D. C. Brown, and T. J. Wistuba, *University of Arkansas, Fayetteville.*

Thirty-two weanling pigs averaging 19 d of age and 5.7 kg initial BW were randomly assigned to 16 pens in an on-site nursery to determine the effects of supplementation with mannan oligosaccharides (MOS) on growth and immune function. Pigs were fed one of two dietary treatments for 21 d after weaning: 1) corn-soybean meal control diet (1.5% Lys, 14.5% lactose) with 3.8% spray-dried plasma, 2% spray-dried blood cells, 6.8% processed soy protein, and 8.5% fish meal, and 2) control diet with 0.3% MOS. Dietary treatments were randomly assigned to pens in a completely randomized design and initial BW was used as a covariate when analyzing ADG, ADFI, and gain:feed (G/F). Blood samples were obtained from each pig on d 0 and d 14 after weaning to measure α_1 -acid glycoprotein concentration (AGP), and on d 14 to determine differential leukocyte counts, lymphocyte proliferation response, and macrophage phagocytosis of sheep red blood cells. Average daily gain and G/F were greater ($P \leq 0.05$) when pigs were fed diets supplemented with MOS from d 0 to 14 and d 0 to 21 after weaning. Dietary treatment did not affect ADFI or AGP. However, on d 14 after weaning, AGP was greater in pigs regardless of dietary treatment compared to the initiation of the study (557 ± 51 vs 934 ± 51 μ g/mL, $P \leq 0.01$). Percentage of neutrophils was lower ($P \leq 0.08$) and percentage of lymphocytes was greater ($P \leq 0.05$) in blood from pigs fed MOS compared to pigs fed the control diet. Lymphocyte proliferation in response to mitogen stimulation *in vitro* and percentage of phagocytic macrophages were not altered by dietary treatment. Supplementation of MOS in the diets of weanling pigs improves gain and efficiency, and may impact immune function as evidenced by the alteration in the percentage of blood neutrophils and lymphocytes.

Item	Control	MOS	SE	P =
ADG, g (d 0 to 14)	154	253	31	0.05
ADG, g (d 0 to 21)	220	301	24	0.04
G/F (d 0 to 14)	0.63	0.82	0.04	0.01
G/F (d 0 to 21)	0.66	0.80	0.04	0.04
AGP, μ g/mL	940	924	100	0.91
% Neutrophils	53	45	3	0.08
% Lymphocytes	43	51	2	0.03
% Macrophage phagocytosis	16	17	2	0.43

Key Words: Swine, Mannan oligosaccharides, Leukocytes

158 Dietary galactooligosaccharides (GOS) affect nutrient digestion, bacterial populations, and ileal short-chain fatty acid (SCFA) production in the pig. M. R. Smiricky^{*}, C. M. Grieshop, E. A. Flickinger, and G. C. Fahey, Jr., *University of Illinois, Urbana-Champaign.*

Fermentable substrates in the pig diet alter the fermentative activity of gut bacteria and increase proliferation of beneficial bacteria. The objectives of this study were to evaluate the influence of GOS additions to the diet on nutrient digestion, bacterial populations, and ileal SCFA production. 12 pigs (avg. initial BW = 26 kg) were surgically fitted with a simple-T cannula and fed a diet free of GOS for 21 d. On d 22, pigs were randomly allotted to 3 dietary treatments, a GOS-free (CON) diet and CON with 3.5% added GOS from soy solubles (SS) or transgalactooligosaccharides (TOS). The diets were formulated to contain 17% CP and contained chromic oxide for digestibility determinations. Pigs were fed twice daily (0800 and 2000 h, equal portions at each meal). Initial feeding level was determined on the basis of $0.09 \times \text{BW}^{0.75}$. The experimental period lasted 7 d, with 5 d of diet adaptation, fecal collection on d 6, and ileal digesta collection on d 7. Diets, feces, and digesta samples were analyzed for DM, OM, CP, and chromic oxide concentrations. Feces and ileal digesta were analyzed for *Lactobacillus* and *bifidobacteria* populations. Digesta samples were analyzed for SCFA production. Ileal and total tract DM and OM digestion was decreased ($P < 0.05$) by addition of GOS to the diet. Ileal and total tract N digestibilities were decreased by addition of SS to the diet. Ileal *bifidobacteria* and *Lactobacillus* populations were numerically increased by addition of GOS to the diet. Fecal *bifidobacteria* were increased ($P < 0.05$) by addition of SS to the diet. Fecal *Lactobacillus* populations were increased ($P < 0.05$) by TOS addition when compared to CON diet and increased ($P < 0.05$) further with the addition of SS to the diet. However, ileal

SCFA production was numerically greater only for those pigs fed diets containing GOS. The diet containing SS resulted in greater production of SCFA than the TOS diet. In conclusion, dietary addition of GOS to pig diets resulted in greater concentrations of beneficial bacteria and only a small decrease in nutrient digestibility.

Key Words: Digestibility, Bacteria, Fermentation

159 Botanicals for nursery pigs. P.J. Holden* and J.D. McKean, *Iowa State University, Ames, IA.*

The historical use of botanicals to treat or prevent infectious diseases has been supplanted with relatively low cost, effective and available synthetic antimicrobial products. Selected herbs possess natural antimicrobial activity and other characteristics useful in value-added animal protein production and their inclusion in animal feeds as alternative growth promotion and efficiency stimulating strategies may address antibiotic resistance concerns while producing a more holistically grown pork product. Echinacea, garlic, goldenseal and peppermint were evaluated with pigs weaned at 18 d and 6.25 kg. Pigs were allotted to 1.2 x 1.2 m raised-deck pens at random by litter and initial weight. Each pen received 16 kg of prestarter treatment per pig and starter treatment diets for the remainder of the 5-wk study. The positive diet contained 45 ppm of Mecadox. Botanical treatments consisted of the same diet without Mecadox and botanicals replaced corn, with the 0% level considered a negative control. Pigs were weighed and feed disappearance measured weekly. ADG, ADF and F/G were analyzed using the GLM procedure of SAS with the pen as the experimental unit. **Echinacea** (0 to 3%) was the most efficacious botanical evaluated. In the first three weeks pigs fed additions of 2 or 3% Echinacea had ADG and F/G similar to Mecadox controls and improved over the negative control. **Garlic** (0 to 5%) was evaluated in two trials. High garlic levels reduced performance primarily by depressing feed intake. Feeding any garlic depressed performance compared to Mecadox. Garlic also flavored the meat of harvested animals. **Goldenseal** (0 to 1.0%) was not statistically efficacious in one trial and was poorer than Mecadox controls. **Peppermint** (0 to 5%) was not a statistically efficacious in nursery diets when evaluated over two trials. Additions generally were no better than the negative control and sometimes statistically depressed performance. More information at www.extension.iastate.edu/ipic/reports/00swinereports/Nutrition00.html

Key Words: Swine, Botanical, Nursery

160 Plant extracts enhance sow lactation performance. S. E. Ilsley¹, H. M. Miller¹, H. M. R. Greathead¹, and C. Kamel*², ¹University of Leeds, Leeds, UK, ²AXISS France SAS, Archamps, France.

Many plant extracts promote health and growth. This study aimed to evaluate their ability to stimulate piglet and sow performance when supplemented in the diets of lactating sows. Three extracts were tested: Yucca Shidigera, Quillaja Saponaria and Combination (a blend of capsaicin, cinnamaldehyde and carvacrol). Eighty sows (25% Large White, 50% Landrace, 25% Duroc) of mixed parity were housed in conventional indoor farrowing crates from d107 of gestation to weaning. Sows were allocated according to parity, liveweight, fatness and past performance, to one of 4 dietary treatments: Control (CTR), Combination (COM, 100 ppm), Yucca (Y, 200 ppm), Quillaja (Q, 250 ppm). Diets were otherwise identical, containing 3,333 kcal DE/kg and 1.0% total lysine. From d107-114 of gestation, sows received 2.5 kg feed/d. In lactation

sows were fed *ad-libitum* with FI recorded daily. Piglet liveweight and sow P2 backfat were recorded on d1, 7, 14, 21 and at weaning on d23 2.5. Data, corrected for litter size and birth weight, were analysed using the GLM procedure of Minitab 12.2. Piglet growth between birth and d1 was better for COM sows. (117 g vs CTR 99 g, Q 77 g, Y 107 g; P < 0.01, SEM = 7.9). Similarly, between d15-21, piglets of COM sows outperformed all other treatments (COM 290 g/d, CTR 246 g/d, Q 235 g/d, Y 255 g/d; P < 0.001, SEM = 9.3). Piglet weights on d21 were also greater for COM sows (6878 g vs CTR 6584 g, Q 6330 g, Y 6498 g; P < 0.05 SEM = 132). Sow FI and P2 backfat loss were unaffected by treatment. Improved growth rates in the first 24h suggest facilitation of lactogenesis or enhanced piglet vigor at birth. The improved piglet weight gains of COM sows from d15-21 suggest enhanced milk yield at a time when it normally limits piglet growth. As sow FI and backfat loss remained unchanged, this indicates greater efficiency in feed utilisation for milk production. Alternatively, or additionally, piglets may have been utilising the milk with greater efficiency resulting in enhanced growth.

Key Words: Sows, Plant extracts, Lactation

161 Plant extracts enhance broiler performance. D. Jamroz¹ and C. Kamel*², ¹The Agricultural University of Wrocław, Poland, ²AXISS France SAS, Archamps, France.

Many plant extracts reportedly improve animal performance and well-being. This study evaluated their effects on live performance parameters and carcass characteristics at slaughter in commercial broilers. A commercial feed formulation based on ground wheat, barley, and soybean meal containing a coccidiostat and an enzyme with 0.5% chromic oxide as an indigestible marker served as the control diet. Four treatments were compared: control diet without additive (negative control), control diet with Avilamycin (10 ppm; positive control), and XT (a blend of capsaicin, cinnamaldehyde and carvacrol) at 150 and 300 ppm. 1,120 broilers were housed in conventional indoor floor pens from day 1 to 48 and allocated to 1 of 4 dietary treatments: Control (CTR), XT150 (XT, 150ppm), XT300 (XT, 300ppm), and Avilamycin (AV, 10ppm). Diets were otherwise identical, containing a metabolizable energy content of 12.5MJ/kg. The trial was run over two periods: 1-21 days and 22-48 days. Broilers were fed *ad libitum* with FI recorded daily. Broiler liveweight was recorded on d1, 21, and 48. Mortality was recorded daily. Concurrently, a digestibility trial was run in 420 broilers for apparent ileal nutrient digestibility coefficients and gut flora characterization. Raw data means were analyzed by STATISTICA PL ver. 5.1 (1997). Broilers on the XT diets between d1 and 17 had significantly better daily weight gains (XT300 625g vs XT150 608g, AV 605g, CTR 578g P<0.001) and feed conversion ratios (XT300 1.44 vs XT150 1.49, AV 1.47, CTR 1.56, P<0.05). Similarly XT broilers showed greater liveweights at d48, and at slaughter higher percentages of breast muscle. Digestibility studies performed at d21 showed that XT broilers significantly digested fiber, fat, ash, and nitrogenous substances better. In addition, XT broilers showed lower caecal counts for *E. coli* and *C. perfringens*. This study illustrates that plant extracts fed to commercial broilers give similar live performance levels as the antibiotic growth promoter Avilamycin. These benefits may be due to the greater efficiency in the utilization of feed, resulting in enhanced growth. The improved digestibility leads to a more balanced gut flora, with the potential to reduce shedding of pathogenic bacteria (i.e. *E. coli* and *C. perfringens*) into the environment.

Key Words: Plant extracts, Broilers, Gut flora

Production, Management, and the Environment Dairy Management

162 Nutritionally induced growth pattern changes of pregnant heifers and subsequent changes in body weights and dry matter intake. H. C. Freely*, C. L. Ferrell, and T. G. Jenkins, *USDA, ARS, U.S. Meat Animal Research Center.*

The objective of this study was to determine the effect of altering the amount of feed provided at different periods of pregnancy and lactation on the efficiency of feed utilization for calf production. MARC III heifers (n=128) were individually fed a corn silage-based ration (2.39 Mcal ME/kg DM). Heifers were allocated to three treatments that varied

in the timing that dry matter was offered. Dry matter intakes from 94 through 186 d of gestation were M-M-M-M 674±4 kg, L-H-M-M 521±5 kg, and L-L-L-H 523±5 kg. Dry matter intakes from 187 d of gestation to parturition were M-M-M-M 817±9 kg, L-H-M-M 938±12 kg, and L-L-L-H 679±8 kg. Dry matter intakes from parturition through 27 d postpartum were M-M-M-M 260±4 kg, L-H-M-M 264±3 kg, and L-L-L-H 220±3 kg. Dry matter intakes from 28 through 66 d postpartum were M-M-M-M 385±5 kg, L-H-M-M 377±6 kg, and L-L-L-H 528±10 kg. At 187 d of gestation, BW of L-H-M-M (n=40; 448±6 kg) and L-L-L-H heifers (n=43; 447±6 kg) did not differ (P=0.83), but was less

than M-M-M-M heifers ($P<0.001$; $n=45$; 478 ± 5 kg). At parturition, BW of M-M-M-M (472 ± 5 kg) and L-H-M-M heifers (466 ± 5 kg) did not differ ($P=0.43$), but was greater than L-L-L-H heifers ($P<0.001$; 436 ± 5 kg). Birth weight of M-M-M-M (31.6 ± 0.6 kg) and L-H-M-M calves (31.8 ± 0.8 kg) did not differ ($P=0.91$), but was greater than L-L-L-H calves ($P<0.001$; 28.3 ± 0.6 kg). Twenty-eight days postpartum, BW of M-M-M-M ($n=43$; 470 ± 5 kg) and L-H-M-M heifers ($n=40$; 463 ± 5 kg) did not differ ($P=0.35$), but was greater than the L-L-L-H heifers ($P<0.001$; $n=42$; 432 ± 5 kg). At 28 d of age, BW of M-M-M-M (56 ± 1 kg) and L-H-M-M calves (57 ± 1 kg) did not differ ($P=0.49$), but was greater than L-L-L-H calves ($P<0.001$; 50 ± 1 kg). At 66.2 \pm 0.3 d postpartum ($n=124$), BW of heifers ($P=0.51$; 461 ± 3 kg) and calves ($P=0.29$; 80 ± 1 kg) did not differ among treatments. We interpret these results to suggest that altering patterns of nutrient supply can be used as a viable management tool for decreasing feed cost.

Key Words: Heifers, Pregnancy, Growth

163 Effects of raising regime on milk yield of primiparous holstein cows. L. A. Torbert^{*1}, J. G. Linn¹, D. G. Johnson², G. J. Cuomo², H. Chester-Jones³, and M. L. Raeth-Knight¹, ¹University of Minnesota, St. Paul, MN, ²West Central Research and Outreach Center, Morris, MN, ³Southern Research and Outreach Center, Waseca, MN.

Raising heifers on pasture is an alternative to traditional confinement systems. There is limited research investigating the effects of raising system during growth on lactation performance. The objective of this study was to compare first lactation performance of heifers raised on pasture versus in confined feedlot pens from 18 to 22 months of age. In May 2000, 63 pregnant heifers were allocated among 3 treatments: continuous grazing (C), rotational grazing (R), or feedlot/confinement (F). Heifers in F were fed alfalfa haylage with corn to achieve a similar average daily gain as heifers on pasture. Heifers remained on their management treatment until 4 weeks prior to calving, when they were moved to a tie stall barn. Following calving, all cows received the same diet: (dry matter basis): 39% corn silage, 12% chopped alfalfa hay, 16% ground corn, and 33% supplement. Of the original 21 heifers assigned to each treatment, 3 C, 2 R, and 6 F cows did not complete 250 days of lactation and were removed from the study. In addition, displaced abomasums (DA) occurred in 3 C, 2 R, and 7 F cows. There were no differences found ($p>0.05$) in body weight (BW), body condition score (BCS), milk production, or milk composition across raising management treatments. Dry matter intake (DMI) was significantly different ($p<0.03$) across treatment with R cows consuming more dry matter per day than F cows. Milk production was numerically highest for R cows, but not different ($p>0.05$) than C or F cows.

	Continuous	Rotational	Feedlot	P-value
N, through 250 days	16	17	11	
DMI, kg/d	19.6 ^{ab}	20.5 ^b	18.3 ^a	0.025
BW, kg	536.9	526.8	539.6	0.758
BCS	2.9	2.9	3.1	0.285
Milk, kg/d	30.1	33.3	31.2	0.192
Fat, kg/d	1.0	1.1	1.0	0.514
Protein, kg/d	0.9	1.0	0.9	0.217
Lactose, kg/d	1.5	1.6	1.6	0.300
DA, % of assigned (21)	14.3	9.5	33.3	

Key Words: Dairy heifers, Lactation performance, Management

164 Economic analysis of high yielding dairy cows under different feeding systems combining pasture, total mixed ration and concentrates. P. R. Tozer^{*1}, F. Bargo¹, and L. D. Muller¹, ¹Pennsylvania State University.

The objective of this research was to utilize partial budgeting to compare the net income of high yielding Holstein cows managed under 3 different feeding systems including total mixed ration (TMR), pasture-based diets, or a combination of both. The variables considered in the analysis were milk income, and feed, feeding, fencing and water system expenses (revenues and costs were based on 2000 values). The potential economic advantage of the combination of pasture with TMR compared to a typical TMR under non-grazing is the reduction in feed costs with the inclusion of pasture in the diet. Forty-five Holstein cows (109 DIM) were assigned to one of three dietary treatments: TMR, non-grazing;

pasture plus TMR (pTMR); and pasture plus concentrate (PC). Cows on the TMR were fed a nutritionally balanced TMR ad libitum. Cows on the PC received pasture as the sole forage in a rotational grazing system plus 1 kg concentrate/4 kg milk. Cows on the pTMR grazed with the PC cows between the a.m. and p.m. milking and were housed overnight and fed 17 kg DM/d of TMR. Cows on TMR yielded the highest net income per cow per day (\$6.00) even though the expenses exceeded the other two treatments (\$3.92). The higher net income was due to higher yields of milk (38.1 kg/d) and milk components (1.24 kg/d fat, 1.13 kg/d true protein). Cows on the PC had the lowest daily net income (\$5.04) principally due to lower yields of milk (28.5 kg/d) and milk components (0.89 kg/d fat, 0.79 kg/d true protein) even though the expenses were also the lowest (\$2.69). Cows fed the pTMR yielded higher daily net income per cow (\$5.14) than the PC cows and lower than the TMR cows (32.0 kg/d milk, 1.06 kg/d fat, 0.93 kg/d true protein). Providing high producing cows with additional nutrients with a pTMR, can increase the profitability of dairy grazing systems compared to a feeding system of pasture and concentrate.

Key Words: Grazing, Economics, Feeding systems

165 Application of mixed model methodology to the determination of the economic optimal pre-pubertal rate of gain of dairy heifers. N. R. St-Pierre^{*}, The Ohio State University, Columbus.

A recent report concluded that the economic optimal pre-pubertal (PP) rate of gain of dairy heifers is less than 700 g/d. The authors, however, used ordinary least-squares (OLS) to model observations from three independent studies. We have shown that OLS yields biased parameter estimates when used on unbalanced data typical of multi-experiment summaries (meta-analyses), whereas estimates obtained with mixed model methods are free of bias under the assumption of a correct functional form. The objective of this research was to estimate the optimal PP rate of gain using mixed model methods, while appropriately accounting for first lactation feed costs and time discounts in the economic analysis. Study A involved 273 animals assigned to three PP treatments with average daily gains (ADG) of 680, 830, and 940 g/d. Study B used 68 animals assigned to four treatments (two involved an implant) with PP-ADG of 705 and 1,009 g/d. Study C used 105 heifers assigned to 3 treatments (one involving bST) resulting in PP-ADG of 770 and 1,120 g/d. The OLS regression of first lactation milk yield (kg/305 d; MY) on PP-ADG resulted in the following linear equation (SE of estimate in parentheses): MY = 11,763 (1,564) # 3.422 (1.781) * PP-ADG (RMSE=715.6). The slope had an overall P=0.11 of being different from zero. A mixed model with the fixed effects of PP-ADG, an overall intercept, and random effects of Study and interaction of Study*PP-ADG was fitted with the observations weighed according to the reciprocals of the SEM² to account for the unequal variances of observations across studies. The random interaction was not significant and was removed in the final model. The overall (across study) regression was: MY = 10,493 (539) # 2.085 (0.379) * PP-ADG (RMSE=0.51). The overall slope had a P=0.01 of being different from zero. Estimates of random effects were: Study A, 831.8 (427.5); Study B, -385.4 (431.35); and Study C, -446.4 (433.5). Thus, when properly analyzed by a mixed model, the data suggest a far lower reduction in first lactation production from increased PP-ADG than OLS. Using this relationship with estimated market costs of nutrients and a 5% time discount rate, the optimal PP-ADG ranges between 800 and 900 g/d.

Key Words: Pre-pubertal Growth, Mixed Models, Economic Optimum

166 Feeding neonatal calves milk replacers (MR) with different protein, fat, and lactose levels. T. M. Hill^{*}, J. M. Aldrich, A. J. Proeschel, and R. L. Schlotterbeck, Akey.

Two trials (48 calves each) were conducted to evaluate how varying CP levels, source of fat, fat levels, and lactose levels of a MR fed at 454 g daily would affect calf growth. In both trials, bull calves (42 kg, less than 1 week old) were randomly assigned to MR treatments and fed fixed amounts of MR (all milk CP plus synthetic lysine and methionine) with free-choice starter for 6 weeks. Calves were fed starter alone after 6 weeks. Fresh water was offered free-choice at all times. Calves were weighed initially and weekly. Starter intake, fecal scores, and medical treatments were recorded daily. Data by trial were analyzed as a completely randomized design with means separated using Student Newman Keuls test. Average initial serum protein levels of calves did not differ

($P > .1$) among treatments for either trial. In trial 1, three MR were fed. The fat source was a blend of animal fat, vegetable fat, and specific fatty acids. The lactose level was fixed at 40% by limiting the whey and using a corn-derived carbohydrate. The lysine and methionine levels of all MR were formulated to be equal by using milk protein and synthetic amino acids. The three MR were A) 20% CP, 20% fat, B) 20% CP, 15% fat, and C) 18% CP, 15% fat. There were no differences ($P > .1$) in gains, starter intake, hip width changes, body condition score changes, medical treatments, and scour scores among treatments. In trial 2, MR A and C from trial 1, plus MR D (20% CP, 20% fat) and E (20% CP, 15% fat) formulated with milk proteins, no amino acids, no corn-derived carbohydrate, and edible lard as the fat source, were tested. From 0-6 weeks, MR A and C supported faster ($P < .05$) gains than MR D and E. Starter intake was lowest ($P < .05$) for calves fed MR D. There were no differences ($P > .1$) in any measurement between 6 and 8 weeks of age. These data suggest that MR should be formulated with consideration to amino acids, fatty acids, and carbohydrate sources rather than crude protein and crude fat.

Key Words: Milk Replacer, Calves, Nutrients

167 Effect of sprinkling frequency and airflow on respiration rate, skin temperature and body temperature of heat stressed dairy cattle. M.J. Brouk*, J.F. Smith, and J.P. Harner, III, *Kansas State University*.

Sixteen heat stressed lactating cows (8 primiparous and 8 multiparous) were arranged in a replicated 8x8 Latin Square design to evaluate the effect of sprinkling frequency and airflow on respiration rate, skin temperature and body temperature. Cattle were housed in freestall dairy barns and milked 2x. During testing, cattle were moved to a tie-stall barn for a 2-hour period from either 1-3 pm or 3-5 pm on 8 different days in late August and early September. During the testing period, respiration rates were determined every five min by visual evaluation. Skin temperature of three sites was measured with an infrared thermometer and recorded every 5 min. Body temperature was continuously recorded every minute throughout the testing period utilizing a data logger and vaginal probe. Treatments were 4 different wetting frequencies with and without supplemental airflow. Wetting frequencies were control, every 5 min, every 10 or every 15 min. Supplemental airflow was either none or 19.8 cm/min. Each single wetting cycle within each treatment utilized similar amounts of water. Initial data were collected for three initial 5-min periods prior to the start of the treatments. Average respiration rates were higher ($P < .05$) 101.0 vs 72.6 breaths/min for controls as compared to cows treated with wetting cycles every 5 min in addition to supplemental airflow. Cows wetted every 5 min with supplemental airflow responded with the fastest ($P < .05$) and greater ($P < .05$) drop in respiration rate reducing the initial respiration rate by 50% at the end of 90 min of treatment. Wetting had a greater ($P < .05$) effect on respiration rate than airflow. However, the combination of wetting and airflow had the greatest ($P < .05$) effect on respiration rate. When cooling heat stressed dairy cattle, the most effective treatment included continuous supplemental airflow and wetting every 5 min.

Key Words: Heat Abatement, Heat Stress, Environmental Modification

168 Effect of utilizing evaporative cooling in tie-stall dairy barns equipped with tunnel ventilation on respiration rates and body temperature of lactating dairy cattle. M. J. Brouk*, J. F. Smith, and J. P. Harner, III, *Kansas State University*.

During the summer of 2001, six tie-stall dairy barns in northeast Missouri were monitored to determine the effects of evaporative cooling on the environment, respiration rate and body temperature of lactating dairy cattle housed in barns equipped with tunnel ventilation. Temperature and relative humidity were continuously monitored and recorded every 15 minutes in six barns (3 with and 3 without evaporative cooling systems) using data loggers for a three-month period. Temperature and relative humidity data were averaged by hour prior to statistical analysis. Respiration rate, infrared skin temperature and rectal body temperature of 20 animals per barn (10 primiparous and 10 multiparous) were measured on three different days during summer heat stress. Measurements were taken between 7-8 am, 4-5 pm and 10-11 pm on each of the three days. Cattle housed in evaporative cooled tunnel ventilated barns had lower ($P < .05$) afternoon and evening respiration rates and body temperatures than those housed in barns without evaporative

cooling. Evaporative cooling reduced ($P < .05$) afternoon barn temperatures, however relative humidity increased ($P < .05$) as compared to barns with only tunnel ventilation. Evaporative cooling in conjunction with tunnel ventilation reduced afternoon heat stress of dairy cattle housed in tie-stall barns. High environmental relative humidity reduced the cooling capacity of the evaporative cooling, however on the days of animal observation it reduced heat stress of lactating dairy cattle.

Key Words: Heat Abatement, Heat Stress, Environmental Modification

169 Non-dietary sources of variation of milk urea nitrogen (MUN) in Ohio dairy herds. P.J. Rajala-Schultz*, ¹*The Ohio State University*.

The purpose of this study was to describe non-dietary sources of variation and factors associated with MUN in Ohio dairy herds. The data came from 24 herds, 1681 cows and 12,939 test days. Half of the herds were classified as low producing herds (rolling herd average (RHA) milk production $\leq 7,258$ kg) and half as high producing herds (RHA milk production $\geq 10,433$ kg). MUN was measured from the monthly DHI test day milk samples spectrophotometrically by an automated procedure with a Skalar Segmented Flow Analyzer. The data were analyzed using multilevel modeling technique in MLwiN[®], separately for both production groups. Different levels of organization were herd, cow, and test day. Initially, a simple random intercept model containing only a constant was run. Explanatory variables previously identified being associated with MUN were then added to the model as fixed effects. The unadjusted mean MUN in high producing herds was 13.9 and 11.3 mg/dl in low producing herds. Variation in MUN was greater in low than in high producing herds. Also, the variance structure was different between these groups. In low producing herds, 67.2% of the variation in MUN was at test day level, only 0.2% at cow level and 32.6% at herd level. In high producing herds, however, highest proportion of the variance (49.0%) was found at herd level, 12.1% at cow level and 38.9% of the variation was at test day level. With significant independent variables in the model, the proportion of variation explained at herd level increased. MUN concentration was lower during the first month of lactation than later in the lactation. Also, season of the test day was associated with MUN (highest levels in spring and summer). Cow's test day milk production and fat-protein ratio in milk were positively associated with MUN levels in high producing herds. The observed differences in the proportions of variance at different levels between the production groups may be explained by management factors. Lower variability in MUN between test days in high producing herds indicates more consistent day-to-day feeding and management within herds in this group.

Key Words: Milk urea nitrogen, Variation, Multilevel modelling

170 The effects of prepartum milking on postpartum reproductive performance in dairy heifers. S. Bowers*, S. Gandy¹, K. Graves¹, S. Eicher², K. Scott², M. Schutz³, and S. Willard¹, ¹*Mississippi State University, Mississippi State, MS*, ²*USDA-ARS, West Lafayette, IN*, ³*Purdue University, West Lafayette, IN*.

The prepartum milking of dairy heifers may be beneficial to postpartum production performance through the acclimation of heifers to the milking parlor. The objective of this study was to determine if the prepartum milking of dairy heifers would improve postpartum reproductive health, as determined by rates of uterine involution, ovarian follicular development and the resumption of estrous cycles. Pregnant heifers (Holstein, $n = 21$, Jersey, $n = 10$) were assigned to either a prepartum milked (pre-milked; $n = 15$) or control ($n = 16$) treatment group. Pre-milked heifers were milked twice-daily starting three weeks prior to anticipated calving dates, while control heifers did not enter the parlor until after calving. Following calving, measurements were taken twice weekly to assess reproductive health and included palpation for uterine tone (1 = poor, 5 = excellent) and uterine position (0 = below pelvic rim; 2 = above pelvic rim / normal position), vaginal electrical conductance (VEC; relative units: RU) measurements, and the quantification of follicular development and cross-sectional area of the uterine horns (uterine difference) by transrectal ultrasonography. Blood serum samples were collected for progesterone (P_4) analysis and quantified by RIA. Uterine tone, uterine position and uterine difference did not differ ($P > .10$) relative to treatment, but changed over time ($P < .0001$) postpartum. VEC increased ($P < .0001$) from week 2 (73.1 ± 1.9 RU) to week 9 (94.2 ± 2.2 RU) postpartum, but also did not differ ($P > .10$) relative

to treatment. Pre-milked heifers tended ($P < .08$; $2.5 \pm .24$) to have more large follicles at 30 d post-partum relative to controls ($1.8 \pm .26$), while numbers of small- and medium-sized follicles did not differ ($P > .10$) between treatment groups. Initiation of luteal activity (i.e., day in which two consecutive P_4 samples were > 1 ng/ml) did not differ ($P > .10$) between control (25.9 ± 2.5 d) and pre-milked (33.1 ± 3.5 d) heifers. In summary, with the exception of follicular numbers on selected days, no overt differences in reproductive parameters were observed between the pre-milked and control heifers.

Key Words: Pre-milking, Uterine involution, Heifers

171 Dry matter intake prediction equation for non-lactating Jersey cows in late gestation and breed dry matter intake differences in late gestation. P. D. French^{*1}, H. H. Meyer¹, R. E. James², and J. K. Drackley³, ¹Oregon State University, ²Virginia Tech, ³University of Illinois.

An equation for predicting prepartum DMI of Jersey cows was developed using data from 54 multiparous Jerseys involved in testing seven diets at three universities. Dietary concentrations of CP and NDF ranged from 12 to 15% and 35 to 40%, respectively. An exponential equation, similar to that in NRC (2001), was used to describe prepartum DMI. The equation was $DMI (\% \text{ of BW}) = a + be^{(kt)}$, where a is asymptotic intercept at time infinity, b is the magnitude of decline in DMI, $be^{(kt)}$ is the shape of the curve, and t is day prepartum. The following equation for predicting DMI during the final 21 d of gestation was generated using the NLIN procedure of SAS: $DMI (\% \text{ of BW}) = 2.34 - 0.60e^{-0.16t}$. The prediction equation was evaluated using 15 multiparous Jersey cows. The prediction equation underpredicted DMI by 0.16% of BW and bias was greater near parturition. The two data sets were combined to generate the following equation for predicting DMI during the final 21 d of gestation: $DMI (\% \text{ of BW}) = 2.35 - 0.53e^{-0.16t}$. Data from 54 nonlactating multiparous Holstein and Jersey cows in late gestation involved in testing three diets were analyzed using the MIXED procedure of SAS to determine if DMI differs between breeds. Dry matter intake as a % of BW was greater for Jerseys ($P < 0.01$). The decline in DMI of Holstein cows as parturition approached was greater compared to that of Jerseys (breed by day interaction, $P < 0.01$). Exponential equations were developed for each breed and differences between breeds for a , b , and k were tested using the t-test. Coefficients for a , b , and k were 2.08, -0.99, and -0.19 for Holsteins and 2.37, -0.50, and -0.08 for Jerseys. Coefficients a and k were similar for Holsteins and Jerseys. However, coefficient b was less ($P < 0.05$) for Holsteins, indicating greater DMI depression compared to Jerseys. The DMI prediction equation and recognition that breed differences exist will aid in prepartum ration formulation.

Key Words: Dry matter intake, Prepartum, Jersey

172 The effects of prepartum milking on postpartum production performance in dairy heifers. S. Bowers^{*1}, S. Gandy¹, K. Graves¹, S. Eicher², K. Scott², M. Schutz³, and S. Willard¹, ¹Mississippi State University, Mississippi State, MS, ²USDA-ARS, West Lafayette, IN, ³Purdue University, West Lafayette, IN.

The acclimation of heifers to the milking parlor via prepartum milking may be beneficial to heifer postpartum production performance, and has been shown previously to improve postpartum heifer udder health (e.g., reduced udder edema). The objective of this study was to determine the impact of prepartum milking on postpartum milk production and associated performance characteristics in dairy heifers. Pregnant heifers (Holstein, $n = 21$, Jersey, $n = 10$) were assigned to either a prepartum milked (pre-milked; $n = 15$) or control ($n = 16$) treatment group. Pre-milked heifers were milked twice-daily starting three weeks prior to anticipated calving dates, and milk production recorded at each milking. All heifers were evaluated on day 21, 14, and 7 before calving, and twice weekly after calving through 60 days postpartum. On these days, body weight (BW), body condition score (BCS), udder edema scores (0 = no edema apparent, 10 = severe edema) and milk conductivity readings were recorded. Milk production from pre-milked heifers increased ($P < .01$) from $2.3 \pm .62$ kg at three weeks prior to calving to $10.1 \pm .95$ kg within 1 week of calving and did not differ ($P > .10$) between breeds. Post-calving milk production was higher ($P < .0001$) for Holstein than Jersey heifers, but did not differ ($P > .10$) by treatment within breed. While BW and BCS did not change pre-calving within breed relative to treatment ($P > .10$), post-calving BW and BCS were decreased ($P < .05$). Overall through week six postpartum pre-milked

heifers had lower ($P < .01$) udder edema scores than control heifers ($1.9 \pm .22$ and $3.0 \pm .26$, respectively), and through week five had lower ($P < .0001$) milk conductivity readings (indicative of fewer incidences of udder infections) than control heifers. In summary while udder health was improved post-calving in pre-milked heifers compared to controls, other production performance characteristics (e.g., milk production, BW and BCS) remained unaffected.

Key Words: Pre-milking, Milk production, Heifers

173 Effects of feeding low phytic acid corn and phytase on phosphorus balance in lactating dairy cows. B.E. Hill^{*}, S.L. Hankins, J.F. Kearney, J.D. Arseneau, D.T. Kelly, S.S. Donkin, B.T. Richert, and A.L. Sutton, Purdue University, W. Lafayette, Indiana.

Effects of feeding low phytic acid corn and phytase on phosphorus balance in lactating dairy cows
B.E. Hill, S.L. Hankins, J.F. Kearney, J.D. Arseneau, D.T. Kelly, S.S. Donkin, B.T. Richert, A.L. Sutton Purdue University, W. Lafayette, IN
An experiment was conducted with mid-lactation Holstein cows ($n=32$; av. parity=2.5) to evaluate nutrient excretion and production traits when cows were fed low phytic acid corn (LPA) and phytase. Cows were stratified by previous milk production, parity, and days in lactation and fed a common diet two weeks prior to treatment initiation. Dietary treatments were fed for two weeks before sample collection. Cows were fed diets formulated to meet or exceed current NRC (1989) requirements for all nutrients and contained .38% P. Diets consisted of low phytic acid corn (LPA), or control corn (NC) with or without phytase (127 g/d) in a 2×2 factorial arrangement of treatments. Feed intake and milk production were determined daily, fecal grab samples were obtained on four consecutive days each week to form two weekly composites for fecal analysis. Feed marked with ytterbium was added to the ration at 40 mg/kg DM to determine apparent nutrient digestibility. Milk samples were collected on 4 consecutive milkings during fecal sampling periods and pooled for analysis. Blood serum was obtained weekly for P analysis. Cows across all diets had similar overall milk production (av. 30.1 kg/d), milk composition and DMI (av. 21.5 kg/d). Cows fed LPA diets tended to have a higher overall fecal DM (18.55% vs. 17.74%; $P < .02$) than those fed NC diets. Cows across all treatments had similar fecal ammonium-N, TKN, and serum P. Cows fed LPA diets had significantly less fecal P concentrations (5667.5 vs. 6300.6 ppm; $P < .03$) than those fed NC diets, with no effect of phytase on fecal P. Cows fed LPA and LPA+PHY had significantly lower concentrations of fecal water-soluble P (2478.47 and 2495.65 vs. 3107.61 and 3129.27 ppm; $P < .0001$) than cows fed NC and NC+PHY, respectively. This level of phytase supplementation had no effect on P utilization in the lactating dairy cow. This study demonstrates that low phytic acid corn hybrids have the potential to improve P utilization and reduce both water-soluble and total P excreted in the feces in lactating dairy cows.

Key Words: Phosphorus, Nutrient Excretion, Dairy Cows

174 Effects of voluntary wait and censoring assumptions on life table analysis of reproductive data. DT Galligan¹, JF Ferguson^{*1}, G Azzaro², S Ventura², J Brooks², and G Licitra³, ¹University of Pennsylvania, ²Consorzio Ricerca Filiera Lat-tiero Casearia, ³Universit di Catania.

This project used SAS life table analysis to evaluate the influence of voluntary wait and censoring assumptions on timed event analysis (survival analysis) of dairy reproductive data. Time event analysis has become the method of choice in the evaluation of dairy reproductive data both in research studies as well as on the farm. This method evaluates the number of cows experiencing the event of interest (pregnancy) against those eligible for a given time period of interest (21 d. period) and determines a hazard rate (pregnancy rate = proportion of cows experiencing the event over the time interval of interest). Assumptions about the initiation of the period of eligibility (voluntary wait) influenced summary hazard rates by reducing their values when earlier voluntary wait periods were assumed. Assumptions about the censoring of cows were also evaluated where censoring was assumed to occur: 1) at the beginning of each risk period (the current approach used in several computer herd record system), 2) the middle of the risk period (the current approach in SAS life table analysis) and 3) at the end of the period. Assuming that censoring occurred at the beginning of each risk period dramatically inflated the summary pregnancy rate, while censoring at the end

of each period decreased the summary rate. The end censoring assumption more closely approximated the rates calculated from mid interval censoring. Bias introduced by the timing of the censoring assumption (beginning or ending of an interval) cumulate over intervals when one is calculating a summary hazard.

Key Words: Survival Analysis, Reproduction, Pregnancy Rate

175 Effect of elapsed time between initial thawing of multiple 0.5-mL semen straws and AI on conception rates in dairy cattle. J. C. Dalton^{*1}, A. Ahmadzadeh², B. Shafii², W. J. Price², and J. M. DeJarnette³, ¹University of Idaho, Southwest Research and Extension Center, Caldwell, ID, ²University of Idaho, Moscow, ID, ³Select Sires, Inc., Plain City, OH.

To facilitate the AI of numerous cows in a timely manner, AI technicians routinely thaw multiple semen straws simultaneously. The objective of this study was to determine the effect of elapsed time between initial thawing of multiple 0.5 mL semen straws and AI on conception rates in dairy cattle. Eight dairies (located in ID, WA, CA and OH), 4 with professional AI technicians (PAI) and 4 with herdsman-inseminators (HI) participated in the study. Initial data recorded included beginning thaw time, cow identification number, and time of AI. Herd records were retrieved following pregnancy diagnosis. The average elapsed time from initial thaw to first, second, third, and fourth AI (N=884) was 6.2 ± 0.2, 7.8 ± 0.2, 9.3 ± 0.3, 11.0 ± 0.3 minutes, respectively. The average time from initial thaw to completion of fourth AI was similar for PAI and HI. Conception rates for first, second, third, and fourth straws for PAI were: 46%, 44%, 34%, 42%, respectively. Conception rates for first, second, third, and fourth straws for HI were: 24%, 20%, 33%, 30%, respectively. Within PAI and HI, neither straw number nor elapsed time affected conception rate. However, average conception rate of straws (1 to 4) differed between PAI and HI ($P < 0.01$; 42 vs. 27%, respectively). Although the average conception rate differed between PAI and HI, elapsed time and straw number had no effect on conception rate

within inseminator group. Therefore, PAI and HI may thaw four straws simultaneously without compromising conception rates.

Key Words: Artificial insemination, Multiple semen straws, Elapsed time

176 Factors affecting prepartum dry matter intake of pregnant nonlactating Holstein and Jersey cows in late gestation. P. D. French^{*}, Oregon State University.

An experiment was conducted using 15 multiparous Holstein and 15 multiparous Jersey cows to determine if DMI and plasma parameters differed between breeds. Cows were blocked by expected calving date and received a TMR beginning 30 d prior to expected calving date. The TMR contained (dry matter basis) 35% corn silage, 21% oat hay, 16% alfalfa hay, 18% ground corn grain, 7% soybean meal, and 3% mineral-vitamin premix. Diet dry matter concentrations of crude protein and NDF were 14% and 35%, respectively. Blood samples were collected at 21, 14, 11, 9, 7, 5, 3, 2, 1 d prior to expected calving date and on two consecutive days following parturition. Plasma was analyzed for β -hydroxybutyrate, glucose, growth hormone, and NEFA. Data were analyzed using the MIXED procedure of SAS to determine if differences exist between Holsteins and Jerseys. Mean DMI the last 21 d of gestation was 13.9 kg/d for Holsteins and 11.0 kg/d for Jerseys. The magnitude of decline in DMI as parturition approached was greater for Holsteins (breed by day interaction; $P < 0.01$). Dry matter intake declined 39% for Holsteins and 24% for Jerseys the day prior to parturition compared to 21 d prior to parturition. Plasma NEFA was greater ($P < 0.01$) for Holsteins (439±27 mM) compared to that of Jerseys (323±27 mM). Glucose (60.5±0.6 mg/dl for Holsteins and 60.5±0.7 mg/dl for Jerseys), β -hydroxybutyrate (6.48±0.19 mg/dl for Holsteins and 6.61±0.20 mg/dl for Jerseys), and growth hormone (4.43±1.02 ng/ml for Holsteins and 4.78±1.03 ng/ml for Jerseys) did not differ between breeds. This experiment confirms previous reports that the decline in DMI is less for Jerseys compared to that of Holsteins. Future investigations are necessary to determine the cause and effect relationship between breed differences in DMI depression and NEFA.

Key Words: Jersey, Dry matter intake, Nonesterified fatty acids

Ruminant Nutrition Feedlot

177 Effect of source of energy and rate of gain on performance, carcass characteristics, ruminal fermentation, and glucose and insulin profiles of early-weaned steers. J. P. Schoonmaker^{*1}, M. J. Cecava², D. B. Faulkner³, F. L. Fluharty¹, H. N. Zerby¹, and S. C. Loerch¹, ¹The Ohio State University, ²Archer Daniels Midland, ³University of Illinois.

Seventy-three crossbred steers (initial BW 170.5 ± 5.5 kg) from The Ohio State University (experiment 1) and 216 crossbred steers (initial BW 135.4 ± 4.4 kg) from the University of Illinois (experiment 2) were used to determine the effect of source of energy and rate of gain on performance, carcass characteristics, and glucose and insulin profiles in early-weaned steers. Cattle were weaned at an average age of 119 d in both experiments, and allotted by age, weight, and breed to one of 4 diets: high-concentrate, fed ad libitum (ALC), high concentrate, fed to achieve a gain of either 1.2 kg/d (1.2C) or 0.8 kg/d (0.8C), or high-fiber, fed ad libitum (ALF). At 218 d of age all steers were placed on the high concentrate diet and fed ad libitum until slaughter. Steers were implanted with Compudose at the initiation of both experiments, and with Revalor-S when cattle were estimated to be 100 d from slaughter. When steers in experiment 1 averaged 181 and 279 d of age, serum samples were collected to determine glucose and insulin concentrations on 10 steers per treatment. Steers were slaughtered when a terminal fat thickness of 1.27 cm was reached (experiment 1) or after 273 d on feed (experiment 2). *Experiment 1:* Days in the feedlot ($P < 0.01$) and age at slaughter ($P < 0.01$) were lowest for ALC and ALF steers, intermediate for 1.2C steers, and greatest for 0.8C steers. ALC steers gained the fastest from 119 d of age until slaughter, followed by ALF and 1.2C; 0.8C steers gained the slowest ($P < 0.01$). Final weight was low (504 kg), but did not differ ($P > 0.57$) among treatments. At 181 d of age, insulin was elevated ($P < 0.10$), and at 218 d of age, ALC had a higher percentage ($P < 0.07$) of intramuscular fat, as measured by ultrasound, compared to cattle on the other diets. *Experiment 2:* ADG from 119 d of age until

slaughter ($P < 0.06$) and final body weight ($P < 0.04$) were greatest for ALC and lowest for 1.2C and 0.8C; ALF were intermediate, and did not differ from ALC or 1.2C and 0.8C. Growing phase diet did not affect subsequent marbling score at 218 d of age or at slaughter ($P > 0.81$). Controlling growth by limit feeding a high concentrate diet for only 100 d does not extend the growth curve, or enhance intramuscular fat deposition at slaughter compared to ad libitum intake of a high concentrate or high fiber diet, respectively.

Key Words: Beef cattle, Early-weaning, Marbling

178 Beef cattle can successfully be fed 80% potato waste in the finishing diet. J.L. Duynisveld^{*} and E. Charmley, Crops and Livestock Research Center, AAFC, Nappan NS.

One hundred finishing beef steers were used to assess the effect of level of potato waste in the diet on feed intake, rate of gain, feed conversion efficiency, carcass grade and size, and meat quality, texture, color and sensory characteristics. Potato waste was comprised of potato steam peel, cull french fries and steamed cull potatoes, with proportions varying over the feeding period. Potato waste had on average 18% DM, 9.7% CP and 52.2% starch. Cattle were backgrounded for 90 d at a rate of gain of 1.2 kg/d before being assigned to one of five treatments. All rations comprised of 20% grass silage and 80% concentrate. Treatments were formulated by altering the proportion of potato waste to barley in the concentrate, with potato waste included at 0, 25, 50, 75, and 100% of the concentrate. Two pens, each of 10 animals, were assigned to each ration, which was fed for either 79, 107, or 135 d. Increasing the proportion of potato waste in the diet had few effects on any parameters measured, indicating that even very high levels of potato waste can be successfully fed to finishing cattle. Rate of gain showed a quadratic response ($P < 0.05$) to potato waste inclusion, being higher (1.7 kg/d) for the 50% inclusion rate than for 0 or 100% inclusion rates (1.5 kg/d). Dry

matter intake decreased linearly ($P < 0.05$) as the proportion of potato waste increased, and was 20% lower in the 100% potato diet vs the 0% potato diet. Feed conversion efficiency was improved by 15% in the 100% potato waste ($P < 0.05$) over 0% potato waste treatment. Carcass characteristics were similar, regardless of inclusion level of potato waste. Diet had no effect on meat color, tenderness, or cooking losses. Increasing time on feed reduced rate of gain, but had little effect on carcass grade characteristics. Beef was more tender the longer cattle were on feed, but there were no other major affects associated with time on feed, nor were there significant diet x time on feed interactions on any parameters studied. We conclude that potato waste can be fed at very high levels, but optimum performance is realized at more moderate inclusion levels.

Key Words: Beef, Potato Waste, Finishing Cattle

179 Effect of Roundup Ready® corn (event NK603) on performance in beef feedlot diets. J. J. Simon¹, K. J. Vander Pol^{*1}, G. E. Erickson¹, T. J. Klopfenstein¹, C. N. Macken¹, E. P. Stanisiewski², and G. F. Hartnell², ¹University of Nebraska-Lincoln, Lincoln, NE, ²Monsanto Company, St. Louis, MO.

A 144-day feeding trial was conducted utilizing 200 backgrounded steer calves (321 kg) to evaluate effects of glyphosate-tolerant corn (Event NK603) upon performance and carcass characteristics of finishing steers. Treatments consisted of either Roundup Ready® Event NK603 (RR) corn, a non-transgenic control corn hybrid RX670 (PAR), or one of two non-transgenic commercial hybrids [RX740 (COM1), DK647 (COM2)]. Cattle were randomly allocated with ten steers per pen, using a CRD (5 pens/trt). Diets (DM basis), consisted of 10% steep liquor, 7.5% ground alfalfa, 3.0% dry supplement, and 79.5% of the individual corn hybrids respectively. The experiment was designed to contrast the RR hybrid versus the average of the two commercial hybrids and to contrast the RR hybrid versus the PAR hybrid. Dry matter intake (kg/d) for the RR, PAR, COM1, and COM2, corn hybrids were 10.9, 10.9, 10.9 and 11.1 respectively. Average daily gain was not different across hybrids and averaged 1.78, 1.87, 1.78, and 1.84 kg/d for the RR, PAR, COM1, and COM2, respectively. Further, feed efficiency, measured as ADG/DMI, was 0.163, 0.172, 0.163, and 0.166 for RR, PAR, COM1, and COM2 hybrids, respectively. No significant differences were observed between the RR hybrid and the average of the COM1 and COM2 hybrids (COM) on initial weight, final weight, DMI, ADG, or feed efficiency. Also, no differences ($P > 0.05$) were detected between the RR hybrid and the PAR hybrid for initial weight, final weight, DMI, ADG, and feed efficiency. Similarly, no differences in carcass characteristics or meat composition were observed when RR was contrasted with the other hybrids. Overall, RR event NK603 was shown to be substantially equivalent to the control and commercial hybrids when fed to finishing cattle.

Key Words: Cattle, Feedlot, Transgenic corn

180 Effect of corn root worm protected corn (event MON863) on performance in beef feedlot diets. K. J. Vander Pol^{*1}, G. E. Erickson¹, C. N. Macken¹, M. P. Blackford¹, T. J. Klopfenstein¹, E. P. Stanisiewski², and G. F. Hartnell², ¹University of Nebraska-Lincoln, Lincoln, NE, ²Monsanto Company, St. Louis, MO.

A 112-day feeding trial was conducted utilizing 200 yearling steers (365 kg) to evaluate the effects of corn root-worm protected corn (*Bt*, Event MON863) upon performance and carcass characteristics of finishing steers. Treatments consisted of either *Bt* Event MON863 corn (*Bt*), a non-transgenic hybrid RX670 (PAR), or one of two non-transgenic commercial hybrids [RX740 (COM1), DK647 (COM2)]. Cattle were randomly allocated with ten steers per pen, using a CRD (5 pens/trt). Diets (DM basis), consisted of 10% steep liquor, 7.5% ground alfalfa, 5.0% dry supplement, and 77.5% of the respective corn hybrids. The experiment was designed to contrast the *Bt* hybrid versus the average of the two commercial hybrids, and to contrast the *Bt* hybrid versus the PAR hybrid. Dry matter intake (kg/d) for the *Bt*, PAR, COM1, and COM2 corn hybrids were 12.7, 12.4, 12.7, and 13.1 respectively, with the COM2 corn hybrid having a significantly higher ($P < 0.05$) DMI than the other three corn hybrids. Average daily gains (kg/d) were not significantly different (2.25, 2.14, 2.12, and 2.20), for the *Bt*, PAR, COM1, and COM2 corn hybrids. Further, feed efficiency, measured as ADG/DMI, was 0.176, 0.172, 0.166, and 0.169 for *Bt*, PAR, COM1, and COM2 hybrids, respectively. When using the preplanned contrasts, cattle fed *Bt* were more efficient ($P < 0.05$) than cattle fed either PAR or the

two commercial hybrids. No other significant differences were observed for ADG, DMI, final weight, 12th rib fat thickness, or marbling score, among corn hybrids. Overall, feeding *Bt* corn with event MON863 in this study elicited similar gains and DMI with improved feed efficiency compared with other hybrids, suggesting comparable feeding attributes for feedlot cattle.

Key Words: Cattle, Feedlot, Transgenic Corn

181 Impact of grain processing and forage on microbial protein synthesis in beef cattle fed barley-based diets. K. M. Koenig^{*1}, K. A. Beauchemin¹, and L. M. Rode², ¹Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB, Canada, ²Rosebud Technology, Ltd., Lethbridge, AB, Canada.

Effects of the degree of grain processing and the amount of forage in barley-based feedlot diets on microbial protein synthesis (MPS), ruminal pH, and nutrient digestibility were evaluated using four Jersey steers (initial BW 442 ± 15 kg) with ruminal and duodenal cannulas. The experiment was designed as a 4×4 Latin square with four periods of 21 d. Dietary treatments were arranged as a 2×2 factorial with two levels of barley silage (20 and 5% DM basis) and two degrees of barley grain processing (processing index (PI) of 86 and 61%). Thus, the four dietary treatments were: high forage (20%) and barley grain with a PI of 86%, low forage (5%) and barley grain with a PI of 86%, high forage and barley grain with a PI of 61%, and low forage and barley grain with a PI of 61%. Decreasing the amount of forage in the diet from 20 to 5% and increasing the concentrate from 80 to 95%, increased the amount of rumen fermentable starch ($P < 0.05$), but there was no corresponding increase in MPS ($P > 0.15$). This was due in part to reduced efficiency of MPS when the 5% forage diets were fed ($P = 0.009$). The extent of grain processing had no effect on ruminal starch fermentation, MPS, or microbial efficiency ($P > 0.15$), but when 5% forage was combined with the more extensively processed grain, ruminal fiber digestibility was reduced ($P < 0.06$). Despite, the lack of effect of forage and grain processing on MPS, intake and ruminal escape of feed protein were greater and, hence, protein delivery to the intestine was improved for the low forage diets. Ruminal pH tended to be lower for the low forage diets ($P = 0.13$), but it did not negatively affect feed intake. In conclusion, barley grain rolled to a PI of 61 to 86% and combined with 5 to 20% barley silage in finishing diets had little effect on MPS. Nutrient intake and utilization were maximized when the amount of forage in the diet was limited to 5%.

Key Words: Barley, Grain processing, Forage, Microbial protein synthesis, Beef cattle

182 Effect of growth promotants on physiological characteristics of feedlot cattle exposed to hot and cold conditions. W.M. Kreikemeier^{*1}, T.L. Mader¹, and J.B. Gaughan², ¹University of Nebraska-Lincoln, Northeast Research and Extension Center, ²University of Nebraska-Lincoln, Northeast Research and Extension Center, ²The University of Queensland-Gatton Campus.

Six British x cross steers and six British x cross heifers (BW = 396 ± 29 kg) were utilized in a metabolism trial to determine the effects of growth promotant implants on respiration rate (RR; breaths/min), pulse rate (PR; beats/min) and rectal temperature (RT; °C) when animals were exposed to thermoneutral (THN), hot (HOT) or cold (CLD) conditions. Steers and heifers were randomly assigned to one of three treatments (T) 1) estrogenic implant (E) 2) trenbolone acetate implant (TBA) and 3) E+TBA. The main effects of heifers implanted with E had higher RT (39.19; $P < .01$) and PR (71) when compared to TBA (38.71 and 70) and E+TBA (38.39 and 67). Similarly, main effects of steers implanted with E had higher RT (39.55; $P < .01$) and TBA had the lowest (38.96) when compared to E+TBA (39.23). Steers implanted with E+TBA had the highest PR (81; $P < .01$) when compared to E and TBA steers (71 and 74, respectively). When exposed to HOT and CLD, implanted steers had RR of 123 and 23 (SE = 4.6), respectively; implanted heifers, had RR of 105 and 28 (SE = 4.2), respectively. Steers implanted with E and exposed to CLD had the lowest ($P < .10$) PR (69), while steers implanted with E + TBA and exposed to HOT had the highest ($P > .10$) PR (85). The PR among heifer implant treatments were similar. The implant*stress interaction of RT and PR on steers and heifers are reported in the table. Implanting steers and heifers with E increased RT under both HOT and CLD when compared to implanting with TBA. Differences in RR and PR among implant treatments were less definite.

Treatment*sex interactions for rectal temperature and pulse rate

	Steers			Heifers		
	E	TBA	E+TBA	E	TBA	E+TBA
Rectal Temperature						
THN	39.26 ^b	38.67 ^a	38.72 ^a	38.77 ^{bc}	38.50 ^b	38.37 ^b
HOT	39.97 ^d	39.39 ^b	39.61 ^c	39.86 ^e	39.20 ^d	39.28 ^d
COLD	39.41 ^{bc}	38.82 ^a	39.36 ^b	38.94 ^{cd}	38.43 ^b	37.51 ^a
Pulse Rate						
THN	69.4 ^a	73.5 ^{abc}	84.4 ^d	69.8	67.7	67.0
HOT	74.5 ^{bc}	77.4 ^c	85.3 ^d	72.1	73.9	69.7
COLD	69.4 ^a	71.7 ^{ab}	73.2 ^{abc}	70.6	68	65.5

^{abcd}Means within a sex are different $P < .10$.

Key Words: Implants, Environmental Stress, Feedlot

183 Effects of dietary cobalt source and concentration on performance, vitamin B₁₂ status, and ruminal and plasma metabolites in growing and finishing steers. M.E. Tiffany^{*1}, J.W. Spears¹, and F.R. Valdez², ¹North Carolina State University, ²Kemin Industries, Des Moines, IA.

An experiment was conducted to determine the effects of cobalt (Co) source and concentration on performance, vitamin B₁₂ (B₁₂) status, and plasma and ruminal metabolites in steers. Angus-cross ($n = 120$) steers were stratified by weight and randomly assigned to treatment. Treatments consisted of 0 (control, analyzed 0.05 mg Co/kg), 0.05, 0.10, and 1.0 mg of added Co (as propionate, KemTRACE[®] Co)/kg DM, or 0.05 and 0.10 mg of added Co (as carbonate)/kg DM. A cottonseed hull-corn-soybean meal based growing diet was fed for 84 d followed by a high concentrate finishing diet. Performance was not affected by Co supplementation during the growing phase. During the finishing phase, ADG ($P < 0.05$) and ADFI ($P < 0.10$) were higher in steers receiving Co supplementation. Cobalt source did not affect performance. Plasma B₁₂ was higher ($P < 0.05$) in Co supplemented steers by d 84, and plasma methylmalonic acid (MMA) was lower ($P < 0.02$) throughout the growing phase. Increasing supplemental Co from 0 to 0.05 mg/kg or from 0.10 to 1.0 mg/kg during the finishing phase increased ($P < 0.10$) plasma B₁₂. Control steers had higher ($P < 0.10$) plasma MMA and succinate (SUC) concentrations during the finishing phase than steers supplemented with 0.05 mg Co/kg. During the growing phase, as supplemental Co increased from 0 to 0.05 and from 0.05 to 0.10 mg/kg, liver B₁₂ increased ($P < 0.05$ and 0.08 respectively). During the finishing phase, liver B₁₂ increased ($P < 0.02$) at each level of supplementation. Steers supplemented with 0.10 mg Co/kg from Co propionate had higher ($P < 0.10$) ruminal propionate and lower ruminal butyrate molar proportions than those fed a similar amount of Co from carbonate, during the growing phase. During the finishing phase, Co supplementation resulted in lower ($P < 0.10$) ruminal acetate and butyrate percentage and higher ($P < 0.10$) propionate percentage. These results suggest that moderate Co deficiency reduces performance and vitamin B₁₂ status of finishing steers.

Key Words: Cattle, Cobalt, Vitamin B₁₂

184 Corn-based diets for cattle: effects of dry- vs steam-rolling, and two combinations of antibiotics. D.J. Gibb^{*1}, T.A. McAllister¹, and M.N. Streeter², ¹Agriculture and Agri-Food Canada, Lethbridge, AB, ²Alpharma Inc., Fort Lee, NJ.

Rumensin[®] and Tylan[®] are commonly included in high grain finishing diets to improve feed efficiency and reduce the incidence of liver abscesses, which often result from feeding these diets. Processing grains affects their digestibility and may also encourage liver abscess. Using 240 British cross steer calves (332–23 kg) in 16 pens, growth performance on dry-rolled (DR) vs steam-rolled (SR) corn-based finishing diets medicated with 12 ppm laidlomycin propionate + 42.2 ppm chlortetracycline hydrochloride (Cattlyst[®] + Aureomycin[®]) or with 30.4 ppm monensin sodium + 10.5 ppm tylosin phosphate (Rumensin[®] + Tylan[®]) was evaluated. Treatments were arranged in a 2 × 2 factorial ($n = 4$). Individual bunk attendance was monitored via radio frequency identification in one pen per diet. Diets were fed for 125 d following a 27-d adaptation from 65% to 91% concentrate. In the first 56 d and overall, DMI was higher ($P < 0.05$) with Cat+Aur than with Rum+Tyl (8.8 vs 8.3 and 9.2 vs 8.8 kg/d), but DMI did not differ ($P = 0.69$) between DR and SR. Cattle fed Cat+Aur tended toward more rapid gain ($P = 0.11$) than those fed

Rum+Tyl (1.54 vs 1.47 kg/d). Processing method did not affect ($P = 0.29$) rate of gain, but SR tended ($P = 0.06$) to improve feed/gain as compared to DR (5.84 vs 6.08). Steers fed Cat+Aur spent more ($P < 0.001$) time at the bunk than those fed Rum+Tyl (125 vs 120 min/d). On DR diets, bunk visits were more frequent ($P = 0.03$) and eating intensity (time with head down/time at bunk) was higher ($P < 0.001$) with Rum+Tyl than with Cat+Aur. On SR diets, however, eating intensity was higher ($P < 0.001$) with Cat+Aur. Carcasses tended ($P = 0.07$) to be heavier with Cat+Aur than with Mon+Tyl, but no other differences in carcass traits were observed. Liver abscess rates were 14% with Cat+Aur and 6% with Rum+Tyl ($P = 0.14$). Severely abscessed livers followed the same trend, also unaffected ($P = 0.17$) by treatment. Feeding Cat+Aur may increase DMI and ADG compared to Mon+Tyl, but its effects on liver abscess are less clear.

Key Words: Laidlomycin, Chlortetracycline, Liver Abscess

185 The effects of supplementing fish oil into the drinking water of dairy cows on lactation performance and milk fatty acids. V. R. Osborne^{*1}, B. W. McBride¹, R. R. Hacker¹, S. Radhakrishnan¹, A. R. Hill¹, and J. K. Kramer², ¹University of Guelph, Ontario, Canada, ²Agriculture and Agri-food Canada, Guelph, Ontario, Canada.

Previous experiments have shown that drinking water can be used as a vehicle to transfer nutrients to dairy cattle. An experiment was conducted to determine if fish oil supplemented into the drinking water of lactating dairy cattle had similar effects on milk production and composition as when oil was delivered in the feed. Sixteen multiparous Holstein cows (60 DIM) were randomly allocated in a repeated measures design to receive either, refined Menhaden oil top dressed (216 ml) on their TMR daily, or oil metered into their drinking water (2g/L). Feed and water intakes, and milk yield and composition were monitored for a 7-d covariate period followed by 28 d of oil supplementation. Water intake (105.2 vs 102.5 L/d), DM intakes (22.4 vs 21.7 kg/d) and milk yield (38.6 vs 39.0 kg/d) were similar for the water and feed supplemented oil treatments respectively. Milk fat composition was also not affected by treatment with both groups experiencing a 17-20 % decline in fat percentage. The route of fish oil delivery had no effect on eicosapentaenoic acid concentration. However, docosahexaenoic acid levels (% of total fatty acids) were higher in cows supplemented with fish oil in the water than through the feed (0.041 vs 0.027 $P < 0.01$), and conversely the total conjugated linoleic acid isomers were higher in milk from cows supplemented with oil in feed (1.224 vs 1.502 $P < 0.01$, oil in water vs feed respectively). These results indicate that drinking water can be an effective method for supplementing fish oil into the diets of lactating dairy cows.

Key Words: fish oil, drinking water, milk fatty acids

186 A longitudinal study to describe the presence of *Escherichia coli* O157:H7 and *Salmonella* spp. in feedlot cattle pens. D. R. Smith^{*1}, R. A. Moxley¹, S. Hinkley¹, L. L. Hungerford¹, J. D. Folmer¹, G. E. Erickson¹, and T. J. Klopfenstein¹, University of Nebraska, Lincoln, NE.

A longitudinal study was conducted to describe the presence of *Escherichia coli* O157:H7 and *Salmonella* spp. in 31 pens of commercial feedlot cattle for each week of their summer feeding period. Pens were tested for the presence of the organisms by bacterial culture of 1) a composite of 20 fresh fecal pats from the pen floor and 2) seven devices prepared from rope available overnight for cattle to rub or chew. The difference in the proportion of positive-testing pens was tested by chi-square analysis. The mean population of the pens was 157 cattle (59-282). The mean feeding period was 20 weeks (15-26). Pens were monitored for a total of 627 pen-weeks. Of these, 95 pen-weeks (15%) were positive for *E. coli* O157:H7 by culture of composite feces, and 274 pen-weeks (44%) were positive by culture of the rope devices. *Escherichia coli* O157:H7 was recovered at least once from the composite feces of 27 pens (87%) and at least once from the ropes of all 31 pens (100%). Twenty-four of 31 pens (77%) were rope-positive for *E. coli* O157:H7 the first week the pen was sampled, however, only 14 of 35 pens (40%) were rope-positive the week of marketing ($p < 0.005$). *Salmonella* spp. was recovered from the composite fecal samples of 21 pens-weeks (3%) and 142 pen-weeks (23%) were positive for *Salmonella* spp. by culture of the rope devices. *Salmonella* spp. was recovered at least once from the composite feces of 18 pens (58%) and at least once from the ropes of 27 pens (87%). Two

of 31 pens (6%) were rope-positive for *Salmonella* spp. the first week the pen was sampled, however, 11 of 35 pens (31%) were rope-positive the week of marketing ($p < 0.05$). Culture of the rope devices identified both organisms in a greater proportion of pen-weeks than culture of the composite feces. The pattern of appearance of the *E. coli* O157:H7 and *Salmonella* spp. over the course of the feeding period was not similar.

Key Words: *E. coli* O157:H7, *Salmonella*, Feedlot cattle

187 Effect of implanting during summer grazing and (or) finishing on feedlot performance and carcass characteristics of steers. L.J. McBeth^{*1}, D.R. Gill¹, and C.R. Krehbiel,
¹Oklahoma State University.

The effects of implantation with Ralgro during summer grazing and (or) Revalor S during finishing on feedlot performance and carcass characteristics were determined. Non-implanted crossbred steers ($n = 180$; BW = 280 17.3) were randomly assigned to one of three treatments. Treatments were: 1) no implant during summer grazing or finishing (CON; $n = 20$); 2) no implant during summer grazing and Revalor S implantation during finishing (IMPLF; $n = 80$); or 3) Ralgro implantation during summer grazing and Revalor S implantation during finishing (IMPLGF; $n = 80$). Steers grazed native range for 74 d prior to finishing. Upon arrival at the feedlot, steers were blocked by weight and randomly assigned to 36 pens (18 pens/block; 5 hd/pen). The heavy and light blocks were fed for 132 and 147 d, respectively. Steers that received Ralgro during summer grazing had 9.8% greater ($P < 0.01$) ADG (1.32 vs 1.19 kg/d, respectively), and entered the feedlot heavier (346 vs 337 kg; $P < 0.01$) than steers not implanted. However, by d 56 IMPLF steers (445 kg) had similar ($P > .10$) BW compared with IMPLGF steers (450 kg), and IMPLF and IMPLGF steers had greater ($P = 0.01$) BW than CON (428 kg). Steers that received an implant during finishing had greater ($P < 0.01$) ADG throughout the feeding period (1.74, 1.85, and 1.46 kg/d for IMPLGF, IMPLF, and CON, respectively). Dry matter intake did not differ ($P = 0.36$) across the entire feeding period (avg = 12.0 kg); however, DMI was greater ($P = 0.05$) for IMPLF and IMPLGF steers from d 84 through 112 (8.4%) and d 112 to the end of the feeding period (11.7%) compared with CON steers. Steers that received an implant during finishing had higher ($P < 0.01$) ADG:DMI. No significant differences ($P > .10$) were observed for dressing percent, kidney pelvic and heart fat, marbling, rib eye area, yield grade or tenderness among treatments. However IMPLF and IMPLGF steers had greater ($P < 0.01$) hot carcass weight (370, 374, and 340 kg for IMPLGF, IMPLF, and CON, respectively) and 12th rib fat thickness ($P = 0.01$) than CON steers. In this experiment, performance advantages gained by implanting during the summer grazing period were compensated for by d 56 of the finishing period by cattle that received an implant in the feedlot.

Key Words: Implant, Feedlot, Steers

188 Effects of vitamin E supplementation on feed intake and febrile responses of beef cattle challenged with infectious bovine respiratory virus. J. D. Rivera^{*1}, G. C. Duff², M. L. Galyean³, L. A. Stalker¹, M. M. Reed¹, and B. R. Mitchell¹,
¹New Mexico State University, Las Cruces, NM, ²University of Arizona, Tucson, AZ, ³Texas Tech University, Lubbock, TX.

Sixteen crossbred steers (average BW = 270 \pm 16 kg) were used to determine effects of supplemental vitamin E on DMI and metabolic responses following infection with infectious bovine respiratory virus (IBRV). Cattle were acquired from a local auction in Clayton, NM, given a modified live IBRV vaccine on receiving, transported to Las Cruces, NM, and trained to use Calan Gates (American Calan, Northwood, NH). On arrival at Las Cruces, individual BW were recorded and jugular blood samples were collected. Ten days before the IBRV challenge, steers were stratified by BW, assigned to one of four treatments (four steers/treatment) and given ad libitum access to feed (steam-flaked corn based). Treatments were 0, 285, 570 or 1,140 IU/animal daily of vitamin E top dressed to the feed and were initiated 7 d before the IBRV challenge. On d 0, steers were weighed, a blood sample obtained, and rectal temperatures (RT) recorded for each animal, after which, each steer was given an intranasal 4-mL dose (2 mL per nostril) of IBRV (Cooper Strain, Lot 97-11). After the challenge, RT were recorded daily for 5 d and on d 7. Blood samples were obtained on d 1, 2, 3, 5 and 7. A treatment \times time effect was noted for RT ($P = 0.04$). A linear effect of vitamin E was noted for RT with cattle receiving 1,140 IU/d of vitamin E, having the highest RT on d 2 ($P = 0.02$) and 3 ($P = 0.11$)

following challenge. No differences ($P > 0.10$) were noted for BW, ADG, or DMI during this period; however a trend ($P = 0.12$) for a decreased DMI with increasing vitamin E during the wk of the IBRV challenge was noted. Changes in RT and DMI are interpreted to suggest that supplemental vitamin E might enhance the inflammatory response to an IBRV challenge in steers.

Key Words: Beef cattle, Vitamin E, Febrile response

189 Performance and carcass characteristics of steers fed different feeding levels and implant strategies during the growing period. G. Scaglia^{*1}, L. W. Greene¹, F. T. McCollum III¹, and T. H. Montgomery², ¹Texas A&M University Agricultural Research and Extension Center, Amarillo, Texas, ²West Texas A&M University, Canyon, Texas.

Ninety-six growing steers (270 kg) were assigned to 12 pens in a completely randomized design. Implant and feeding level (FL) treatments were randomly assigned to a pen of steers in a 2 \times 2 factorial arrangement. Factors were: A) Synovex-S (I) or no implant (NI), and B) FL to gain 0.7 (L) or 1.4 (H) kg/d during the growing period. Steers were fed a diet consisting of 65% steam rolled corn (SRC), 25% alfalfa pellets and 10% supplement (S). After 91 and 59 d for L and H, respectively, steers were transitioned to ad libitum consumption of a high concentrate finishing diet consisting of 80% SRC, 10% cottonseed hulls and 10% S. During the finishing period, all cattle were implanted with Synovex-S and reimplanted with Revalor-S. Steers were harvested when the average fat thickness of the steers in the pen was 12 mm as measured by ultrasound. There was an interaction between implant and FL for ADG ($P = 0.10$) and feed conversion (FC; $P = 0.05$). The interactions occurred due to a higher ADG and FC (gain/feed) in implanted steers fed H but not L diets. Implant treatments did not affect subsequent ADG or FC during the finishing period. Steers fed H gained more ($P = 0.04$) than those fed L from reimplant to harvest (1.21 vs. 0.95 kg/d). Treatment did not affect marbling score, quality grade, fat thickness or yield grade. An interaction occurred between implant and FL for hot carcass weight (HCW; $P = 0.083$) and rib eye area (REA; $P = 0.029$). Implanting L steers increased HCW but not in H steers. In steers fed L, I increased REA compared to NI (88.2 vs. 82.9 cm², respectively), but not when steers were fed H (86.5 vs. 89.0 cm², respectively). Implant during the growing period did not affect subsequent performance in the finishing period.

Key Words: Implant, Feeding Level, Steers

190 Insulin responsiveness improved as glucogenic potential increased in protein supplements fed to young post-partum range beef cows. R.C. Waterman^{*1}, J.E. Sawyer¹, F. Valdez², J. Horton², and M.K. Petersen¹, ¹New Mexico State University, Las Cruces NM USA, ²Kemin Industries, Inc. Des Moines, IA USA.

Cattle grazing dormant range show yearly variation in response to supplementation. This variation may be partially due to changes in tissue responsiveness to insulin, which is altered by nutritional status. A study at the Corona Range and Livestock Research Center during a normal (2000) and a drought year (2001) evaluated supplements differing in source and quantity of glucogenic precursors. Protein supplements (36% CP) were fed to 2-year-old postpartum beef cows at 908 ghd⁻¹d⁻¹ and provided 327 g CP, 118 g UIP (Loglu); 327 g CP, 157 g UIP (Midglu); or 327 g CP, 163 g UIP + 100 g propionate salt (Higlu; NutroCalTM, Kemin Industries, Inc.). Supplements were individually fed on Fridays and Mondays for 90 d postpartum. A glucose challenge was conducted 65 d postpartum via a jugular indwelling cannula at a rate of 0.5 mlkg⁻¹ BW of a 50% dextrose solution, and serum was collected for 180 minutes. Area under the curve (AUC) was determined for both serum insulin and glucose concentrations using the trapezoidal summation method. Serum glucose half-life was determined by calculating the time required for a 50% decrease in peak serum glucose concentrations. Data were analyzed by using supplement, year, and supplement by year as model variables. No treatment by year interactions were detected. Area under the curve for insulin was similar ($P > 0.1$; 300 51) for all cows; however, glucose AUC was lowest ($P < 0.1$) for Higlu and Midglu-fed cows when compared to Loglu (13189 1004, 14615 898, and 16055 1004, respectively). Glucose half-life was less ($P < 0.1$) in Higlu-supplemented cows (100, 69, and 56 14 min for Loglu, Midglu, and Higlu, respectively). Insulin sensitivity improved as glucogenic potential increased in supplements

fed to postpartum beef cows, and may serve as a tool to improve young cow productivity.

Key Words: Insulin, Glucose, Supplementation

191 Effects of delayed implant protocols on performance, carcass characteristics and meat tenderness in Holstein steers. J.L. Beckett*¹ and J. Algeo², ¹Cal Poly State University, ²Algeo Nutrition Consulting.

One hundred eighty-six Holstein steers (156 kg) randomly assigned to one of five treatment groups (n = 38) were used to investigate the effects of delaying the onset of implant treatment during the early and intermediate feeding phases on growth and carcass characteristics. Implants contained Zeranone (Z), trenbolone acetate (TBA) or estradiol (E₂). Treatment descriptions are listed in the following table. Animals were weighed at 30-d intervals and weight gain, average daily gain (ADG), and feed efficiency were calculated. Steers were harvested after 288 d on feed and carcass measurements were collected. All implanted groups had heavier (P<0.05) average final live weights and improved ADG (P<0.05) than non-implanted controls, but did not differ (P>0.05) within implanted treatments. Average REA were greater (P<0.05) for all implanted groups compared with the control group, but did not differ (P>0.05) by implant. The percents of carcasses with USDA quality

grade of Choice or better were significantly lower (P<0.05) for treatments B and C (27.0 and 31.6%, respectively) compared with treatment E (57.9%). Treatments A and C (40.5 and 52.8%, respectively) were intermediate and were not different (P>0.05) from other treatments. Warner-Bratzler shear force values did not differ (P>0.05) between treatments. However, sensory evaluation indicated less desirable tenderness in delayed implant groups compared with the control treatment (P<0.05). Based on these data, delayed initiation of implants during the early growth phase of Holstein steers does not adversely affect growth and improves quality grade compared with early implants, but may decrease tenderness in the resulting meat.

Treatment	Day 0	Day 60	Day 120	Day 180
A	Z(36)	TBA (80) +E ₂ (16)	None	TBA (120) +E ₂ (24)
B	None	TBA (80) +E ₂ (16)	None	TBA (120) +E ₂ (24)
C	None	Z(36)	Z(36)	TBA (120) +E ₂ (24)
D	None	None	Z(36)	TBA (120) +E ₂ (24)
E	None	None	None	None

Key Words: Holstein steers, Implants, Tenderness

Breeding and Genetics
Applications of Random Regression Models in Animal Breeding

192 Random regression models in animal breeding. L. R. Schaeffer*¹, ¹CGIL, Dept. Animal & Poultry Sci, Guelph, Ontario, Canada N1G 2W1.

Random regression models (RRM) have become common for the analysis of longitudinal data or repeated records on animals over time. The best known application of RRM has been to genetic evaluation of dairy cattle using test day production records. Other applications include growth traits in all species, feed intake, body condition scores, and conformation traits. A general description of a RRM is given with a simple example. Some unique applications of RRM have been to the analysis of survival data and to the study of genotype by environment interactions. Examples of these applications are provided and discussed. RRM allow the researcher to study changes in genetic variability with time and allow selection of animals to alter the general patterns of response over time.

Key Words: random regressions, applications, dairy cattle

193 Implementation issues for Markov Chain Monte Carlo methods in random regression test-day models. J. Jamrozik*, University of Guelph, Guelph, ON, Canada.

Markov Chain Monte Carlo (MCMC) methods make it possible to estimate parameters for complex random regression (RR) test-day models. Models evolved from single-trait with one set of random regressions to multiple-trait applications with several random effects described by regressions. Gibbs sampling (GS) is used for models with linear (with respect to coefficients) regressions and normality assumptions for random effects. Efficient, model-specific algorithms based on iteration on data and block sampling have been applied for problems with up to 4 million levels in the mixed model equations and more than 3000 dispersion parameters. General-purpose software is currently also available. Difficulties associated with implementations of MCMC schemes include lack of good practical methods to assess convergence, slow mixing caused by high posterior correlations of parameters and long running time to generate enough posterior samples. Those are illustrated through comparison of GS schemes for single-trait RR test-day models with different model parameterisations, different functions used for regressions and posterior chains of different sizes. Orthogonal polynomials showed better mixing properties in comparison with 'lactation curve' functions of the same number of parameters. Increasing the order of polynomials resulted in a smaller number of independent samples for covariance components. GS under hierarchical model parameterization had a lower level of autocorrelation and required less time for computation. Posterior means and

standard deviations of genetic parameters were very similar for chains of different size (20,000 - 1,000,000) after convergence. Minimal length of the chain for a specific parameter and a given level of Monte Carlo error can be determined using estimates of the posterior standard deviation and the number of independent samples from a shorter chain after burn-in. Single-trait RR models with large data sets can be analysed by MCMC methods in relatively short time. Multiple-trait (lactation) models are computationally more demanding and better algorithms are still required.

Key Words: Gibbs sampling, Random regression models, Test-day data

194 Accuracy of genetic evaluation of beef cattle for growth fitting a random regression model. K. Meyer*¹, ¹Animal Genetics and Breeding Unit, University of New England.

A simulation study was carried out to assess the potential improvement in accuracy of genetic evaluation of beef cattle for growth by replacing the current multi-trait (MT) analysis comprising birth, weaning, yearling and final weights with a random regression model (RRM) analysis. Data were simulated assuming a cubic regression on Legendre polynomials of age for direct and maternal, genetic and environmental effects and heterogeneous error variances for ages from birth to 730 days, maintaining the original data and pedigree structure for three data sets. Set I comprised records from an experimental herd with monthly weight recording. Data sets II and III were field data, selecting a subset of herds with ≥ 55% animals with at least four weights recorded, and all herds for a breed. Each data set was analysed fitting a RRM using all records available (RR), a MT model using up to four records per animal, and a RRM (RR*) using the same subset of records as the MT analysis. Accuracy of evaluation (ρ) was calculated as correlation between true and estimated breeding values at target ages and averaged over replicates. Across all animals, ρ for RR* was consistently larger than for MT due to more appropriate modelling of variances. For data sets II and III, RR yielded little additional gain. For data set I, the overall ρ increased by 0.026 to 0.037 equivalent to 4.2 to 6.3% for 200, 400 and 600-day breeding values (RR vs. MT), and 0.024 or 4.1% for 200-day maternal genetic effects. Gains were largest for bulls with few progeny, ranging up to 9.3%.

Key Words: Random regression model, Genetic evaluation, Beef cattle

195 Differences in genetic parameters for production traits and somatic cell scores estimated using a multiple trait random regression test day model in the Italian Holstein population. A.B. Samore*^{1,2}, F. Canavesi¹, S. Biffani¹, P. Boettcher³, and J. Jamrozik⁴, ¹ANAFI, Italy, ²Wageningen University, The Netherlands, ³IDGVA-CNR, Italy, ⁴CGL, University of Guelph, Canada.

Genetic parameters for a multiple test day random regression model, that Italy is planning to implement for routine genetic evaluation in the future, need to be estimated for production and somatic cell scores. The lactation model now used in Italy accounts for heterogeneity of genetic variance across herds. A similar adjustment could be still necessary when using a test day model. A first data set was randomly sampled by herd number including 82,368 test day (TD) records from 5,675 cows without regards to production level. Low (52,527 TD) and high (71,986 TD) production data sets were created by randomly sampling herds differing for milk production by more than two standard deviations. Genetic parameters were estimated using an animal model and including the fixed effect of herd-test day, and the random effects for permanent environment, animal, and residual. The shape of lactation was modelled using the function of Wilmink (1987) as: $W(t) = w_0 + w_1 t + w_2 \exp(-0.05t)$. The residual covariances differed across 4 stages in each lactation. In total the model estimated 666 genetic, 666 permanent environmental, and 120 residual (co)variances for each data set. A Bayesian approach, as described in Jamrozik et al. (1998), was used to obtain the means of the posterior distributions for all parameters of the model. Heritabilities ranged from .15 to .38 depending on trait and parity. A wide range of values was found for correlations between traits and parities. Interesting null or slightly favourable correlations were reported between somatic cell scores and production traits (on average -.10), also in first lactation (from -.02 to -.04), in the first data sets. Differences in parameters were found for different levels of milk production and will be considered to define the adjustment for heterogeneity of variances across herds in the official test day model evaluation procedure.

Key Words: Genetic parameters, Italian Holstein, Test day model

196 Nonparametric Bayesian Analysis Of Test Day Milk Yield Data. R. Rekaya*¹, ¹Dept. of Animal and Dairy Science, University of Georgia.

The practice of hierarchical modeling has increased in the last decade both in applied statistics and in animal breeding, in part, as a result of development in Markov Chain Monte Carlo methods (MCMC) to overcome the computational complexity. In hierarchical models, as with all parametric models, specification of distributions for parameters and often hyper-parameters is required. Usually a considerable uncertainty is associated with those distributions leading to inevitable concerns about the sensitivity of the resulting inferences to the assumed forms of component distributions. Hence, a nonparametric or semi-parametric modeling that avoids the prior specification of distribution forms is a logical choice to assess such uncertainty. Dirichlet process prior represents the

cornerstone of modern nonparametric Bayesian modeling by allowing in a relatively easy way, the relaxation of the parametric assumptions. A total of 3,214 test day milk yield records from 341 cows with complete lactations were analyzed using a parametric and a nonparametric hierarchical model. A three stage hierarchical model was assumed, where the first stage describes the conditional distribution of the data. Wood's incomplete gamma function was used. At the second stage, the joint distribution of the lactation curve parameters was assumed to be normal in the parametric case and unknown with a Dirichlet process prior for the nonparametric model. Posterior means of heritability for the three parameters of the lactation curve were 0.24, 0.27 and 0.14 using the parametric model and 0.16, 0.32 and 0.14 using the nonparametric model. Those changes were behind the Monte Carlo errors. Non-negligible changes were observed also for the genetic correlations between the lactation parameters. The posterior mean of the precision parameter of the Dirichlet process was 5.7. This small value does not support the normality assumption for the distribution of the lactation curve parameters used in the parametric case.

Key Words: Nonparametric, Dirichlet, Milk

197 Changes of genetic correlation between milk production and body size over time in Holsteins using random regression models. S. Tsuruta*¹, I. Misztal¹, T. J. Lawlor², and L. Klei², ¹University of Georgia, Athens, GA, ²Holstein Association USA Inc., Brattleboro, VT.

The objective of this study was to investigate changes of genetic correlations between milk production and body size traits with random regressions on year. Genetic parameters for production traits (milk, fat, and protein yields), linear type traits (stature, strength, body depth, and thurl width), and the body size composite (BSC = stature \times 0.50 + strength \times 0.25 + body depth \times 0.15 + thurl width \times 0.10) in Holsteins were estimated using bivariate (production and type) random regression models. About 40,000 first lactation cows with linear type scores obtained from Holstein Association USA Inc. and with 305-d production records obtained from USDA-AIPL were used in this analysis. Some of the protein records were missing. The first order Legendre polynomial for additive genetic effects was included in the models as linear random regression on year at calving. Heritability estimates for BSC increased over the years, ranging from 0.30 to 0.44. The genetic correlations between milk yield and BSC were positive and constant (0.09 to 0.10). The genetic correlations between fat yield and BSC increased in the 1980s but were stable (around 0.10) in the 1990s. The genetic correlations between protein yield and BSC were also positive, but decreased from 0.15 to 0.10 in the 1990s. The genetic correlations between milk yield and each linear type trait were all positive and relatively stable over time; especially, those for body depth were higher (0.14 to 0.16) than for other linear type traits. These results indicate that the trend of larger cows producing more milk has not changed for the last 20 yr.

Key Words: Genetic correlation, Body size, Random regression

Dairy Foods

Whey Proteins: Structure, Production, Function, and Future

198 β -Lactoglobulin: Properties, Structure and Function. L. Sawyer*, The University of Edinburgh.

β -Lactoglobulin (BLG) is the major whey protein of ruminant species. It is present also in the milks of many, but not all, other species. Its amino-acid sequence and 3-dimensional structure show that it is a member of the lipocalin family that includes a widely diverse series of molecules most of which bind small hydrophobic ligands and may act as specific transporters, as does serum retinal binding protein. BLG appears to bind a wide range of ligand molecules but it is still unclear whether this is its physiological function. During heat treatment in milk processing plants, BLG is believed to be a major initiator of aggregation and hence fouling of heat-exchangers. It has also been linked to milk allergy. In reviewing the physicochemical properties of the protein, emphasis will be placed upon those studies that give insight into the behaviour during unfolding and denaturation under a variety of conditions. Further, by considering the lipocalin family in general, and in particular the species

distribution of BLG, some speculation as to the physiological function can be made.

Key Words: β -Lactoglobulin, Structure

199 Heat-induced reactions involving β -lactoglobulin and other milk proteins in milk, whey, and model systems. L. K. Creamer*¹, G. A. Manderson¹, Y-H. Hong², P. Havea¹, Y-H. Cho³, H. Singh⁴, A. Bienvenue⁵, and R. Jimenez-Flores⁵, ¹NZDRI, Palmerston North, New Zealand, ²Chonnam University, Kwanju, Korea, ³Mass. General Hospital, Boston, MA, USA, ⁴IFNHH, Massey University, Palmerston North, NZ, ⁵DPDC, Calpoly, San Luis Obispo, CA, USA.

Heat treatment of milks is an essential step in modern dairy processing and the effects can be far-reaching in terms of product functionality and the heat-induced gelation of whey protein concentrate (WPC) solutions is important in functional food applications. Heating WPC solutions or milk beyond pasteurisation causes some of the individual whey proteins

form aggregates and to aggregate with the other whey proteins. Studies using various kinds of two-dimensional polyacrylamide gel electrophoresis (PAGE) analysis as the major tool with simple solutions of pure whey proteins confirmed that β -lactoglobulin (β -Lg) was the most important whey protein in these aggregations. A previously unknown group of intermediates, the non-native β -Lg monomers, was of particular interest and some characteristics of these and other early heat-induced intermediates were determined. The changes in the positions of the disulphide bonds in β -Lg as a consequence of heat treatment were identified from mass spectroscopy-based analyses. \otimes Heated mixtures of α -lactalbumin (α -La) and β -Lg were found to contain 1:1 disulfide-bonded dimers as well as non-native monomers, dimers, trimers, etc. of both α -La and β -Lg. The findings from this and other model systems were then tested in WPC solutions using one- and two-dimensional PAGE. \otimes In heat-treated milk the whey proteins interact to form disulfide bonds with the casein micelles and κ -casein (κ -Cn) is the most significant casein in this reaction and β -Lg was the most important whey protein in this reaction. In a model system, κ -Cn and β -Lg formed 1:1 aggregates as well as large polymeric aggregates. A heat-induced complex of β -Lg and κ -Cn was isolated from a heated mixture of casein micelles and β -Lg by chromatography. Analysis of this complex identified a number of novel disulfide bonds between β -Lg and κ -Cn. \otimes These results have shown that β -Lg is critical to the heat-induced changes in both milk and WPC, and have lead us to re-evaluate the likely mechanism for the initial changes within β -Lg in response to heat-treatment.

Key Words: β -Lactoglobulin - κ -casein complex, Non-native β -lactoglobulin monomers, Heat-induced β -Lg - α -La complex

200 Functional properties of whey proteins. M. Britten*, FRDC, Agriculture and Agri-Food Canada, St-Hyacinthe, Qc., Canada.

In recent years, the use of whey proteins in formulated foods has increased. Health conscious consumers recognize their high nutritional value. Specific biological activities have also been attributed to whey proteins which makes them suitable ingredients for the formulation of functional foods. Along with a healthy image, whey protein provides foods with improved texture and overall quality. A better control of protein polymerization is however required to optimize their use. Heating a whey protein dispersion leads to polymer formation. The pH, calcium and protein concentrations during treatment determine aggregate size, shape and hydration. These characteristics influence their behavior in food systems. Controlled aggregation of whey protein is used to increase the viscosity and improve the mouth feel of liquid products. Added to cheese milk, whey protein aggregates are trapped in the curd and increase the yield, moisture and reduce firmness of cheese. In specific aggregation conditions, whey proteins form opaque dispersions and can be used as clouding agents in beverages. Gel formation is usually induced by heating native whey protein dispersions. However, it can also be obtained from polymerized whey protein dispersions by acidification or by the addition of salts. Use of polymerized whey proteins in yogurt formulations increases firmness and reduces syneresis. Whey proteins are also used in the preparation of emulsions and foams. They adsorb at interfaces and form a membrane which prevents emulsion coalescence or foam collapse. Whey protein membrane has also been shown to provide protection against lipid oxidation. The combination of interfacial adsorption and gel formation properties is used to produce solid-like emulsions and foams. This approach finds applications in baked foods or in the development of nutrient carriers. Whey protein polymerization offers new means to control food texture and stability. It should support the development of formulated food especially designed for health conscious consumers.

Key Words: protein polymers, gel formation, emulsions

Extension Education and International Animal Agriculture The Impact of Governmental Policies on North American Animal Agriculture

203 Mexico: Agricultural policies, trade agreements and challenges for the animal scientist. M Garcia-Winder*¹, ¹T.C. Jacoby & Co.

The importance of the agricultural sector in Mexico is not only determined by the number of people living in rural areas (25% of total

201 Technological, functional and biological properties of peptides obtained by enzymatic hydrolysis of whey proteins. S.F. Gauthier* and Y. Pouliot, Centre de recherche STELA, Université Laval, Quebec, Canada.

The study of peptides released by enzymatic hydrolysis of whey proteins has been initially focussing at functional properties in model systems. Our first work showed that sequences 41-60 and 21-40 from β -lactoglobulin (β -LG) were responsible for improved emulsification properties in tryptic hydrolysates of β -LG. Further work showed that adding negatively charged peptides from chymotryptic hydrolysates of whey proteins could prevent phase separation of dairy-based concentrated liquid infant formulas, as a replacement of carrageenin. Hydrolysis of whey proteins using bacterial enzymatic extracts was also successful in improving heat stability of whey proteins in an acidic beverage. Recent work demonstrated the occurrence of interactions between peptides β -LG 102-105, β -LG 142-148 and the native β -LG. These latest results suggest that β -LG could be used as a carrier for bioactive peptides. Finally, the emerging functional foods and nutraceuticals have triggered the development of new knowledge on the biological activity of whey proteins. Whey proteins are recognized to comprise peptide sequences having ACE-inhibiting properties. Our work led to the development of whey protein enzymatic hydrolysate that has demonstrated antihypertensive properties when orally administered to SHR rats at a dosage of 75 mg/kg. Our work has shown that the enzymatic hydrolysis of whey proteins is not only improving their functional and technological properties but it is also providing powerful tools to exploit their full potential by generating bioactive peptides.

202 The quantitative analysis of whey proteins - where we are and where we are going. DE Otter* and EA Foegeding, North Carolina State University, Raleigh, NC.

As whey proteins become ingredients in more sophisticated nutraceutically and functionally based foods and dairy products it is imperative that they can be accurately quantified. My presentation will highlight some of the research presently being undertaken to address this issue and to suggest directions for future research.

Previous work has concentrated on quantifying the major whey proteins; α -lactalbumin, β -lactoglobulin, bovine serum albumin and immunoglobulin. There is however an increasing demand to also quantify the minor components, such as glycomacropeptide, lactoferrin and folate binding protein; the bioactivity of the different proteins/peptides; and the amount of native and denatured protein. Researchers are using a number of diverse methods for measuring the individual whey proteins. The idiosyncrasies of each method must be considered when quoting values for the individual proteins.

The cornerstone of any successful quantitative method is the availability of well-defined calibration standards. A wide array of analytical techniques such as nitrogen analysis, UV spectroscopy, PAGE, HPLC and CE has been used to characterise a set of whey protein standards. These techniques all have their individual limitations but when used together they give a good estimate of protein purity. An alternative method based on the unique amino acid 'fingerprint' of each whey protein has also been used to characterise the standards (Tsao et al., The Food Technologist, 28 (3), 94, 1998). Using an in-line nitrogen detector to accurately quantify the nitrogen content of specific HPLC peaks has further enhanced the characterisation. The identity and integrity of the proteins in these peaks has been verified by HPLC-mass spectrometry. Another important component of method development is method validation and accreditation. This usually involves an inter-laboratory comparison study under the auspices of an international organisation such as AOAC or IDF. The steps involved for an HPLC method for the quantification of bovine IgG that is currently going through this process will be described.

Key Words: Whey proteins, Quantitative analysis, Calibration standards

population), or because of its contribution to GNP (6.3%), but also because it is a sector with higher poverty levels and in more need of development. The incorporation to GATT, was the beginning of profound transformations. As a consequence agricultural policies have been

radically modified to respond to the challenges of open economies and international trade. During the last decade these policies have been directed towards providing direct support to production, to enhance trade and to promote the development and transfer of technology. Presently, Mexico has signed several free trade agreements with NAFTA being the most notable one. Animal production has shown remarkable annual growth (4.9% for meat, 4.3% for dairy and 6.3% for egg) during the last 10 years. Due to increased demand and trade liberalization, the net trade balance for the sector has been negative, accounted primarily by a deficit in dairy and meat, a condition that is also observed in processed animal products, where dairy cause more than 50% of this deficit. In

contrast with the importance of the rural sector, during the last decade public spending has not only been reduced but diversified among programs and institutions with many contradictory goals. Among challenges for the future are the need to increase production, productivity and sustainability of the livestock sector, the development of new products for a more demanding population, improvement of animal welfare and protection and recovery of natural resources. These challenges require animal scientist willing to find new paradigms and to participate in activities traditionally considered outside the scope of animal science.

Key Words: Agricultural policies, Trade agreements, Animal science

Milk Synthesis

Regulation of Mammary Gland Function by Growth Factors and Downstream Signaling Cascades

204 Effect of transforming growth factor-beta-1 on mammary development. K. Plaut*, A. Dean, and T. Patnode, *University of Vermont, Burlington, VT/USA.*

The mammary gland is dependent on hormones and growth factors for development and differentiation. While studies have been conducted to understand the role of growth factors that stimulate mammary growth, few studies have focused on the role of growth inhibitors in mammary development. Transforming growth factor - beta 1 (TGF- β 1) is a potent inhibitor of mammary growth and stimulates the extracellular matrix (ECM). The ECM effects mammary development because it provides the scaffolding that supports the epithelial cells of the gland. We studied the effect of TGF- β on mammary development in cell lines and mammary tissue. Incubation of mammary epithelial cells with 2.5 - 5 ng/ml of TGF- β 1 + 10% fetal bovine serum (FBS) results in at least a 50% reduction in cell growth compared to FBS controls. Using flow cytometry, we characterized changes in the cell cycle in response to TGF- β . NOG-8 cells were synchronized by serum starvation for 48 hours followed by incubation in media supplemented with 10% FBS and 0 or 2.5 ng/ml TGF- β 1. Cells were harvested at 6, 48, and 72 hours post-treatment. There were fewer cells in G0/G1 and a higher proportion of dying cells in the TGF- β treated cells compared to controls at all time points. A cell cycle specific mini-array is being used to determine which genes in the cell cycle are changed in response to TGF- β 1. In addition to the effects on cell cycle, TGF- β also effects the production of extracellular matrix proteins, which causes a change in cell shape and function. Cells exposed to 5 ng/ml TGF- β 1 changed from a cobblestone morphology to elongated fibroblast-like morphology and expressed high levels of fibronectin as determined by immunocytochemistry. The cells continued to be growth inhibited. Last, studies are underway to determine the *in vivo* effects of TGF- β on the mammary gland of heifers. Changes in DNA synthesis, cell cycle gene expression and expression of extracellular matrix proteins are being used to measure the response. These studies will lead to a better understanding of how TGF- β effects mammary cell growth.

Key Words: mammary, transforming growth factor beta, growth inhibitor

205 Mammary development, growth and plasma levels of IGF-I and IGF-binding proteins in gilts provided different energy levels from weaning to puberty. MT Sorensen*, M Vestergaard, S Purup, and K Sejrsen, *Danish Institute of Agricultural Sciences, Foulum, Denmark.*

We investigated the effect of feeding level from weaning (d 28) to slaughter at puberty (d 162) on growth rate, mammary development and plasma levels of IGF-I and IGF-binding proteins (IGFBP) in 10 litters of 4 female pigs. From d 28 to 90 (period 1) and from d 90 to 162 (period 2), pigs were fed either *ad libitum* (A) or restrictively (R; i.e. 30% lower feed intake in period 1 and 25% lower in period 2) in a 2x2 factorial design with treatments named AA, AR, RA and RR. In period 1, ADG of A-gilts was 622 g vs. 522 g for R-gilts ($P<0.001$). At the end of period 1, A- compared with R-gilts had higher plasma levels of IGF-I (303 vs. 220 ng/ml, $P<0.01$) and IGFBP-3 (770 vs. 564, arbitrary units, $P<0.01$), but lower IGFBP-2 (291 vs. 396 a.u., $P<0.02$) and 28 kDa IGFBP ($P<0.06$). In period 2, ADG of RA- and AA-gilts was 1012 g vs. 792 g for RR- and AR-gilts ($P<0.001$). Furthermore, RA-gilts showed compensatory growth compared with AA-gilts (1054 vs. 971 g/d, $P<0.07$) with no difference in feed intake. At the end of period 2, there was a tendency for higher plasma IGF-I ($P<0.15$) in AA-

and RA-gilts compared with AR- and RR-gilts whereas IGFBP-2 and 28 kDa IGFBP were reduced ($P<0.01$). The amount of dissected mammary tissue was higher in AA- and RA-gilts compared with AR- and RR-gilts (86 vs. 59 g/gland, $P<0.001$), and although DNA concentration was lower in AA- and RA-gilts compared with AR- and RR-gilts (342 vs. 397 μ g/g tissue, $P<0.04$), total amount of mammary DNA was highest in AA- and RA-gilts. The concentration of mammary RNA was not affected by treatment. Feeding level in period 1 did not affect the mammary measures. We conclude that to obtain high mammary growth, a period with *ad libitum* feeding before puberty is needed, however, this period does not have to commence at weaning. Furthermore, differences in growth rate are associated with differences in IGF-I and IGFBPs, and female pigs fed restrictively from weaning to d 90 and *ad libitum* until puberty grow as fast as do continuously *ad libitum* fed pigs.

Key Words: mammary, gilt, IGF

206 Polycation-mediated transfection of the porcine mammary gland. M. Amstutz*, S. Reuss¹, R. Neiswander², T. Meek¹, S. Courtney¹, and F. Schanbacher², ¹*The Ohio State University Agricultural Technical Institute, ²Ohio Agricultural Research and Development Center, Wooster USA.*

Production of recombinant proteins in the milk of livestock has thus far been limited to transgenic and viral-mediated gene transfer methods. Our previous studies have demonstrated the feasibility of polycation-mediated transfection of bovine and murine mammary cells *in vitro* and the guinea pig mammary gland *in vivo*. These experiments were conducted to determine if direct intramammary infusion of polycation-DNA complexes in the porcine mammary gland would result in recombinant human growth hormone (hGH) secretion in milk. A second parity Yorkshire sow (sow 1) was tranquilized on day 112 of gestation. Teat ends were cleaned with alcohol and mammary glands transfected by infusing each teat opening with 50 ml of HBSS containing either; DEAE-dextran (DEAE) 1.25 mg/ml (sham transfection), or DEAE-dextran 1.25 mg/ml and plasmid DNA (50 μ g/ml). Following parturition milk samples were collected daily, defatted, and stored at -80°C until assayed for hGH by radioimmunoassay. Milk from sham transfected and uninfused mammary glands contained no hGH. Milk from the DEAE-DNA transfected mammary gland contained hGH on all 14 days of lactation with expression peaking on day 6 at 5.5 ng hGH/ml and declining to 1.5 ng/ml by day 14. A second experiment was conducted as described above utilizing a first litter gilt (sow 2). Milk from two mammary glands transfected with DEAE-DNA again contained hGH throughout the first 12 days of lactation while sham and control samples contained none. Expression profiles for sow 2 were similar to sow 1 with expression peaking at 1.1 (gland 3) and 0.88 (gland 2) ng hGH/ml on days 8 and 9 respectively. Differences in hGH expression levels may be due to variation in time from transfection to parturition (3 days for sow 1 vs. 6 days for sow 2) or parity differences. Although expression levels differ between animals these results demonstrate the feasibility of transfecting the porcine mammary gland via direct intramammary infusion.

Key Words: Transfection, Porcine, Polycation

207 Frequent milking in early lactation that increases milk yield also increases prolactin receptor mRNA expression. G. Dahl*, T. Auchtung, J. Underwood, and J. Drackley, *University of Illinois*.

The periparturient surge of prolactin (PRL) is essential to optimize lactogenesis in cattle. The importance of PRL following parturition in cattle, however, has previously been thought to be limited. Frequent milking early in lactation (i.e., pre-peak) causes persistent increases in milk yield for that lactation, yet the mechanism for that response is unknown. This experiment tested the hypothesis that more frequent milking increases PRL sensitivity early in lactation and subsequently leads to higher milk yield. Jersey cows ($n=4/\text{treatment}$) were milked twice (2X) or four times (4X) each day for the first 21 d of lactation and subsequently all were milked 2X. Blood samples were collected on d 4, 7, 14, and 21 for quantification of PRL in plasma. Additionally, lymphocytes were harvested and prolactin receptor (long and short forms; PRL-R) mRNA was quantified as a proxy for PRL-R expression in mammary epithelial cells. Relative to 2X, 4X increased yield during the first 21 d of lactation from 21.8 to 26.8 kg/d (SED = 2.8 kg/d; $P<0.05$), and the difference persisted for at least the next 21 d (2X = 27.3 vs. 4X = 33.1 kg/d; SED = 2.7; $P<0.056$). Compared with 2X, 4X increased the concentration of PRL in plasma from 8.3 to 10.1 ng/mL (SED = 1.3; $P<0.11$). Expression of mRNA for short and long forms of PRL-R was greater in 4X cows on d 4 relative to 2X cows ($P<0.02$). In summary, doubling the frequency of milking for the first 21 d of lactation caused a persistent increase in milk yield, greater PRL in plasma and increased PRL-R mRNA expression. We conclude that more frequent milking early in lactation increases PRL sensitivity in the mammary gland through greater release and reception of PRL signaling.

Key Words: prolactin, receptor, frequent milking

208 Effect of growth factors and hormones on mam-mogenesis and lactogenesis in cattle. Robert Collier*¹, J.C. Byatt², M.F. McGrath², P.J. Eppard², J.L. Vicini², and C. Stiening¹, ¹*University of Arizona, Department of Animal Sciences*, ²*Monsanto Company*.

In vitro and in vivo models were employed to test effects of growth factors and hormones on mam-mogenesis in cattle. Bovine mammary collagen gel culture was utilized to identify direct acting mitogens. These were then infused via the streak canal in half udder studies utilizing pregnant dairy and beef cattle to determine if mam-mogenic activity identified in vitro was present in vivo. Hormones and growth factors identified as mam-mogenic in vivo were then utilized in half and full udder lactation trials to determine if increased mam-mogenesis translated into increased milk yield. Growth factors identified as mam-mogenic in vitro and in vivo were insulin-like growth factor I, epidermal growth factor and transforming growth factor alpha. Hormones identified as mam-mogenic in vivo were prostaglandins of the E series, bovine growth hormone and bovine placental lactogen. All of these were tested in half and full udder lactation trials by intramammary infusion in the last trimester of pregnancy with exception of bovine placental lactogen which was administered systemically. All failed to demonstrate an increase in milk production post-partum. Prostaglandins of the E series (PGE) were shown to cause large increases in udder volume and secretory activity when infused in the mammary gland during late pregnancy. Further studies demonstrated that PGE is synthesized by mammary tissue and concentration of PGE in mammary secretion increases dramatically during the peripartum period. It is proposed that PGE is involved in Stage II lactogenesis. At present, we cannot identify a mam-mogenic hormone treatment which results in increased milk yield postpartum. This may indicate that lactation potential is established during ductal development prior to onset of pregnancy.

Key Words: hormones, growth factors, mam-mogenesis

209 Both phosphatidylinositol 3-kinase (PI3K) and mitogen activated protein kinase (MAPK) pathways are required for IGF-I regulation of IGF binding protein-5 synthesis in bovine mammary cells. J. Fleming* and W. Cohick, *Rutgers University*.

IGF-I is an important mediator of mammary epithelial cell (MEC) proliferation, and thus is critical to the normal development of the mammary gland. The IGF binding proteins (IGFBP) modulate cell growth

through both IGF-dependent and independent mechanisms. Since the development of the mammary epithelium involves complex interactions between stromal and secretory components, we investigated IGFBP synthesis by primary bovine mammary fibroblasts (BMF). BMF were found to synthesize IGFBP-2, -3, and -5 by Northern analysis. IGFBP-5 mRNA levels were increased 4.5-fold over serum-free controls by IGF-I treatment (200 ng/ml) for 8 hr. Increases in IGFBP-3 mRNA levels were also observed, though to a lesser degree. In contrast, IGFBP-2 mRNA levels were unchanged. To determine if the effect of IGF-I on IGFBP-5 mRNA levels was specific to this cell type, we investigated the effect in the MEC line MAC-T. IGFBP-5 mRNA levels were similarly increased by IGF-I in MAC-T cells. To determine the intracellular pathways used by IGF-I to regulate IGFBP-5 synthesis, we first examined which pathways are activated by IGF-I. Western analysis of cell lysates using antibodies specific to phosphorylated forms of the proteins revealed that IGF-I activated components of both the PI3K and the MAPK cascades in BMF. Activation of both AKT and ERK 1/2 by IGF-I was observed at 5 min and was maximal between 15 and 30 min. We have previously reported that IGF-I stimulates the PI3K, but not the MAPK pathway in MAC-T cells. To determine which of these pathways mediates IGF-I stimulation of IGFBP-5, inhibitors of the PI3K (LY294002) and MAPK (PD98059) pathways were employed. In both BMF and MAC-T cells, inhibition of either pathway alone decreased IGFBP-5 synthesis by at least 50%. When both pathways were concurrently blocked, an even larger decrease in synthesis was observed. These studies indicate that while IGF-I activates different signaling pathways downstream of its receptor in BMF compared to MAC-T cells, both the PI3K and the MAPK pathways are required for IGF-I stimulated synthesis of IGFBP-5.

Key Words: Insulin-like growth factor-I, IGF binding protein, Mammary

210 Parathyroid hormone-related peptide (PTHrP) enhances mammary tight junction (TJ) formation under low-calcium (Ca) conditions through maintaining intracellular Ca stores. K. Stelwagen* and M. R. Callaghan, *AgResearch Ltd., Hamilton, New Zealand*.

TJ play an essential role in cell-cell contact between epithelial cells and as such play a critical role in cell functioning. We have previously demonstrated the requirements of endocrine factors (glucocorticoids, prolactin) and extracellular Ca for the formation and maintenance of mammary TJ. Given that PTHrP is involved in cellular Ca homeostasis, we postulated a role for PTHrP in the regulation of mammary TJ. The effect of PTHrP on TJ was studied in the mouse mammary cell line COMMA-1D by measuring transepithelial electrical resistance (TER) across the cell monolayer. Data shown are after 24 h culture in low-Ca (2 μM) medium. PTHrP (0, 10 or 100 nM) did not affect TER in cells in normal-Ca (1.8 mM) medium. However, when cells were kept in a low-Ca medium PTHrP increased TER in a dose-related fashion (PTHrP, 0 nM vs. 10 nM vs. 100 nM: 544^a vs. 563^a vs. $686^b \pm 42 \Omega\cdot\text{cm}^2$, $^{ab}P<0.05$). The presence of an apical Ca-channel activator (Bay K-8644, 50 μM) increased the TER beyond that of PTHrP alone (0 nM vs. 100 nM vs. 100 nM+Bay K vs. Bay K alone: 896^a vs. 1036^{ab} vs. 1198^b vs. $907^a \pm 81 \Omega\cdot\text{cm}^2$, $^{ab}P<0.05$), whereas PTHrP did not affect TER in the presence of a Ca-channel blocker (Nifedipine, 50 μM ; 0 nM vs. 100 nM vs. 100 nM+Nifedipine vs. Nifedipine alone: 1250^a vs. 1604^b vs. 438^c vs. $405^c \pm 80 \Omega\cdot\text{cm}^2$, $^{abc}P<0.05$). Western analyses showed that the expression of the major TJ protein occludin was highest with 0 nM PTHrP and lowest with the 100 nM dose, approaching that observed in cells grown in normal-Ca medium. This indicates that with a low-Ca challenge there is enhanced TJ synthesis (repair), but that there is less synthesis occurring as the level of PTHrP increases, which increasingly facilitates a replenishment and/or maintenance of intracellular Ca stores. These data corroborate the TER data. In conclusion, PTHrP enhances mammary TJ formation when extracellular Ca is limiting by maintaining intracellular Ca supplies.

Key Words: Mammary, Tight junction, PTHrP

Nonruminant Nutrition

Phytase, What is New and What Needs to be Done?

211 Overview of nutritional and environmental benefits of phytases. Gary L. Cromwell*, *University of Kentucky, Lexington.*

The majority of the P in cereal grains and oilseed meals is organically bound as phytic acid or phytate. This form of P is nutritionally unavailable to nonruminant animals due to the lack of phytase in their digestive tract. As a result, swine and poultry diets must be supplemented with highly available, inorganic sources of P to meet their P requirements. The poor bioavailability of P in the natural feedstuffs along with high dietary levels of supplemental P result in higher levels of fecal P compared with ruminant animals. In the early 1970s, research at Arkansas showed that supplementing a chick diet with microbial phytase improved the utilization of P. Studies in the early 1990s at Kentucky and Michigan showed that feeding pigs a low-P, corn-soy diet supplemented with phytase from a mutant strain of *Aspergillus niger* improved the bioavailability of P. At about the same time, research in the Netherlands and at our station also demonstrated the efficacy of phytase produced by recombinant *Aspergillus niger* in studies with pigs and chicks. In November, 1995, a commercial source of recombinant-produced phytase (Natuphos®) was approved for use in the USA. Since then, other sources and forms of phytase have been developed and evaluated. A considerable amount of research has been conducted with phytase. From 1992 to 2001, 82 papers involving phytase were published in Poultry Science (n=55) and the Journal of Animal Science (n=27), with 48 of these published in the last 4 years. The studies clearly show that phytase increases the digestibility and bioavailability of P from phytate, reduces the amount of inorganic P needed to maximize growth and bone mineralization, and markedly reduces fecal excretion of P. Phytase also seems to increase the bioavailability of Ca, Zn, and other divalent cations that otherwise bind to phytate. Some studies suggest that phytase may improve ileal digestibility of amino acids slightly, but other studies have not shown this response. This new technology offers substantial benefits to swine and poultry production by reducing the potential for environmental problems associated with excess P excretion.

Key Words: Phosphorus, Phytase, Phytate

212 Comparative properties of various phytase genes and proteins. E. Mullaney*, *SRR-ARS-USDA.*

Today the market for phytase as an animal feed additive is over 500 million dollars. Most of this market is for a fungal phytase that was first identified in 1968. Developments in molecular biology in the following years enabled its gene to be cloned and over-expressed. Commercialization of this enzyme has proceeded rapidly over the last decade. During that period other phytases have been characterized and several have had their genes cloned. These phytases include isolates from fungi, bacteria, and plants. Biochemical research on these different enzymes has revealed various active site motifs that are represented. These include histidine acid phosphatase, beta propeller phytase, and recently a purple acid phosphatase. The importance of disulfide bridges and the differences in the catalytic properties of fungal phytases have also been investigated. Furthermore, X-ray crystallization research of several phytases has provided details on their physical structure and how they interact with their substrate, phytic acid. Given this extensive number of studies on the properties of these phytases and the diversity of catalytic mechanisms, this information constitutes a valuable resource for further improvement of this enzyme. A review of the most recent research on the properties of these enzymes and the genes encoding them will be presented.

Key Words: Phytase, Acid phosphatase, Phytic acid

213 Expression, engineering, and testing of phytases. X. G. Lei*, *Cornell University.*

Phytases initiate the release of phosphate from phytate (*myo*-inositol hexakisphosphate), the major phosphorus (P) form in animal feeds of plant origin. These enzymes have been supplemented in diets for food animals to improve P nutrition and to reduce their P excretion. An "ideal phytase" is expected to be effective in releasing phytate-P in the digestive tract, stable to resist inactivation by heat from feed processing and storage, and cheap to produce. Site-directed mutagenesis, based on three-dimensional structure data and sequence comparisons of various

phytases, has been successfully applied to improve their pH optimum and catalytic efficiency. Different phytase expression systems, including plants, bacteria, fungi, and yeast, bear respective advantages and limitations. Effectiveness of the improved phytases should be tested with animal feeding under practical conditions.

Key Words: Phytase, Gene expression, Protein engineering

214 The EnviropigTM physiology, performance and potential contribution to nutrient management. C.W. Forsberg*, J.P. Phillips¹, S.P. Golovan¹, R.G. Meidinger¹, M. Cottrill¹, A. Ajakaiye¹, M.Z. Fan¹, D. Hilborn², and R.R. Hacker¹, ¹University of Guelph, Guelph, ON, ²Ontario Ministry of Agriculture, Food and Rural Affairs, Woodstock, ON.

The EnviropigTM produces salivary phytase encoded by the AppA phytase gene from *Escherichia coli*. This enzyme is produced by the salivary glands in sufficient quantities to allow almost complete utilization of phytate present in the diet. This results in a reduction of greater than 60% in the phosphorus content of feces from pigs receiving an industry standard diet lacking supplemental phosphate. Similar performance results have been obtained with two additional lines of transgenic phytase pigs. Phosphorus present in the feces appears to be primarily of gastrointestinal endogenous origin. Manure produced by the transgenic pigs contains a similar proportion of soluble inorganic phosphorus to total phosphorus as that in feces from non-transgenic pigs, but the content is proportionately lower. The NMN2001 nutrient management program developed by the Ontario Ministry of Agriculture, Food and Rural Affairs for assessing maximum pig units per acre without phosphorus and nitrogen pollution from the spreading of manure was applied to the EnviropigTM. It was found that for a soil not subjected to erosion, 38% less land would be required for the spreading of manure from an EnviropigTM herd as compared to a non-transgenic herd, while in the case of a soil subjected to erosion, such as a sandy soil with a sloping terrain 63% less land would be required for the spreading of manure from an EnviropigTM herd. If crude protein in the diet was reduced with the simultaneous inclusion of limiting essential amino acids, the acreage could be reduced even further for some soil types. Because of these very optimistic results work is continuing on the characterization of the EnviropigTM.

Key Words: EnviropigTM, Phytase, Pig

215 Considerations on the field application of phytase. D. R. Cook*, *Akey, Lewisburg, OH.*

The successful application of phytase under practical feed milling and livestock production conditions is dependent on nutritional, stability, regulatory, and statutory issues, as well as ingredient availability and milling capabilities. The dietary level and phosphorus equivalency of phytase chosen for complete feeds plays a crucial role in determining economic viability of phytase use. Increased phytate phosphorus digestibility in response to graded levels of phytase follows a curvilinear pattern. Phytase levels on the linear portion of this curve will result in phosphorus release for the least cost per unit of phytase and should be considered. Whether or not phytase is given credit for improving amino acid and energy digestibility will further influence cost-effectiveness. Ingredient availability (e.g. liquid fat, meat and bone meal) and diet formulation on energy density also will influence cost effectiveness of phytase. Susceptibility of phytase to degradation from heat and humidity forces distributors, feed mills, and producers to carefully manage inventory to avoid losses in potency and necessitates a safety margin to account for product losses over normal transportation and storage times. Feed mills need to ensure tag claims match units of activity based on manufacturer definitions (e.g. FTU vs FYT vs PTU). Local and state laws regulating phosphorus application may force livestock and poultry producers to use phytase. Alternatively, some cropping systems which rely on livestock and poultry effluent may prefer higher levels of phosphorus than provided in feeds formulated with phytase. Matching phytase potency to ingredient handling and feed mixing capabilities is crucial for adequate mixing of phytase in complete feeds. Feed processing methods (e.g. expansion, pelleting) will influence at what point in the feed manufacturing process phytase is applied (e.g. added at the

mixer vs. post-pellet application). While it is clear that dietary phytase improves phytate phosphorus utilization by monogastrics, practical application of this technology for optimum efficacy and cost-effectiveness requires an integrated approach.

Key Words: Phytase, Phosphorus, Field application

216 Phytase does improve energy, protein, and amino acid utilization. Z. Mroz*, *Institute for Animal Science and Health, IDTNO Animal Nutrition, Lelystad, The Netherlands.*

Feeding phytate-rich diets with supplemental microbial phytase has often resulted in improved ADG and/or feed efficiency of pigs. This implies that (1) not only minerals but also organic compounds from intrinsic phytate complexes could be "liberated" intraluminally; (2) de novo complexing/precipitation of dietary or endogenous protein with phytic acid in digesta could be diminished or prevented; (3) the activity of endogenous enzymes could be inhibited to a lesser degree with decreasing contents of phytic acid in digesta. The extent to which dietary protein and/or energy digestibility/utilization from phytate-rich diets is improved by microbial phytase seems to be a result of such factors as (1) acidity/buffering capacity of individual ingredients, feeds, and intragastric/intraluminal contents; (2) sources and levels of dietary phytate, phytase, protein, and energy; (3) feeding regimen (restricted/ad libitum); (4) specific configurations and stability of phytate complexes; (5) the degree of synchrony of energy and nitrogen release in the small intestine with body protein/fat accretion patterns. Based on the available literature data it can be concluded for practical implications that corn- or cereal-soybean based diets supplemented with 500 FTU/kg microbial phytase (Natuphos) may have improved apparent ileal digestibility of CP/essential AA in the range from 1 to 3%-units, and DE from 32 to 46 kJ/kg of diet.

Key Words: Pigs, Microbial phytase, Protein and energy availability

Production, Management, and the Environment Environmental Stress on Livestock and Economic Implications

218 The physiological response to stress. Robert Collier*¹, Wolfram Alison¹, and Coppola Crista², ¹*University of Arizona, Department of Animal Sciences,* ²*Colorado State University.*

Stress is an external event or condition which results in a strain on a physiological system. This strain can be measured on farm by reduced productivity or animal health. Under controlled laboratory conditions the strain can be measured as increased basal metabolic rate, increased adrenal axis secretion, reduced immune function or reduced reproductive performance. In future, gene expression technology will permit identification of specific genes which are turned on or off during periods of stress. This will allow researchers to identify markers for stress at the molecular level. Major stressors in animal production systems are associated with animal handling, housing and feeding practices. High productivity itself does not constitute a stress to animals. However, failure to alter management practices to accommodate higher production does impose a stress on animals. For example, doubling of average milk yield per cow in the last 50 years has increased dairy cattle cooling requirements in summer and reduced heating requirements in winter. Failure to modify housing structures to accommodate this change results in stress on animals. It has been proposed that increasing milk production with exogenous somatotropin (bST) is stressful to cattle. However, bST does not alter basal metabolism, adrenal axis or immune function and production is increased. Increased heat production associated with increased milk yield in bST treated cattle is accommodated with a concomitant increase in evaporative heat loss via increased sweating rate. Key to reducing stress in domestic animals is not to reduce production levels but to improve animal management practices

Key Words: stress, physiology, production

217 Does supplemental dietary microbial phytase improve amino acid utilization?. O. Adeola*, *Department of Animal Sciences, Purdue University.*

Environmental concerns emanating from the excretion of large quantities of phosphorus in effluents from intensive animal production operations have led to the current routine use of microbial phytase. Following extensive investigations, microbial phytase supplementation of diet has been shown to consistently improve the utilization of phytate-bound phosphorus and a plethora of data is available in the literature to support this. The release of phosphorus from phytate during the digestion process is theorized to release other nutrients that may be bound in the phytate complex. Furthermore, hydrolysis of phytate is hypothesized to attenuate the inhibitory effect of phytate on digestive enzymes and consequently ameliorate the depression of nutrient absorption. While a limited pool of data exists on small increases in apparent amino acid digestibility in both swine and poultry literature, these have seldom translated into improved growth performance when the effect of enhance phytate-phosphorus utilization is factored out. Conversely, there are also data on a lack of response in amino acid utilization (both pre- and post-absorptive) to microbial phytase supplementation. Several factors may play important roles in amino acid utilization response to dietary microbial phytase supplementation. Identification of such factors and quantification of their effects on the magnitude of response to phytase would be important in ascribing meaningful "amino acid response factor" to dietary supplemental microbial phytase and moving the swine and poultry nutrition industry ahead.

Key Words: Swine and poultry, Phytate and phytase, Amino acid digestibility

219 Environmental stress in beef cattle. T Mader*¹, ¹*University of Nebraska.*

The performance, health, and well-being of cattle are strongly affected by climate. While new knowledge about animal responses to climatic stress continues to be developed, managing cattle to reduce the impact of adverse weather remains a challenge. During the summers of 1992, 1995, 1997, and 1999, reported feedlot death losses in the Midwest averaged between 1,000 and 5,000 head each year as a result of severe heat episodes. In the winters of 1992-93 and 1997-98, feedlot death losses exceeded 50,000 as a result of snowstorms and/or extended periods of cold, wet weather. In the winter of 1996-97 reported cattle deaths (feedlot and cow/calf) in the Northern Plains approached 250,000 head due to excessive snowfall coupled with sustained periods of sub-zero wind-chills. More recently, feedlot cost of gains averaged 12% greater for cattle finished in February, March, and April of 2001 compared with the same period in 2000 (Feedstuffs data). Individual feedlots incurred deaths approaching 1,000 animals or over five times normal death losses. In many livestock operations, alternative management strategies are needed to mitigate climatic stress in cattle. Altering the microclimate by providing protection from the environment is one of the most useful tools helping animals cope with climatic conditions. However, changes in facilities and management strategies do not need to eliminate environmental stress completely, but rather minimize the severity of the environmental challenge and aid the animal in adapting to it. Inexpensive management alternatives, such as the use of bedding in winter or sprinklers in summer, need to be considered. When designing or modifying facilities it is important that changes made to minimize impact of the environment in one season do not result in adverse effects on animals in another season. Using permanent wind barriers to minimize cold stress in the winter may require that shade or sprinklers be provided in the summer to minimize heat stress. In addition to facility changes, dietary manipulation may be beneficial for feedlot cattle challenged by environmental conditions.

Key Words: Cattle, Climatic stress, Management strategies

220 The effects of environmental stress on the performance of dairy cattle. J.N. Spain*, M. Lucy, and D. Spiers, *Brody Environmental Center, University of Missouri - Columbia.*

Environmental stress reduces the productivity and health of dairy cattle resulting in significant economic losses. Heat stress affects animal performance and productivity of dairy cows in all phases of production. This effect in calves and growing heifers is due to repartitioning of energy necessary for maintenance of homeothermy. The outcomes include decreased growth, increased susceptibility of disease, and ultimately delayed initiation of lactation. Dry cows exposed to thermal stress during late pregnancy have reduced milk yield during the subsequent lactation period. Heat stress is most apparent in the lactating dairy cow that must dissipate excess heat resulting from increased metabolism. Dry matter intake and milk yield decrease as cows are exposed to ambient temperatures above the upper critical temperature of their comfort zone. Cow health is adversely affected as evidenced in the increased somatic cells in milk during summer months. Heat stress also negatively affects reproductive function. Normal estrus activity and fertility are disrupted in dairy cattle during summer months. Given the negative effects of heat stress, research has focused on means of improving animal performance by assisting the dairy cow in maintaining #normal# thermal balance. Research has focused on methods of reducing heat gain through dietary supplementation and environmental modification. Manipulations of the diet to reduce the heat of digestion and metabolism have been proposed as a way of reducing internal heat load. Supplemental shades and housing systems have been developed to reduce exposure to solar radiant heat load. To facilitate heat loss, supplemental and strategic cooling systems have been developed and proposed. With the ever-increasing genetic potential for milk synthesis and the concomitant increase in metabolic heat production, the methods used to describe, monitor, and alter the thermal balance of heat stressed dairy cattle must be studied further.

Key Words: Dairy Cattle, Heat Stress

221 Survival, performance, and productivity in swine as influenced by adverse environmental temperatures. J.A. Carroll*, *Animal Physiology Research Unit, Agricultural Research Service-USDA, Columbia, Missouri.*

The impact of thermal stress on survival, performance, and productivity is evident in all stages of swine production. Thermal stress is associated with reduced survival of the neonate, poor reproductive performance in sows and boars, and poor growth and carcass quality in finishing pigs. Thermal stress invokes numerous changes in the pig's metabolism, behavior, and endocrine system. While the primary causes of neonatal mortality have been attributed to crushing, starvation, and disease, the actual causes of mortality may be more closely linked with one another than previously believed. We now know that interactions exist among thermal status, nutrition, and disease in pigs. Piglets with disease and nutritional problems experience chilling and express altered behaviors that increase the likelihood of being laid on by the sow. At birth, neonatal pigs have a limited ability to cope with environmental stressors (cold, disease, limited nutrition) that predispose it to relatively high rates of neonatal morbidity and mortality. In contrast to older animals, the early neonatal piglet does not increase its intake in response

to cold temperature. Intake actually decreases during cold exposure, increasing the likelihood of starvation. Unlike the young pig, in which exposure to cold stress poses major health risks, in older pigs, exposure to heat stress hinders performance and productivity. At high ambient temperatures, sufficient feed intake by the sow is likely a greater concern for piglet survival and performance. Exposure to ambient temperatures greater than 25°C decreases intake in lactating sows, resulting in reduced milk production and associated piglet growth. In boars, heat stress has been shown to alter sperm cell count and quality, thus decreasing reproductive efficiency and capabilities. Finally, in finisher pigs, heat stress has been reported to reduce growth rate and alter carcass composition. Therefore, heat stress not only reduces overall productivity in finishing pigs, but also reduces the value of the final product. Given the associated economic losses due to thermal stress in pigs, continued research on the interactions among thermal stress, nutritional requirements, immunological status, and overall performance are undoubtedly needed and warranted.

Key Words: Pig, Environmental Temperature, Stress

222 Economic losses from thermal stress by U.S. livestock industries. N. R. St-Pierre*¹ and G. Schnitkey², ¹*The Ohio State University, Columbus,* ²*University of Illinois, Urbana.*

Farm animals have well known zones of thermal comfort (ZTC). The range of ZTC is primarily dependent on the species, the physiological status of the animals, the relative humidity and velocity of ambient air, and the degree of solar radiation. Economic losses are incurred by the U.S. livestock industries because farm animals are raised in locations and/or seasons where temperature conditions venture outside the ZTC. The objective of this study was to provide estimates of the economic losses sustained by major U.S. livestock industries from thermal stress. Species (production) considered were: chicken (meat), chicken (eggs), turkey (meat), cattle (meat), cattle (milk), and pig (meat). Losses considered were: (1) decreased performance (growth, lactation, egg production), (2) increased mortality, and (3) decreased reproduction. USDA and industry data were used to estimate the population size of each species in each month of the year, for each of the 50 States. Weather data from the National Weather Service were used to estimate mean daily maximum and minimum temperatures and relative humidity, and their variances for each of the 50 States. A model based on a plateau and abrupt threshold leading to a linear decrease in performance and reproduction and a linear increase in mortality above and below the ZTC was used for each species. Solar radiation and air velocity were assumed negligible. Probabilities of exceeding the minimum or maximum values of ZTC were calculated from means and variances of weather data. Two losses were estimated. The total potential losses (TPL) were calculated as if no thermal stress abatement strategies were used by any of the animal industries. Clearly, this estimate is biased upwards but it sets a ceiling to the magnitude of the actual losses. Total abated losses (TAL) were calculated by the additional factoring of the prevailing management practices used by each industry to reduce the effects of thermal stress. Details of the results will be presented by species and for each of the major animal producing States.

Key Words: Thermal Stress, Economic Losses, Animal Production

Graduate Paper Competition

ADSA Production Division, ADSA Southern Branch, and Northeast ASAS/ADSA Section

223 Beta-Lactoglobulin as a facilitator of transcellular transport of IgG in Caco-2 cells. L. F. Sutton*¹, M. Worku², and B. Alston-Mills¹, ¹*North Carolina State University,* ²*North Carolina A&T University.*

An earlier investigation suggested that Beta-Lactoglobulin (BLG) can facilitate IgG uptake in intestinal cells of neonatal piglets. The objectives of the present study were to use an in vitro model to corroborate in vivo data. Also investigated were properties of specific binding using competition at receptor sites, type of Fc receptors, and overall passage of the IgG molecule from apical to basolateral sides of the intestinal cell. The human intestinal cell line Caco-2 was used to investigate effects of BLG. Cells were grown in a porous transwell system, seeded at 4.6×10^4 cells/well, with a total of 18 wells. Media were added to both compartments in the transwell system with 2.5ml added to the basolateral side

and 1.5ml to the apical. Media were changed every other day. Cells were cultured as a monolayer until confluency was reached (day 14) and the tightness of the monolayer was measured by determining the transepithelial electrical resistance (TEER). After apical projections and villi differentiations were observed, approximately day 21, several treatments were used to identify uptake and passage of IgG. Fluorescently labeled IgG was added with unlabeled IgA to determine specificity of binding at the receptor on the apical side. Labeled IgG was added alone in varying concentrations to determine levels of uptake. After a 2 hour incubation, BLG was bound to IgG as a complex. This complex was then added to the apical membrane compartment. Additionally, BLG and IgG were added separately but simultaneously. IgG transcellular transport was evaluated by fluorimetry and microscopically. Unlabeled IgA and labeled IgG competitively bound to the polymeric Ig receptor. Uptake of IgG was evident after incubation with the Caco-2 cells but

fluorescence was highest in cells in which BLG was also added. Greater concentrations of IgG allowed for increased uptake, but persistence in the cell was optimal with the addition of BLG. These results suggest that BLG may, in fact, enhance and protect IgG in passage of Caco-2 cells. Results were best when IgG and BLG were added to Caco-2 cells, separately rather than as a complex.

Key Words: Beta-Lactoglobulin, Caco-2 cells, IgG

224 The effect of *Kluyveromyces marxianus* and *Saccharomyces cerevisiae* on fatty acid composition of equine milk. P. M. Yocum*, V. Fellner, and B. Alston-Mills, North Carolina State University.

Equines are non-ruminant herbivores with hindgut fermentation. Therefore, biohydrogenation of dietary fat and composition of milk lipids may differ from bovines. Two different yeast species were used to determine effects on fatty acid composition of mare milk. Twelve mares were randomly assigned to 1 of 3 groups. The composition of the herd was consistent with common breeds and ages of horses in North Carolina. Mares were allowed access to grass pasture and water ad lib. A commercial pelleted feed was administered at 1% body weight divided into 3 feedings per day along with coastal bermuda grass hay. Yeast treatments were standardized to colony forming units (CFU) as per manufacturer recommendation and administered 14 days prior to expected foaling. Group 1 served as the control group. Group 2 was given 20g of Turval[#] 12 fodder, which included live *Kluyveromyces marxianus* yeast, for 5 days on and 2 days off. Group 3 was given 8g of BIOSAF[#], a concentrate of live *Saccharomyces cerevisiae* yeast, for 5 days on and 2 days off. Twenty-five mls were hand milked from each mare on day 0 (parturition) and days 14, 28, 42 (treatment ceased), and 56 post partum. Milk samples were refrigerated until analyzed. Fatty acid composition was determined using a 100 meter x 0.25 millimeter fused silica capillary column on a SP 2560 gas chromatograph. Fatty acid composition was constant among the control group over time. Stearic acid was not present in the milk of control mares and mares receiving Turval[#] 12 yeast. Turval[#] appeared to decrease content of fatty acids C₁₆ and lower while increasing C_{18:1} and higher. Biosaf[#] appeared to have the opposite effect. This suggests that Turval[#] is down regulating *de novo* synthesis of fatty acids while Biosaf[#] is up regulating *de novo* synthesis of C₁₀ through C₁₆. Small quantities of C_{18:0} were observed in the milk of mares receiving Biosaf[#] yeast. Thus, differential effects were observed on fatty acid composition based on yeast species used in treatment groups.

Key Words: Equine milk, *Saccharomyces cerevisiae*, *Kluyveromyces marxianus*

225 Rapid detection of sub-clinical mastitis in dairy goats. C. Gill*, S. Horner, V. Mc Whinney, and D. Mc Whinney, Prairie View A&M University.

Simple and rapid diagnostic tools for the detection of sub-clinical mastitis are essential for the survival of the goat dairy industry. This is especially important due to the indiscriminate use of antibiotics for the treatment of clinical mastitis. The overuse of antibiotics contributes to antibiotic resistance in both dairy cattle and dairy goats. In clinical mastitis the infected goats have reduced udder function and milk production is reduced. Symptoms of sub-clinical mastitis are more subtle and not easily detected. The objective of this study was to determine the sensitivity and specificity of a rapid detection bacterial test strip (V-StripTM). Milk was taken from teats of normal and infected goats during late lactation and analyzed with the V-StripTM, traditional Foss Somatic Cell Count (SCC), California Mastitis Test, heterotrophic bacterial plate count, and selective and differential bacterial analyses. Our results have shown correlation between the California Mastitis Test, the Foss-O-Matic Cell Count and the V-StripTM. Goats showing high heterotrophic plate counts (1x10⁶), SCC count >1 million and in which *—italicizestaphylococcus* was isolated had a positive reaction to the bacterial activity on the V-StripTM. Scanning the results of the bacteria activity on the V-StripTM enhanced its readability. There were some variations among goats with a high SCC and those with no identifiable bacterial activity on the V-StripTM. These results indicated that a higher concentration of dye may be needed in the V-StripTM for visual detection of bacterial activity in goats' milk.

Key Words: Mastitis, Goat, Rapid detection

226 Supplemental lactoferrin improves performance of dairy calves during the preweaning phase. E. D. Robblee*, P. S. Erickson¹, N. L. Whitehouse¹, A. M. McLaughlin¹, C. G. Schwab¹, J. J. Rejman², and R. E. Rompala³, ¹University of New Hampshire, Durham, NH, ²ImmuCell Corporation, Portland, ME, ³Blue Seal Feeds, Inc., Londonderry, NH.

Lactoferrin (Lf) is a milk protein that exhibits broad-spectrum antimicrobial properties. Previous studies have shown that supplemental Lf can alter the microbial populations in the gut of non-ruminants, and increase preweaning average daily gains in calves. In the present study, 40 Holstein calves were used to examine the effects of supplemental Lf (0, 1, 2, or 3 g/d) on health, growth, and feed intake from 3 d of age to 2 wk postweaning. Lf was mixed and fed with a non-medicated milk replacer. Calves were housed in individual pens and offered a textured, non-medicated calf starter and water for ad libitum intake. Body weight, wither height, hip height, and heart girth were measured weekly. Daily dry matter intakes (DMI) of milk replacer and calf starter were determined. Fecal scores (1 = constipated, 4 = watery diarrhea) were recorded three times per week. Calves were weaned when the following four criteria were met: 1) minimum of 21 d of age, 2) DMI of starter was at least 1% of birth weight for three consecutive days, 3) cumulative DMI of starter was at least 9% of birth weight, 4) weight gain was at least 12% of birth weight. Preweaning average daily gains and gain to feed ratios increased linearly with Lf supplementation, whereas postweaning gain to feed ratios decreased linearly with Lf. Overall average daily girth gains increased linearly with Lf. Preweaning average daily hip height gains followed a quadratic response, with 2 g Lf/d having the lowest gain. Postweaning average daily hip height gains increased linearly with Lf. Preweaning fecal scores responded quadratically, with 1 g Lf/d having the lowest score. Days medicated responded similarly to fecal scores preweaning and overall. Withers heights, body weights, weaning ages, and DMI#s were not different among treatments. Based on the observed increased gain to feed ratios and average daily gains, and the reduced fecal scores and morbidity for the preweaning phase, it appears that Lf may be a beneficial supplement in the diets of dairy calves during this period.

Key Words: Lactoferrin, Calves, Preweaning

227 Lactating dairy cows endogenously synthesize *trans*-7, *cis*-9 CLA. B.A. Cori*, L.H. Baumgard¹, J.M. Griinari², P. Delmonte³, K.M. Morehouse³, M.P. Yurawecz³, and D.E. Bauman¹, ¹Cornell Univ., USA, ²Univ. of Helsinki, Finland, ³Food and Drug Admin., USA.

Conjugated linoleic acids (CLA) have beneficial health effects in studies with animal models. *cis*-9, *trans*-11 and *trans*-7, *cis*-9 CLA are the most prevalent isomers in ruminant food products. The majority of *cis*-9, *trans*-11 CLA in milk fat is endogenously synthesized by Δ^9 -desaturase and we tested the hypothesis that *trans*-7, *cis*-9 CLA is also endogenously synthesized. In exp. 1, sterculic oil (SO) was abomasally infused (4 d) to inhibit Δ^9 -desaturase. Four cows (115 ± 9 DIM) were used in a 4 x 4 Latin square design and treatments were: skim milk (500 mL/d; control), partially hydrogenated vegetable oil (250 g/d; PHVO), SO (8.8 g/d), and PHVO+SO. Samples of milk, plasma, and rumen fluid were collected. In exp. 2, we used a *trans*-10, *cis*-12 CLA supplement to inhibit Δ^9 -desaturase. Four cows (228 ± 54 DIM) were abomasally infused (5 d) with 0 g/d (control) or 14.0 g/d of 10,12 CLA supplement with milk and plasma samples collected. Samples were analyzed by GC to derive the total fatty acid profile and by Ag⁺-HPLC to determine the CLA isomer profile. In exp. 1, SO decreased milk fat *cis*-9, *trans*-11 CLA by 65% (SO vs. control) and 61% (PHVO+SO vs. PHVO). Milk fat content of *trans*-7, *cis*-9 CLA decreased 71% (SO vs. control) and 68% (PHVO+SO vs. PHVO). In exp. 2, 10,12 CLA supplement decreased milk fat content of *cis*-9, *trans*-11 and *trans*-7, *cis*-9 CLA by 25% and 44%, respectively. Milk fat *cis*-9 C_{14:1} was reduced 84% by SO infusion and 43% by 10,12 supplement infusion. Using *cis*-9 C_{14:1} content to correct for the extent of Δ^9 -desaturase inhibition, endogenous synthesis of *trans*-7, *cis*-9 CLA represented 85% and 102% in exp. 1 and 2, respectively. Similar corrected values for *cis*-9, *trans*-11 CLA indicated endogenous synthesis accounted for 77% and 58%, respectively. When combined with CLA isomer patterns in rumen fluid and plasma, results indicate the majority of *cis*-9, *trans*-11 CLA was endogenously

synthesized with a minor portion from rumen escape, whereas *trans*-7, *cis*-9 CLA was almost exclusively from endogenous synthesis.

Key Words: CLA, desaturase

228 Observational study assessing the significance of nutritional and management factors associated with milk urea nitrogen levels during the non grazing season. E. Leger*, I. Dohoo, G. Keefe, J. Wichtel, P. Arunvipas, and J. VanLeeuwen, *Atlantic Veterinary College*.

The objective of this study was to assess the impact of nutritional and management factors on MUN levels during the non-pastured period. Eighty-three Prince Edward Island (PEI) and nine Nova Scotia (NS) dairy herds were enrolled in the study. In each of these commercial herds, the amount of variation in test-day MUN which could be explained by nutritional and management factors was examined. Thirty-one herds were classified as total mixed ration herds (TMR) and 61 as component herds (CR). Between October 1999 and January 2001, all herds were visited twice and contacted once by telephone. Stored feeds were sampled as required and a detailed questionnaire relating to nutrition and management was completed during each contact. Collected ration information was evaluated using two computer programs (Spartan and Cornell-Penn-Miner (CPM) Dairy). Multi-level analysis were used to compute the relationship between various CPM and Spartan outputs including the energy-protein ratio (EPR), a ratio which represents the protein and energy requirements relative to protein and energy delivery, feeding practices, feed additives and MUN levels. The CPM EPR accounted for 0.5% of the total observed variation in MUN whereas the Spartan EPR explained 5.9 %. When CPM protein and energy fractions were regressed individually or as a group, they could only explain an additional 5.5 % of the observed MUN variation. Stage of lactation, feed delivery and significant interactions explained an additional 0.79 % of the variation in MUN. Under commercial settings the relationship between MUN and dietary components is weaker than under controlled experimental settings. On commercial farms, MUN values are influenced by a number of factors that are not part of routine nutritional monitoring. This suggests that MUN values may be of more limited use as a nutritional monitoring tool than would be expected from the experimental study data.

Key Words: Milk Urea Nitrogen, Dairy Nutrition, Epidemiology

229 Experimental analysis of activity in healthy dairy cows. J.L. Edwards* and P.R. Tozer, *Pennsylvania State University, University Park, PA*.

A major problem in the dairy industry has been the ability to detect health problems before clinical signs were present. Activity could be one method to identify potential health problems in cows when they are in a subclinical state. Activity, health, and other data was collected on 349 cows in a Florida herd. The Afikim computerized milking and management system measures activity from a pedometer, and records the average steps per hour per day. Health data was used to separate cows into healthy and sick groups. A healthy cow was defined as one which did not have an occurrence of a metabolic or digestive disease, a retained placenta, lameness, or injury during the current lactation. The data was further divided by season, lactation number, and three different physiological stages of lactation. These stages were defined as before the first detected heat or pre-breeding, breeding, and after the last detected heat or post-breeding. Twenty-four autoregressive models were used to fit the data and identify normal activity in healthy cows. Pre-breeding data showed an autoregressive 3, AR(3), or AR(4) model with more variability in the first lactation compared to second and subsequent lactations. General trends showed a very high activity level during the first days of lactation that tapered off until the first heat cycle. The breeding stage was generally an AR(2) with a 21 and 22 day lag, and during the post-breeding stage models were an AR(2) or AR(3). After the last heat cycle, the cows had relatively minimal activity. Further research will be done to compare the models of healthy cows with sick cows to observe activity affected by a metabolic or digestive disease. The final goal will be to predict a disease occurrence based on activity before the cow showed clinical signs of illness.

Key Words: Pedometer, Activity, Autoregressive

230 Effect of various zeolites on nutrient utilization by ruminal microorganisms during continuous culture fermentation. M. Pickett*, T. W. Cassidy¹, and G. A. Varga¹, *The Pennsylvania State University, PA*.

A dual flow continuous culture system was used to investigate the effects of various zeolites on ruminal fermentation and nutrient digestibility. Phillipsite (P) and Clinoptilolite (CL), both naturally occurring hydrophilic zeolites, were selected for their ability to adsorb ammonium. The synthetic hydrophobic zeolite, CBV, was selected for its ability to remove odor causing organic molecules. The four treatments, P, CL, CBV, and control (C) were evaluated using a completely randomized design during three replicates. Diets were formulated to contain on a DM basis 49% forage and 51% concentrate with a nutrient composition of 17.5% CP, 1.73 Mcal/kg NEL, and 34% NDF. All zeolites were included at 2% of ration DM. Four continuous culture fermenters were used with solid mean retention time and liquid dilution rate of 24 h and 11%/h, respectively. On day 7-9 effluents were collected daily and composited for nutrient digestibility determination and for analysis of ammonia-N, and VFA. pH did not differ across treatments and averaged 6.26 ± 0.03. Ammonia-N concentration averaged 8.25 mg/100ml ± 1.29 and did not differ across treatments. Apparent DM digestibility was significantly ($P < 0.02$) reduced for all zeolites when compared to the control (47.6 vs. 43.7). Only CL significantly ($P < 0.09$) reduced NDF digestibility in comparison to the other treatments (64.9, 63.3, 58.0, and 63.4, C, CBV, CL, and P, respectively). Digestibility of total nonstructural carbohydrates was lower ($P < 0.09$) for all zeolite treatments compared to the control (73.2 vs. 74.8%). Total VFA concentration was higher ($P < 0.12$) for all zeolites compared to the control (96.4 vs. 84.6 mM), while individual VFA concentrations did not differ across treatments. Bacterial N content was lowest ($P < 0.02$) for CBV (6.8, 6.4, 6.9, and 6.6, respectively). Zeolite addition to the diet reduced the digestibility of some nutrients, however ruminal fermentation patterns were not negatively impacted by zeolite addition.

Key Words: Zeolites, Ruminal Fermentation, Continuous Culture

231 Influence of nutrition management on rumen fermentation, blood metabolites, type and growth of holstein neonatal calves. B. Saremi* and A. Naserian, *Ferdowsi University Of Mashhad, Mashhad, Khorasan, Iran*.

Calf development is one of the most important parts of the dairy industry. Studies have been done in development of gut tissues and variability of blood metabolites because of their influence on growth and metabolism of neonatal calves. The objective of this study is to determine the influence of two feeding methods on rumen fermentation parameters, blood metabolites, and type and growth of neonatal calves. Twenty female holstein calves were randomly placed on treatments and fed colostrum at 10% of birth weight and milked until 45 days old. Both groups were fed high quality alfalfa and calf starter from seven and thirty days of age and were weaned at 45 days. Calf starter and high quality alfalfa were offered until 90 days old. The weight and frame measures of calves and blood samples were taken from 0 to 90 days in regular periods and measured the glucose, total protein and PUN content. Rumen fluid samples were taken in days 30, 45, 60, 75, 90 by stomach tube. Feed intake was measured daily. There was no difference between treatments on blood glucose ($p \leq 0.065$), protein and urinary nitrogen levels of plasma and rumen fluid ammonia ($p \leq 0.077$). There was no difference of period of growth in protein level of plasma ($p \leq 0.079$). There was a difference in glucose and urinary nitrogen levels of plasma ($p \leq 0.0001$), rumen fluid pH and ammonia due to period of growth ($p \leq 0.0001$) and in rumen fluid pH between treatments ($p \leq 0.0054$). The calves feed intake (concentrate, alfalfa, total DMI) were different between treatments ($p \leq 0.017$, 0.009, 0.0013) and growth period ($p \leq 0.0001$). There were period of growth differences between weight of calves, stomach size, pin to hook length and metacarpus size ($p \leq 0.05$). Heart girth, pin width, body length, wither height and hip height didn't show any significant difference between treatments. All typical factors and weight of calves were different due to the growth period of calves ($p \leq 0.0001$).

Key Words: Holstein dairy calves, nutrition management, type and development

232 Alcohol stability of milk and its relation to milk and blood composition in Holstein dairy cows. Sasan Sobhani*, Reza Valizadeh, and Abbasali Naserian, *Ferdowsi University, Agriculture college, Animal Sci. Dep., Mashhad, Khorasan, Iran.*

The alcohol test is used as the initial classification of milk in dairy farms. It is used as a measure of the natural PH of the milk: acidity, which produces instability of milk proteins to heat. In practical conditions the test could be also positive immediately after milking and therefore this milk maybe rejected by the milk processing industry. This study focuses on variations in some milk and blood composition in individual Holstein cows related to this test. Ten cows with alcohol positive milk and 10 cows with normal milk were selected randomly from a large commercial dairy farm. In the first stage milk and blood samples were taken from all cows. The second stage of this trial continued only with alcohol positive milk cows, and alcohol test were performed for their milk until their milk turned into normal state and then milk and blood samples were taken again. After chemical analyzing of the milk and blood samples,

their means were calculated. Comparison of the means of alcohol positive milk cows with normal group showed that there were significant differences ($p \leq 0.05$) in milk pH, lactose and soluble calcium, magnesium, phosphorous, citrate and potassium and also in blood potassium, chlorine, glucose and pH. But there were not any difference ($p \leq 0.05$) in protein, fat, SNF, sodium, chlorine and urea of milk and blood calcium, sodium and potassium and blood glucose and its pH. Moreover, comparison of the means of alcohol positive milk cows with themselves after their milk turned into alcohol negative test showed that there were significant differences ($p \leq 0.05$) in milk pH, lactose and soluble calcium, magnesium, sodium and potassium and blood glucose and its pH. But there were not any significant differences in the other measured factors. Results show that low levels of blood glucose (39.8 mg/100ml) could be probably the original factor for the incidence of this problem, which require more investigations.

Key Words: Alcohol stability of milk, Milk and blood composition, Dairy cow

Dairy Foods Processing

233 Impact of a novel fat removal process on the fat removed from aged full-fat Cheddar cheese and the fat portion of reduced-fat Cheddar cheese. B. K. Nelson* and D. M. Barbano, *Northeast Dairy Foods Research Center, Cornell University, Ithaca, NY.*

A novel fat removal process was previously developed for the production of reduced-fat Cheddar cheese with typical Cheddar flavor. The physical process involved tempering shredded aged full-fat Cheddar cheese to a specified temperature and then centrifuging the heated shreds to remove fat. Conditions of 30°C and 23,500 × g for 5 min removed 50% of the fat. While the original intent of this investigation was to characterize the fat removed from the full-fat Cheddar cheese, properties of the fat portion of the reduced-fat Cheddar cheese and the aged full-fat Cheddar cheese were also determined. The fatty acid composition of the removed fat was significantly more unsaturated than the fat portions of the reduced- and full-fat cheeses. The triglyceride molecular weight distribution of the removed fat had significantly fewer triglycerides with carbon numbers from 46 to 52 and significantly more triglycerides with carbon numbers from 28 to 42 compared to the fat portions of the reduced- and full-fat Cheddar cheeses. Major differences were observed in the melting profiles of the removed fat and fat portions of the reduced- and full-fat Cheddar cheeses. Only 82.1% of the fat in the reduced-fat cheese and 92.8% of the fat in full-fat Cheddar cheese were liquid at 30°C, while 99.6% of the removed fat was liquid at the same temperature. The different properties of the fat removed from aged full-fat Cheddar cheese compared to ordinary milkfat namely more unsaturation and a lower melting point may prove to be useful in some food product formulations.

Key Words: Cheddar cheese, Fat

234 Milk pH as a function of carbon dioxide concentration, temperature, and backpressure in a heat exchanger. Y Ma* and D Barbano, *Cornell University, Ithaca, NY.*

Raw skim milk, with or without added CO₂, was heated, held, and cooled in a tubular heat exchanger (380 ml/min). The experiment was replicated twice and for each replication, milk was first carbonated at 4°C to contain 0 (control), 1200, and 2400 ppm added CO₂ using a continuous carbonation unit. After 1 d storage at 4°C, sub-portions of milk at each CO₂ level were heated to 40, 56, 72, and 80°C, held at the desired temperature for 30s (except 80°C, holding 20s), and cooled to 4°C. At each temperature five backpressures were applied: 10 (control, without added pressure), 20, 30, 40, and 50 psi. Backpressure was controlled with a needle valve at the heat exchanger exit. Both the pressure gauge and pH probe were inline at the end of the holding section, just before the cooling section. Milk pH during heating depended on CO₂ level, temperature, and pressure. ANOVA analysis showed a significant three-way interaction of the above three factors. The pH of the control milk at both the entrance and exit of the heat exchanger at 4°C was 6.90. However during heating of control milk, pH decreased linearly as a function of increasing temperature but was independent of pressure (Table). The pH of milk with added CO₂ decreased with increasing

CO₂ level and pressure (Table). For milk with added CO₂, at a fixed CO₂ level, the effect of pressure on pH decrease was greater at a higher temperature. At a fixed temperature, the effect of pressure on pH decrease was greater for milk with a higher CO₂ level. Thermal death of bacterial during pasteurization of milk without added CO₂ is probably due not only to temperature but also to the "invisible" decrease in pH that occurs during the process. Increasing milk CO₂ level and backpressure decrease the milk pH even further during heating and may further enhance the microbial killing power of pasteurization.

Table. Influence of CO₂ concentration, backpressure, and holding temperature on milk pH in the holding tube.

	Control	1200	ppm	CO ₂	2400	ppm	CO ₂
Holding temperature	10-50 psi	10 psi	30 psi	50 psi	10 psi	30 psi	50 psi
40°C	6.58	6.06	6.05	6.05	5.90	5.79	5.78
56°C	6.46	6.00	5.97	5.96	5.92	5.72	5.72
72°C	6.35	5.98	5.89	5.88	5.93	5.80	5.67
80°C	6.26	6.00	5.86	5.83	5.96	5.81	5.64

Key Words: Milk pH in Heat Exchanger, Carbon Dioxide, Pressure and Temperature

235 Determination of optimum sampling protocol before milk pick up from Ontario farms. V Servello, I McMillan, R Lencki, and A Hill*, *University of Guelph.*

The objective of this research was to assess the optimum sampling protocol to be followed when obtaining milk samples before pick up from Ontario farms. The study indicated that representative milk samples could be obtained after 2 minutes of agitation as opposed to the 5-minute agitation standard. This result was independent of farm-to-farm variations such as tank shape, size, percent fill, impeller size, rpm, temperature changes, and milk composition. The research involved creaming, intermittent agitation, agitation, and bottom vs. top sampling tests. Creaming tests, which assessed the creaming rate of raw milk for a 3-hour period, indicated that milk stays homogeneous during the first 40-50 minutes of setting. Intermittent agitation tests, which determined the agitation time required to obtain a homogenous milk sample after 1, 2.5 and 4 hr of creaming in full and half full tanks, indicated that if the milk is left to cream from 1 to 4 hours, a homogeneous sample could be obtained after agitating the milk for 2 minutes regardless of % fill variations. Agitation tests, which assessed the agitation time required to obtain a representative sample after 3 hours of creaming from 26 different tanks, showed that 2 minutes of agitation were required. Bottom vs. Top sampling tests, which compared the standard sampling procedure (Top sampling) with a sampling method that uses a device, which fits the outlet valve of a bulk tank (Bottom sampling), indicated that a homogeneous sample could be obtained after 2 minutes of agitation regardless of the sampling method used. On the basis of these results, the optimum sampling protocol recommended was to agitate the milk for 2 minutes every hour, and to take a sample before milk pick up after 2

minutes of agitation using the standard method or the bottom sampling method.

Key Words: Sampling Protocol, Milk sampling

236 Buttermilk fractionation by microfiltration. Harit K. Vyas*, Johanna C. Astaire, and Rafael Jimenez-Flores, *Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo, CA.*

Buttermilk contains milk fat globule membrane (MFGM) material that is rich in glycoproteins and various phospholipids and sphingolipids. These lipids have been shown to possess unique cell signaling activities, and may have potential uses as anticancer agents (Parodi, 1997). Crossflow microfiltration in constant transmembrane mode was used to concentrate MFGM material present in buttermilk. Experiments were carried out at both laboratory and pilot scale using 0.65 μm flat-sheet PVDF and 0.8 μm multi-channel tubular ceramic membranes, respectively. Diafiltration was done using deionized water volumes equal to 1, 2, 3, 4 and 5 times the original volume of buttermilk (i.e. 1, 2, 3, 4 and 5 X diafiltration). Permeates and retentates after each stage of diafiltration were analyzed for total solids, ash, proteins and fat content. The samples were also analyzed for the lipid and protein profiles and for the particle size distribution as well as observed under atomic force microscope. The retentates after 2, 3 and 5 X Diafiltration from pilot scale experiments were concentrated using 10 kDa spiral wound polysulfone ultrafiltration membrane and then spray dried. The total solids, protein, fat and ash decreased from 10, 3.7, 0.45 and 0.75 % wt, respectively, in the buttermilk to 0.7, 0.5, 0.069 and 0.05 % wt, respectively, in the 5X diafiltered retentate. The proportion of fat in the total solids increased in retentate with diafiltration due to the preferential removal of solids not fat. The fat proportion was highest (10% wt), double compared to that in the original buttermilk (5% wt), in the retentate after 3 X diafiltration. The fat in the retentate continuously decreased but increasingly became concentrated in the phospholipids and sphingolipids during diafiltration. After 5 X diafiltration the concentration of these lipids was highest. Atomic force microscopy suggested the presence of MFGM material mainly in the retentate besides in the buttermilk itself. However, a few of MFGM components were also noticed in initial permeate samples from the experiments using reconstituted buttermilk. Fat profile of different permeates also suggested the transport of some lipids through the membrane.

Key Words: microfiltration, fractionation, buttermilk

237 Skim milk fractionation by constant flux microfiltration. Harit K. Vyas* and Phillip S. Tong, *Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo, CA.*

Our primary objective was to characterize the fractionation of skim milk under constant flux microfiltration (MF). The fractionation experiments were carried out at the pilot scale with 0.1 μm multi-channel tubular ceramic membrane module using reconstituted skim milk. Skim milk was concentrated 2X (volume concentration ratio) followed by diafiltration using deionized water equal to two times the original volume of skim milk to further purify the casein rich stream. The casein rich stream was concentrated using 10 kDa polysulfone spiral wound ultrafiltration pilot plant and then spray dried. The MF skim milk permeate was ultrafiltered with diafiltration and the retentate rich in whey proteins was freeze dried. Samples of both of the dried products, skim milk and retentates and permeates at different stages of MF processing were analyzed for total solids, ash, protein and lactose content. Samples were also analyzed for their protein profile. Mass balance was determined for each constituent. After 2X concentration 50% of total lactose, 39% of total whey proteins and 38.5% of total minerals originally present in the skim milk permeated through the membrane. Retentate had 53.3% (DMB) proteins with the casein to whey proteins ratio of 87:13. After diafiltration this ratio was 93:7. No casein was detected in permeate at any stage of the MF process. The freeze dried whey protein concentrate contained 70% protein. These results suggest that casein enriched ingredients and purified whey protein streams can be produced directly from membrane processing of skim milk.

Key Words: Constant flux microfiltration, fractionation, skim milk

238 Effect of trans membrane pressure, cross flow velocity and pH on the permeate flux during selective concentration of skim milk components. M. Singh* and S.S.H. Rizvi, *Institute of Food Science, Cornell University, Ithaca NY 14853.*

The use of cross flow microfiltration (CFM) in the food industry is well documented. Yet, the effects of processing variables such as trans-membrane pressure (TMP), cross flow velocity (CFV) and ionic environment of feed on permeate flux are not completely understood but are necessary for quantifying the process efficacy. CFM of skim milk was carried out at 9 different combinations of uniform-TMP (UTMP) and CFV, to quantify the effects of UTMP and CFV on permeate flux at pH 6.0 and 6.5. Pasteurized skim milk (200kg) preheated to 50°C was microfiltered using every combination (3 x 3) of CFV (5.3, 5.8, 6.3m/s) and UTMP (68.9, 103.4, 137.9kPa). The pH of skim milk was adjusted in process to 6.5 and 6.0 with glucono- δ -lactone to adjust the calcium concentration in retentate. As expected, increasing CFV from 5.3 to 6.3m/s at each UTMP resulted in improved flux in all experiments, with an average increase (at the start) of 24% and 31% at pH 6.0 and 6.5 respectively. High CFV combined with high TMP gave highest initial flux (81.7 and 68.6 $\text{kgm}^{-2}\text{h}^{-1}$ at pH 6.5 and 6.0 respectively) up to a CF of 3 to 4 but declined rapidly after 5x (51 and 48% respectively) and was finally reduced to 17 and 27% of original value at 8x at pH 6.5 and 6.0, respectively. Increasing UTMP at each CFV resulted in high initial flux, which was for example 74% higher at 137.9 than 68.9kPa at 5.3m/s and pH 6.0. In all experiments, the flux performance was reversed after 6-7x and the flux was 29% lower at 137.9 than 68.9kPa at 8x at 5.3m/s and pH 6.0. In every experiment, flux at each CF was higher at pH 6.5 when compared to 6.0 (difference being as high as 50% at the startup at 6.3m/s and 68.9kPa) due to solubilization of micellar calcium and severe fouling at lower pH. High CFV is always more desirable at each UTMP since higher flux was always obtained by using high CFV, which results in higher shear and prevents cake build up on the membrane surface. Higher TMP (137.9 vs. 68.9kPa) is advantageous initially with higher flux upto 6-7x but will result in severe fouling and a sharp drop in flux if the process is continued to higher concentrations (8-10x). Lower UTMP with high CFV is needed to achieve high CF (8-10x) of selected milk components during CFM.

Key Words: Permeate flux, Microfiltration, Skim milk

239 Effects of dairy process on insulin-like growth factor-1 (IGF-1) content and its concentration in several commercial dairy products. S. H. Kang*¹, J. W. Kim², J. Y. Im³, S. J. Oh⁴, and S. H. Kim², ¹Seoul Dairy Cooperatives, ²Korea University, Division of Food Science, ³Kookmin University, Dept. of Food & Nutrition, ⁴Korea Yakult Co. Ltd.

The objectives of this study were to examine the change of Insulin-Like Growth Factor-1 (IGF-1) content during dairy process including homogenization, pasteurization, concentration, spray drying, and fermentation and to examine IGF-1 content in commercial dairy products marketed in Korea. Milk was processed in Seoul Dairy Cooperatives. IGF-I content was determined by radioimmunoassay using 125I after acid-ethanol treatment. All the experiments were triplicated and the data were analyzed by the SAS system using a procedure of analysis of variance. There were no significant differences in IGF-1 content by homogenization (150 bar) and UHT pasteurization (130?, 2 sec), vacuum evaporation and spray drying. However, IGF-1 content significantly decreased from 53.0 17.1 to 3.8 3.2 ng/ml during 13 hr fermentation (pH of 4.06) with commercial starter culture. The mean IGF-1 content of commercial market milk, whole milk powder, skim milk powder, infant formula and sweet cheese whey was 46.2 15.0, 41.3 9.5, 55.8 13.3, 32.2 9.4 and 20.5 6.4 ng/ml, respectively. However IGF-1 content of yoghurts was relatively lower than that of other dairy products and ranged from 7.7 3.4 to 17.4 5.6 ng/ml. The results suggested that commercial dairy process except fermentation did not affect IGF-1 content in the products. The decreased IGF-1 content found in fermented products might be related to the ability of lactic acid bacteria to utilize IGF-1 or IGF binding-protein complex

Key Words: IGF-1, Dairy Products, RIA

240 Effect of meat process conditions on mechanical properties of heat cured whey protein-based edible films: a comparison to commercial collagen films. S.N. Simelane*, A.M. Booren, and Z. Ustunol, *Michigan State University*.

Our previous research has shown that heat cured whey protein isolate (WPI) based films had similar mechanical properties to collagen films. Therefore, the objective of this research was to determine if heat cured WPI-based edible films could withstand temperature, time and relative humidity (RH) conditions typically encountered in a meat process scheme. A whey-protein-isolate based film that can withstand meat processing conditions may provide the meat industry with an alternative to collagen films.

WPI (5%, w/w) was dissolved in distilled water; glycerol (3.3%, w/w) was added and pH adjusted to 8 with 2N NaOH. Solutions were heated at 90°C for 15 minutes while continuously stirred. Candelilla wax (CW; 0.8%, w/w) was added during heating to allow it to melt. Solutions were homogenized, degassed, cast on teflon plates and dried at room temperature (~23°C) overnight at constant relative humidity. Films used were heat cured at 90°C, 12 h. Next, all films (WPI and collagen) were exposed to conditions typical of a Polish sausage processing scheme; 57°C/60min/36%RH - stage 1, 66°C/90min/60%RH - stage 2 and 77°C/30min/80%RH - stage 3. Samples were collected and tested at the end of each stage; films in stage 3 underwent the whole process sequentially. Control samples did not undergo these processing conditions. Mechanical properties; tensile strength (TS) and elongation at break (%E) were tested using ASTM standard procedures.

TS of WPI-based control was lower than that of collagen; TS decreased gradually from stage 2 to 3 for both WPI-based and collagen films. WPI-based films were more flexible; evidenced by higher %E, and their flexibility increased between stages 1 and 2. Collagen films were less flexible but maintained their %E throughout all three process stages. Heat cured WPI-based films appear to withstand the conditions that would typically be encountered in meat processing.

Key Words: Whey, Edible, Collagen

241 Utilization of a milk fat globule membrane fraction in the manufacture of low-fat yogurt. Rodrigo Roesch^{*1}, Douglas Dagleish², and Milena Corredig¹, ¹The University of Georgia, Athens, GA, USA, ²University of Guelph, Ontario, Canada.

The presence of material derived from the milk fat globule membrane (MFGM) makes buttermilk (the byproduct of buttermaking) distinct from any other dairy product. The design of reduced-fat products presents challenges when trying to achieve sensory and texture characteristics similar to those of products with higher fat content. The MFGM (the membrane of fat globules in milk and cream) contains large amounts of protein and phospholipids. In particular, phospholipids are known for their health-enhancing properties and they are considered valuable nutritional and functional ingredients in many food products. The objective of this work was to determine if the MFGM present in commercial buttermilk had unique functional properties compared to sodium caseinate or to the buttermilk powder from which it originated. For this reason, a fraction of MFGM was prepared from buttermilk by microfiltration, and then added to skim milk to prepare low-fat yogurt. Samples were homogenized, poured into sterilized cups, heat treated at 90°C for 10 min and then cooled to 43°C. After cooling the samples were inoculated with commercial yogurt culture. Triplicate experiments were performed, and the rheological properties and microstructure of yogurt containing MFGM were compared to those of samples with added buttermilk powder and sodium caseinate. MFGM extracts had a positive effect on the rheological properties of the low-fat yogurt. When addition of MFGM isolate was compared to the addition of buttermilk powder, no differences seemed to be present in the viscoelastic properties of the samples when lactose in buttermilk powder was taken into consideration. Light scattering measurements of the yogurt mix showed that the addition of MFGM increased the number of particles > 1 µm present. In addition, confocal microscopy with a fluorescent dye (Biodipy[®], Molecular Probes) showed differences in microstructure between control samples and yogurt containing MFGM. Results of this research support the potential utilization of MFGM isolates as novel ingredients in fermented products.

Key Words: Yogurt, Milk Fat Globule Membrane

Forages and Pastures Grazing Systems and Fiber

242 Soybean hulls as a supplement for stocker steers grazing annual ryegrass. J. A. Rush and S. P. Schmidt*, *Auburn University*.

Effects of nonstructural-carbohydrate and structural-carbohydrate supplements on the performance of stocker steers grazing cool-season forage were evaluated in a 3-yr replicated grazing experiment. Each yr, 45 crossbred beef steers (avg. initial BW 253 kg) were assigned randomly into one of fifteen 0.81-ha Marshall annual ryegrass (*Lolium multiflorum*) paddocks. The 15 paddocks were assigned randomly to one of five treatments: no supplement (NS), cracked corn (C), cracked corn with monensin (CR), soybean hulls (S), and soybean hulls with monensin (SR). Supplements were fed daily at 0.4% of mean BW; Rumensin-80[®] was added at 0.15% of supplement. Grazing began in Dec. or Jan. and ended in May each yr (average 136 d). There were differences (P<0.01) in gain response to treatments among years, but the treatment by year interaction was not significant (P=0.40). Steers fed supplements gained more over the entire grazing season (170 vs 161 kg) than those not receiving supplements (P=0.06), and cattle supplemented with soyhulls gained more (174 vs 165 kg) than those supplemented with corn (P=0.03). There was a significant (P=0.04) supplement x monensin interaction such that addition of monensin resulted in consistently greater gains for corn but not for soyhulls each year. Average forage height tended to be shorter (P=0.12) in non-supplemented paddocks compared with supplemented paddocks, but there were no differences across treatments in forage quality. These data are consistent with studies in which use of carbohydrate supplements with lower quality forages were evaluated, indicating that supplements containing readily degradable structural carbohydrates result in better forage utilization than supplements containing highly fermentable nonstructural carbohydrates.

Key Words: Stocker cattle, Ryegrass, Soybean hulls

243 The effect of an extruded-expeller soybean meal on milk production in grazing dairy cows. J.M. Hernandez Vieyra*, ¹SOYTECH SA, Buenos Aires, Argentina.

Argentine dairying is based on grazing alfalfa and other pasture crops plus supplementation with grains and byproducts. Pasture production and quality is higher during Spring, when it is suspected that improving protein quality would not have any positive result. One hundred and thirty six first lactation Holstein cows averaging 75 days in milk (DIM) and 21.18 kg of milk were used in a 75 days repeated measurements experiment to determine the response to a high RUP source (SoyPlus, West Central Coop, Ralston, IA) in a typical commercial grazing dairy farm in Argentina. The study duration was from September 9 through November 11 (Spring). Cows were blocked by DIM and milk yield and randomly assigned to two treatments: Control (C) and SoyPlus[®] (SP). Cows strip grazed an alfalfa pasture and a winter oats pasture after each milking, and were located at both sides of the central path of the same plot, to ensure they received the same pasture quality. Strips of both pastures were moved daily, and strips sizes were determined in order to allow high pasture residual after grazing to guarantee cows ate pasture *ad libitum*. Alfalfa pasture and winter oats pasture had 23 and 18 %CP; 33 and 40 % NDF, respectively. Both groups received before milking, 8kg of a concentrate: C 53% high moisture corn (HMC) and 47% corn gluten feed (CGF) and SP 74% HMC, 13% CGF and 13% SoyPlus[®]. C and SP concentrates had 15.5 and 15.8 % CP, and 37.4 and 50.1 % RUP respectively. Milk yield was measured before blocking groups on August 23 (wk0), and during the trial on wk3, wk5, wk6, wk11. Milk production at wk 0 was the same (P<.98) in both groups, when all cows received the same C diet. Milk yield was higher (P<.01) for SP during all the trial, being maximum on wk 6, about 100 DIM. Cows on SP produced significantly (P<.01) more milk than C, 26.59kg (SEM 0.46) vs 23.15kg (SEM 0.41), respectively. The addition of SoyPlus[®]

increasing RUP in diets of grazing dairy cows during Spring, resulted in higher milk production.

Key Words: Pasture, Rumen Undegradable Protein, milk yield

244 Performance of lactating dairy cows fed hyper-nitrogenous red clover based diets supplemented with dextrose. L. M. Bauman¹ and P. C. Hoffman^{*1, 1} *University of Wisconsin, Madison.*

Sixteen early lactation (61 ± 29 DIM) primiparous (N=8) and multiparous (N=8) Holstein cows were assigned to a replicated 4 x 4 latin square to evaluate four dietary treatments. Treatments were arranged as a 2 x 2 factorial and consisted of feeding cows red clover silage based diets with (S) and without .90 kg/cow/d of sugar (dextrose). Diets were also formulated to contain 17.5 (C) and 19.5 % (H) CP to complete the factorial arrangement (C, CS, H, HS). Treatment periods were 21 d with the first 14 d serving as an adaption period followed by 7 d of data collection. Data measurements included milk yield, milk components, milk protein fractions, and nutrient intakes. Treatment diets and production data were also evaluated using the 2001 Dairy NRC model. An abbreviated data summary is listed in the table below. There were no parity by treatment or main effect interactions; therefore, data were combined. Cows fed H produced more milk ($P < 0.001$) that contained more ($P < 0.01$) protein than cows fed C. Cows fed H also consumed more ($P < 0.03$) DM and produced milk containing higher ($P < 0.001$) levels of milk urea nitrogen (MUN). Feeding cows S had no effect on milk yield or components and slightly ($P < 0.10$) depressed milk casein content. The red clover silage contained relatively low levels of RDP (data not shown) and the NRC, 2001 model suggested C diets were adequate in RUP but deficient in RDP. Data suggest characteristically low RDP contents in red clover silages should be accounted for in ration formulation. Data also suggest feeding dextrose was of little value in improving lactation performance.

Item	C	CS	H	HS	SE	Effect ($P \leq$)		
						CP	S	CPxS
Milk, kg/d	33.2	32.5	34.8	34.6	0.5	0.001	NS	NS
Fat, %	3.59	3.64	3.61	3.16	0.07	NS	NS	NS
Protein, %	2.66	2.62	2.69	2.69	0.02	0.01	NS	NS
Casein, %	2.07	2.01	2.07	2.03	0.03	NS	0.10	NS
MUN, mg/dl	10.53	10.44	13.40	13.53	0.13	0.01	NS	NS
DMI, kg/d	21.2	20.7	21.7	21.7	0.3	0.03	NS	NS

Key Words: Red Clover, Lactation, Protein

245 Stock-piled forage or limit-fed corn as an alternative to hay for gestating and lactating beef cows. J. P. Schoonmaker^{*}, S. C. Loerch, J. E. Rossi, and M. L. Borger, *The Ohio State University.*

In experiment 1, 31, 24, and 17 mature, pregnant Simmental x Angus cows (initial BW = 662.0 ± 10.4) in each of 3 years were used to determine the effects stock-piled forage, limit-fed corn, or ad libitum hay on gestation. In experiment 2, 24 mature, pregnant crossbred cows (initial BW = 677.7 ± 9.4) per treatment in each of 3 years were used to determine the effects stock-piled forage, limit-fed corn, or ad libitum hay on lactation. From November to February, or from January to April, respectively, nutritional needs for gestation (experiment 1) or lactation (experiment 2) were met either by 1) rotating cows on approximately 15.2 or 21.7 ha of predominantly orchardgrass pasture, set aside and fertilized in late August, 2) limit-feeding approximately 5.8 kg of whole shelled corn, 1.1 kg of a pelleted supplement, and 1.2 kg of hay daily, or 3) feeding round-baled hay free-choice. During extreme weather conditions, cows grazing stock-piled forage were limit-fed a grain based diet. *Experiment 1:* Weight and body condition did not differ among treatments at the initiation of the trial ($P > 0.93$). Post-calving weight ($P < 0.10$) was greatest for limit-fed cows, and lowest for cows grazed on stock-piled forage; cows fed free-choice hay were intermediate in weight and did not differ from cows limit-fed or cows grazed on stock-piled forage (641.8, 657.4, 634.0 kg; respectively). Calving date, calf birth and weaning weight, and conception rate did not differ among treatments ($P > 0.15$). *Experiment 2:* Initial and weaning weights for cows did not differ among treatments ($P > 0.17$); however, post-calving weight ($P < 0.01$) was greatest for cows fed free-choice hay, intermediate for limit-fed cows, and lowest for cows grazed on stock-piled forage (674.8, 652.4,

624.5). Body condition score at any time point did not differ among treatments ($P > 0.38$). Calving date, calf birth and weaning weight, and conception rate did not differ among treatments ($P > 0.12$). Using current market prices, the cost to feed a cow hay in gestation and lactation was nearly double that of limit-feeding the corn-based diet. Relative to limit-feeding a corn-based diet, the breakeven for feeding stock-piled forage was \$ 0.49/cow/day in late fall for gestating cows, and \$ 0.23/cow/day in mid-winter for lactating cows.

Key Words: Beef Cows, Stock-piled Forage, Limit-fed Corn

246 Digestion of pasture only and pasture plus concentrate diets during continuous culture fermentation. F. Bargo^{*1}, G. A. Varga¹, L. D. Muller¹, and E. S. Kolver^{2, 1} *The Pennsylvania State University, University Park, PA., 2Dexel Ltd., Hamilton, New Zealand.*

A dual flow continuous culture system was used to investigate ruminal fermentation and nutrient digestibility of three levels of intake of pasture only diets and a pasture plus concentrate (PC) diet in a 4 x 4 Latin square design with 10-d periods. The three pasture only diets were defined to determine low (0.33), medium (0.67), and high (1.00) substitution rates (g pasture/g concentrate) when compared to the PC diet. Diets were: low pasture (55 g DM/d; LP); medium pasture (65 g DM/d, MP); high pasture (75 g DM/d, HP); and PC (45 g DM/d pasture plus 30 g DM/d concentrate). Pasture (25.3% CP, 37.5% NDF, 18.0% NSC, 1.52 Mcal/kg NE_L) was fed at 0630, 1000, 1730, and 2100 h. Concentrate (12.9% CP, 14.3% NDF, 57.7% NSC, 1.94 Mcal/kg NE_L) was fed at 0600 and 1700 h. Solid mean retention time and liquid dilution rate in the continuous culture fermenters was 24 h and 11%/h, respectively. On days 8 to 10, effluents were collected daily and composited for nutrient digestibility determination. On day 10, effluents were collected at 0600, 0630, 0700, 0800, 1000, and 1200 h for NH₃-N and VFA analysis. The pH was lower (5.97 vs. 6.55) and the total VFA concentration was higher (113.3 vs. 96.1 mmol/L) for PC compared to HP ($P < 0.05$). Within the pasture only diets, pH linearly decreased from 6.98 to 6.55 and total VFA concentration linearly increased from 61.7 to 96.1 mmol/L as the amount of pasture increased ($P < 0.05$). Concentration of NH₃-N was lower for PC than for HP (15.0 vs. 27.1 mg/dl; $P < 0.05$). The PC diet had similar apparent DM digestibility to the HP diet (50.6%; $P > 0.05$) but higher apparent DM digestibility than the LP diet (52.2 vs. 47.5%; $P < 0.05$). Apparent NDF digestibility was not affected by treatments (77.5%; $P > 0.05$). Concentrate supplementation to pasture reduced pH and NH₃-N concentration compared to pasture only diets, but did not affect DM or NDF digestibility at the same intake.

Key Words: pasture, concentrate, continuous culture fermentation

247 Effect of water addition on selective consumption (sorting) of dry diets by dairy cattle. C. Leonardi^{*1}, F. Giannico², and L.E. Armentano^{1, 1} *University of Wisconsin-Madison, USA, 2University of Bari, Italy.*

The objective was to determine if adding water to a dry diet could reduce sorting, increase intake of long particles and improve cow performance. Eighteen multiparous lactating Holstein cows were utilized in a Cross-over design, with 21-d periods. At the beginning of the study cows averaged 88 DIM and produced 40.8 kg of milk daily. Cows were housed in tie stalls, and fed twice daily at 0800 and 1500 to obtain approximately 10% refusals. Treatments had the same dietary composition, and differed only by adding water (WET) or not (DRY). Diets consisted of 10% alfalfa silage, 30% hay (approximately 80% grass and 20% alfalfa), 44.6% corn grain, 13.2% soybean meal, .6% animal fat, and 1.6% minerals and vitamins (DM basis). Diet DM was 80.2% for DRY and 64.3% for WET. Both diets contained 16.9% CP and 25.9% NDF. Particle size was determined using the Wisconsin Particle Size Separator on the as fed diets. The separator has five square-hole screens (Y1-Y5) with diagonal openings of 26.9 mm =Y1, 18 mm =Y2, 8.98 mm=Y3, 5.61 mm=Y4, and 1.65 mm=Y5, and one pan (PAN). Adding water did not affect total DMI (28.4 kg/d), milk production (41.3 kg/d) or milk composition, although milk fat percentage tended to be greater (3.41 vs. 3.31, $P = .09$) when cows consumed WET. No differences in ruminal pH, or VFA were observed. Diet DM retained on each of the six screens (%), from Y1 to PAN was 2.6, 3.8, 9.1, 7.1, 30.2 and 47.2 for DRY and 1.9, 3.3, 8.4, 7.2, 35.6 and 43.6 for WET. DMI by screen expressed as a percentage of predicted intake assuming no sorting occurred, for DRY vs. WET was for Y1: 61.4 vs. 75.2 ($P = .05$), Y2: 83.8 vs. 98.6

($P<.0001$), Y3: 85.6 vs. 90.8 ($P=.05$), Y4: 95.2 vs. 96.0 ($P=.48$), Y5: 100.1 vs. 101.9 ($P=.09$), and PAN: 105.9 vs. 102.9 ($P=.01$), respectively. Cows sorted against long particles in favor of shorter particles on both diets. Adding water to dry diets reduced sorting and tended to increase milk fat %; however even on the wetter diet one cow completely avoided consumption of Y1 particles.

Key Words: Sorting, Water, Long particles

248 Supplementation of modified yeast cell wall preparations to reduce the effects of toxins in steers fed endophyte-infected fescue. V. Akay^{*1}, J. A. Jackson¹, and K. A. Dawson², ¹University of Kentucky, Lexington, KY, ²Alltech Biotechnology Inc., Nicholasville, KY.

Twelve Holstein steers (160 to 290 kg) were blocked by body weight and assigned to one of four treatments to investigate the effects of modified yeast cell wall preparations (MYCWP) on symptoms of fescue toxicosis in steers fed endophyte-infected (EI) fescue during 27 d study. Treatments were: 1) EI fescue; 2) EI fescue plus MYCWP; 3) endophyte-free (EF) fescue; and 4) EF fescue plus MYCWP. Diets consisted of cracked corn grain (21.6%), cottonseed hulls (21.9%), crimped oat grain (21.6%), fescue seed (21.6%), soybean meal (10.8%), and vitamin and mineral supplementation (2.34%). The MYCWP was added into Diet 2 and 4 at the level of 2 kg/tonne. Steers were kept in a temperature-controlled room (30°C) and fed ad libitum once daily. Rectal temperatures and respiration rates were higher ($P<0.01$), and serum prolactin levels lower ($P<0.01$) for steers fed EI fescue diets compared to those fed EF fescue diets. Addition of MYCWP to EI fescue diets increased rectal temperatures compared to EI fescue without MYCWP. However, addition of MYCWP to EF fescue decreased rectal temperatures compared to EF fescue without MYCWP. Addition of MYCWP to EI fescue diet increased respiration rates compared to EI fescue without MYCWP. Addition of MYCWP to EI fescue diet decreased serum alkaline phosphatase level compared to EI fescue without MYCWP. Serum prolactin levels were higher for EF fescue diet supplemented with MYCWP compared to EF fescue without MYCWP. However, addition of MYCWP to EI fescue diet had no effect on serum prolactin content compared to EI fescue without MYCWP. Fecal ergovaline concentration was higher for steers fed EI fescue with MYCWP compared to those fed EI fescue without MYCWP. In conclusion, MYCWP adsorbed toxins but did not reduce the effects of toxins at high inclusion of EI fescue seed in the steers diet. However, addition of MYCWP to EF fescue decreased rectal temperatures and increased serum prolactin concentrations, which indicates that MYCWP did have a positive effect on reducing heat stress.

Key Words: Fescue, Yeast cell wall preparations, Steers

249 Withdrawn

250 Transport of tall fescue alkaloids across gastric tissues. Andrea Ayers¹, N.S. Hill^{*1}, G.E. Rottinghaus², J.A. Studemann³, D.L. Dawe¹, and F.N. Thompson¹, ¹University of Georgia Athens, GA, USA, ²University of Missouri Columbia, MO, USA, ³USDA-ARS Watkinsville, GA, USA.

Ergovaline is considered to be the alkaloid responsible for fescue toxicosis. Recently studies have shown that alkaloids are excreted primarily in the urine. Since the route of ergopeptine alkaloid (ergovaline) excretion is the bile, presence of alkaloids in urine suggests lysergic acid amides are the circulating form of the alkaloids. Therefore, studies were organized to investigate rumen microbial fermentation of ergot alkaloids, and which compounds transport through gastric tissues. An in vitro ruminal fermentation of endophyte-infected tall fescue was conducted over 0, 2, 4, 6, 12, 24, and 48 h using autoclaved and viable rumen fluid. Ruminant fluids were analyzed for ergot alkaloids with ELISA (total) and HPLC (species). Soluble ergot alkaloids gradually increased in autoclaved fluids ($P<0.05$). Initial total soluble alkaloid levels decreased, but increased after 24 h when viable ruminal fluid was added ($P<0.01$). Concentration of lysergic acid was constant, ergovaline decreased ($P<0.01$), and an unknown alkaloid metabolite increased with time of digestion ($P<0.01$). A second study was conducted using parabiotic chambers to determine which of the ergot alkaloids pass through ovine ruminal

and the omasal tissues. Thus far, only lysergic acid ($P<0.01$) has been observed passing through the gastric tissues.

Key Words: Fescue toxicosis, Ergot alkaloids, Ergovaline

251 The effects of traditional endophyte, endophyte-free, and novel endophyte (MaxQ) Jessup tall fescue hay consumption on digestion and nitrogen retention in steers. A. D. Killebrew^{*}, M. H. Poore, G. B. Huntington, and J. T. Green, North Carolina State University, Raleigh.

A digestion trial was conducted to compare the effects of traditional endophyte (TE), endophyte-free (EF), and MaxQ Jessup tall fescue (*Festuca arundinacea*) hay on digestion and N retention in steers. Hay compositions were as follows: TE (10.84 % CP, 59.91 % NDF, 29.43 % ADF), EF (11.79 % CP, 58.45 % NDF, 28.43 % ADF), and MaxQ (11.56 % CP, 58.56 % NDF, 28.32 % ADF). Eight Polled Hereford steers (273 kg average BW) were used in a replicated, 3x3 Latin square design, with an extra animal allotted to each square. Steers were fed ad lib for 14 days followed by a 9-day adaptation to a restricted intake (based upon the animal with the lowest ad lib intake for the square), and a 5-day collection. TE differed from EF and MaxQ ($P<0.01$) in ad lib DMI (5.02 vs. 5.63 and 5.73 \pm .067 kg/d, respectively) and differed ($P<0.05$) in ad lib DMI as a % BW (1.83 vs. 2.07 and 2.12 \pm .040 %, respectively). There were no differences during the digestion trial for DMI (5.24, 5.15, and 5.29 \pm .055 kg/d), water intake (20.28, 20.47, and 19.90 \pm 1.131 L/d), and urine output (7.46, 7.33, and 7.40 \pm .650 L/d) for MaxQ, TE, and EF, respectively. DM digestibility for TE was lower ($P<0.05$) than EF or MaxQ (61.96 vs. 67.43 or 66.63 \pm .947 %, respectively). TE was also lower ($P=0.05$) for OM digestibility compared to EF or MaxQ (64.87 vs. 69.44 or 68.58 \pm .892 %, respectively). There were no significant differences for NDF or ADF digestibility between hay types. CP digestibility was higher ($P<0.05$) for EF and MaxQ when compared to TE (54.69 and 53.20 vs. 47.40 \pm 1.087 %, respectively). N retention was lower for TE than EF ($P<0.05$) or MaxQ ($P<0.067$) (22.4 vs. 30.4 or 29.1 \pm 1.74 g/d, respectively). Results from this study indicate that TE tall fescue hay had lower ad lib DMI, DM digestibility, and N retention, while the effects of MaxQ tall fescue hay showed no difference from EF tall fescue hay.

Key Words: Cattle, Tall Fescue, Endophyte

252 An evaluation of three grazing systems for beef cows in the Mid-Atlantic region. J. W. Comerford^{*}, V. H. Baumer, H. W. Harpster, E. H. Cash, R. C. Stout, and R. L. Swope, Penn State University.

At 2 locations in each of 3 yr, 15 cow-calf pairs (average 1.86 AU per pair) were allotted to one of three grazing treatments: I=cool season grasses only (predominately orchardgrass); II=a combination of small grain pasture, rape, sudangrass, corn crop aftermath, and orchardgrass; or III=a combination of orchardgrass, alfalfa/grass mixtures, and stockpiled fescue. Land allocation per cow-calf pair remained constant at 1.33 ha. Cattle were rotated twice per week. All grazed forage was sampled pre- and postgrazing, and ungrazed forage was sampled and harvested predominately as wrapped balage. Effects of yr, location, and treatment were significant sources of variation ($P<.05$) for grazed DM, but not for harvested or total DM production. Year, treatment, and their interaction were significant sources of variation for cow weight gain, while calf preweaning ADG was significantly less for treatment III (1.22, 1.20, and 1.14 kg/d for treatments I, II, and III, respectively). There were no differences among treatments in actual grazing days (208 d, 212 d, and 216 d for treatments I, II, and III, respectively) or for grazing days adjusted to AU. Stockpiled fescue available for grazing varied by yr ($P<.05$), and accounted for 44% of total fescue grazing days in treatment III. The results indicate annual production costs should determine the combination of forages available in a pasture system in the region.

Key Words: Grazing system, Average daily gain, Stockpiled fescue

253 Evaluation of Illinois bundleflower as a grazing source for ruminants using dual flow continuous culture fermenters. K.A. Caperoon^{*}, M.D. Stern, C.C. Sheaffer, G.I. Crawford, and R.L.K. Hulbert, University of Minnesota, Saint Paul, MN.

Illinois bundleflower (*Desmanthus illinoensis*) is a warm season perennial legume that is native to the North American grasslands. Because

of its nitrogen fixation capabilities and crude protein concentration, Illinois bundleflower (IBF) has potential in livestock grazing systems for restored landscapes. The objective of the current study was to compare IBF with alfalfa (*Medicago sativa*) and evaluate their effects on nutrient digestion and ruminal microbial fermentation using dual flow continuous culture fermenters. Eight fermenters were provided with diets consisting of either 100% IBF or 100% alfalfa, fed at a rate of 75 g/d for 10 d, and supplied 1.7 and 2.3 g N/d, respectively. Alfalfa contained 34.3% NDF, 24.4% ADF and 20.3% CP while IBF contained 37.7% NDF, 26.4% ADF and 15.0% CP. Solids and liquid dilution rates were maintained at 4.5 and 10%/h, respectively, while fermenter pH was maintained between 6.0 and 7.0. Average fermenter pH was higher ($P < 0.05$) for the IBF treatment (6.53) than the alfalfa treatment (6.13). True organic matter digestion averaged 48.3%, and did not differ between forage source. Non ammonia-N was greater ($P < 0.05$) for alfalfa (1.34 g/d) than for IBF (1.12 g/d). Total N flow was also greater ($P < 0.05$) for alfalfa but bacterial N flow was similar ($P > 0.05$) for the two legumes. For alfalfa and IBF respectively, crude protein degradation (65.2 and 59.7%), NDF digestion (38.7 and 44.3%), and efficiency of bacterial protein synthesis (17.3 and 12.9 g of N/kg OM truly digested) did not differ ($P > 0.05$) between forages. Results from this study indicate that Illinois bundleflower has the potential to be a sufficient N and fiber source for grazing ruminants.

Key Words: Illinois bundleflower, Forage, Fermentation

254 The effect of yeast (*Saccharomyces cerevisiae*) culture included in a free-choice mineral mix on milk production in beef cattle in a fescue-based pasture grazing system. D.J. Kobs* and S.L. Boyles, *The Ohio State University, Columbus, Ohio.*

Cows and calves grazing on Tall Fescue (*Festuca arundinacea*) pasture had access to free-choice control (C) or yeast-culture (Y) mineral mix. The evaluation of milk production was conducted over three years. Control and yeast groups were comprised of 1 group per treatment for Year 1, 4 groups per treatment for Year 2, and 6 groups per treatment for Year 3. Group served as the experimental unit. Milk production was estimated using a weigh-suckle-weigh technique, at approximately Day 60 and Day 120 post-calving. On each day of milk production evaluation, the calves were separated from the cows for 8 h. After 8 h., the calves were weighed and then allowed to suckle for approx. 10-15 min. After suckling, the calves were immediately re-weighed to assess milk production. The weigh-suckle-weigh technique was conducted three times over 24-h. period. The three weight changes were combined and represented an estimate of milk production in a 24-h period. For Year 2, Y cows tended ($P = 0.06$) to have a higher (5.6 kg.) Day 120 estimated milk production over the C cows (4.3 kg.) When Day 60 and 120 were combined, the Y cows had a significantly ($P=0.05$) higher (6.5 kg.) estimated milk production over the C cows (5.3 kg.). For Year 3, Y cows had a significantly ($P=0.05$) higher (6.3 kg) estimated milk production over the C cows (5.0 kg.). When Day 60 and 120 were combined, the Y

cows tended ($P=0.08$) to have a higher (6.9 kg.) milk production estimate over the C cows (6.1 kg.). No differences were found at the Day 60 in Year 2 or 3. When all years were combined, Day 120 Y cows had a significantly ($P\leq 0.01$) higher (5.9 kg.) estimated milk production when compared to C cows (4.6 kg.). In addition, when all years were combined, Day 60 and 120 (combined) Y cows had a significantly ($P\leq 0.01$) higher (6.7 kg.) milk production estimate compared to C cows (5.7 kg.). No differences were found at the Day 60 when all years were combined. Increases in milk production were most likely attributable to increases in intake and digestibility in the late summer months reported in other concurrent experiments.

Key Words: Beef cattle, Yeast culture, Milk production

255 Ruminal undegradable proteins and protein fractions in alfalfa (*Medicago sativa* L.). G. F. Tremblay*, R. Michaud, G. Belanger, and J. Michaud, *Agriculture and Agri-Food Canada, Sainte-Foy, QC, Canada.*

Alfalfa quality would be greatly improved by an increase in its ruminal undegradable protein (RUP) concentration. In a first experiment, 14 genotypes, each represented in the field by four plants harvested at early bloom in the spring of the first production year, were assessed for protein degradation using a rumen inhibitor *in vitro* procedure and the Cornell Net Carbohydrate and Protein System. This system divides protein fractions into soluble non protein N (A), soluble true protein (B1), rapidly degradable true protein (B2), slowly degradable protein (B3), and undegradable protein (C). Genotypes did not differ significantly ($P>0.10$) for CP concentration and the fraction C. However, genotypes differed significantly for fractions A + B1 (32.8 to 46.8%, average of 40.6% of CP, $P<0.01$), fraction B2 (46.2 to 59.6%, average of 52.0% of CP, $P<0.01$), fraction B3 (3.1 to 4.9%, average of 4.1% of CP, $P<0.05$), and *in vitro* RUP concentration (26.6 to 36.0%, average of 30.8% of CP, $P<0.05$). *In vitro* RUP was significantly correlated ($P<0.05$) to fractions B2 ($r = 0.81$) and B3 ($r = 0.52$). In a second field experiment, whole plants of 27 cultivars, seeded in triplicates and harvested at 10% bloom in the spring of the second production year, were assessed for *in vitro* RUP and protein fractions using the same procedures. Cultivars did not differ significantly ($P>0.10$) for any of the protein fractions, including *in vitro* RUP. Fractions A + B1 accounted for 44.3 (42.5 to 47.2) % of CP, fraction B2 for 49.4 (46.9 to 51.8) % of CP, fraction B3 for 2.2 (1.8 to 2.7) % of CP, fraction C for 4.1 (3.4 to 4.8) % of CP, and RUP for 24.3 (22.5 to 26.3) % of CP. Correlations between *in vitro* RUP values and fractions B2 ($r = 0.46$) and B3 ($r = 0.35$) were also significant ($P<0.05$). Our results indicate the presence of genetic variability for ruminal undegradable proteins among alfalfa genotypes and the positive relationship between *in vitro* RUP concentration and degradable true protein fractions (B2 and B3) for both genotypes and cultivars.

Key Words: Ruminal Undegradable Proteins, CNCPS Protein Fractions

Physiology Endocrinology and Metabolism

256 Effect of 14-day subcutaneous injections of several dosages of glucagon on milk yield and composition in lactating dairy cows. G. Bobe*¹, B. N. Ametaj², D. C. Beitz¹, and J. W. Young¹, ¹Iowa State University, Ames, IA, ²Purdue University, West Lafayette, IN.

Fatty liver is a major metabolic disease of dairy cows in early lactation that can be treated by 14-day continuous intravenous infusions of glucagon beginning at d 21 postpartum. Intravenous infusions of glucagon decrease milk yield and concentrations of milk protein and fat and increase milk lactose concentrations at the beginning of the infusion period. We tested whether 14-day subcutaneous injections of several dosages of glucagon beginning at d 8 postpartum have the same effect on milk yield and composition in dairy cows as continuous intravenous infusions of glucagon. Multiparous Holstein cows (n=32) were grouped on the basis of their liver TAG concentration at d 4 postpartum into "Normal" (n=8; <10 mg TAG/g wet weight) and "Susceptible" (n=24; >10 mg TAG/g wet weight) cows. "Susceptible" cows were assigned randomly to 3 groups and received beginning at d 8 post-

partum 0 (Saline Susceptible), 2.5 (7.5 mg/d Glucagon), or 5 mg (15 mg/d Glucagon) glucagon in 60 ml saline (pH 10.25) by subcutaneous injections of glucagon every 8 h for 14 d. "Normal" cows (saline Normal) received the same treatment as "Saline Susceptible" cows. Milk production and composition and dry matter intake (DMI) were measured at d 4, 6, 11, 21, 24, 28, 35, and 42 postpartum. Glucagon injections decreased milk protein yield and concentrations ($P \leq 0.1$). Milk fat concentrations and milk urea nitrogen yield and concentrations decreased during the 14-day glucagon injection period ($P \leq 0.1$). Milk fat yield, milk lactose and organic substance yield and concentrations were not affected by glucagon injections ($P \geq 0.1$). In contrast to continuous intravenous infusions of glucagon, milk yield and DMI were not affected by subcutaneous injections of glucagon ($P \geq 0.1$). We conclude that subcutaneous glucagon injections have similar effects on milk yield and composition as continuous intravenous infusions without the detrimental effects on milk yield and DMI. We conclude that subcutaneous glucagon injections every 8 h for 14 d beginning at d 8 postpartum increase amino acid uptake by the liver for gluconeogene-

sis, thereby decreasing amino acid availability for the mammary gland. (Partly supported under CREES-USDA agreement 99-35005-8576).

Key Words: Fatty Liver, Glucagon, Milk

257 Effect of 14-day subcutaneous injections of several dosages of glucagon on plasma parameters in lactating dairy cows. G. Bobe^{*1}, B. N. Ametaj², R. Nafikov¹, D. C. Beitz¹, and J. W. Young¹, ¹*Iowa State University, Ames, IA*, ²*Purdue University, West Lafayette, IN*.

Many metabolic diseases in dairy cows in early lactation are associated with decreased plasma glucose and insulin and increased β -hydroxybutyrate (BHBA) and NEFA concentrations that can be reversed by 14-day continuous intravenous infusions of glucagon beginning at d 21 postpartum. We tested whether 14-day subcutaneous injections of several dosages of glucagon beginning at d 8 postpartum have the same effect in dairy cows as the less practical continuous intravenous infusions of glucagon. Multiparous Holstein cows ($n=32$) were grouped on the basis of their liver TAG concentration at d 4 postpartum into "Normal" ($n=8$; <10 mg TAG/g wet weight) and "Susceptible" ($n=24$; >10 mg TAG/g wet weight) cows. "Susceptible" cows were assigned randomly to 3 groups and received beginning at d 8 postpartum 0 (Saline Susceptible), 2.5 (7.5 mg/d Glucagon), or 5 mg (15 mg/d Glucagon) glucagon in 60 ml saline (pH 10.25) by subcutaneous injections of glucagon every 8 h for 14 d. "Normal" cows (saline Normal) received the same treatment as "Saline Susceptible" cows. Plasma α -amino nitrogen (AMN), β -hydroxybutyrate (BHBA), glucose, insulin, NEFA, and urea nitrogen (PUN) concentrations were measured 1 hr after injections at d -4, 4, 8, 11, 14, 21, 28, 35, and 42 postpartum. Glucagon injections increased plasma glucose, insulin, and PUN concentrations, decreased plasma AMN and NEFA concentrations ($P \leq 0.1$), and decreased BHBA concentrations numerically. These effects were similar to those of continuous intravenous glucagon infusions. The increased glucose concentrations continued after glucagon injections in "15 mg/d Glucagon" cows ($P \leq 0.1$). The "15 mg/d Glucagon" cows had stronger plasma glucose and insulin and smaller plasma NEFA responses than did "7.5 mg/d Glucagon" cows ($P \leq 0.1$). We conclude that subcutaneous glucagon injections every 8 h for 14 d beginning at d 8 postpartum increase the cellular glucose supply in dairy cows by increased conversion of plasma amino acids to glucose in the liver and increased cellular glucose uptake. Therefore, we can conclude that subcutaneous glucagon injections every 8 h for 14 d beginning at d 8 postpartum are an effective and practical method to improve the health of dairy cows in early lactation. (Partly supported under CREES-USDA agreement 99-35005-8576).

Key Words: Fatty liver, Glucagon, Early lactation

258 Effects of lasalocid on serum concentrations of IGF-I: Correlations among serum concentrations of IGF-I, leptin, and reproductive performance of postpartum Brahman cows. T. A. Strauch^{*1}, D. A. Neuendorff¹, C. G. Brown¹, M. L. Wade¹, A. W. Lewis¹, D. H. Keisler², and R. D. Randel¹, ¹*Texas Agricultural Experiment Station, Overton, TX*, ²*University of Missouri, Columbia, MO*.

Forty-one Brahman cows were blocked to control (C; $n=20$) or lasalocid (L; $n=21$) treatments by BW, body condition score (BCS), and expected calving date. Treatment began 21 d prior to expected calving. Cows were fed 1.4 kg/hd/d of 11:1 corn:soybean meal and the L group received 200 mg/hd/d lasalocid. Cows and calves were weighed and cow BCS assessed at calving and at 28 d intervals thereafter. Blood samples were collected weekly prepartum, at parturition, and twice weekly thereafter. Sterile marker bulls were maintained with cows for estrous detection. Six d after estrus, ovaries were evaluated for corpus luteum (CL) formation, and blood samples from d 6, 7, 8 after estrus were collected. Serum samples were assayed for progesterone (P_4) and leptin concentration. P_4 concentrations > 1 ng/ml were considered indicative of a functional CL. Treatment ended after completion of a normal estrous cycle. Cows removed from treatment were placed with a fertile bull equipped with a chinball marker. There was no treatment difference ($P > .10$) in serum concentrations of IGF-I. Prior to calving there were negative correlations between leptin and P_4 ($P < .0001$; $r = -.36$) and IGF-I and P_4 ($P < .01$; $r = -.20$). At calving, there was a positive correlation between leptin and IGF-I ($P < .04$; $r = .32$). During the postpartum period, there was a negative correlation between leptin and

postpartum interval (PPI; $P < .0001$; $r = -.27$), and positive correlations between leptin and cow BW ($P < .02$; $r = .36$) and leptin and cow BCS ($P < .06$; $r = .29$). These results indicate that feeding an ionophore prior to calving and throughout the postpartum period did not increase serum concentrations of IGF-I. Concentrations of leptin were positively correlated with IGF-I, cow BW and BCS, and negatively correlated with PPI. Nutritional management to increase leptin concentrations postpartum may result in reduced PPI.

Key Words: Leptin, Reproduction, Cows

259 Breedtype influences adrenal responsiveness to ACTH in beef steers. R.J. Hollenbeck^{*1}, T.M. Bryan¹, T.A. Strauch², D.A. Neuendorff², A.W. Lewis², C.G. Brown², R.D. Randel², and T.H. Welsh, Jr.¹, ¹*Texas Agricultural Experiment Station, College Station*, ²*Texas Agricultural Experiment Station, Overton*.

Adrenal responsiveness to exogenous ACTH was studied by use of Angus, Brahman, Bonsmara and BonsmaraXAngus steers (BW=231.1 \pm 7.1 kg; $n=7$ for each breedtype). Blood samples were collected via indwelling jugular cannula at 15-min intervals for 2.5 hr prior to and 5 hr after ACTH administration (0.1 IU/kg BW). Plasma concentration of cortisol (CS) was determined by RIA. Data were analyzed by the GLM procedure of SAS. During the 2.5-hr sampling period prior to ACTH administration plasma CS was lower in the Bonsmara steers (10.7 \pm 5.7 ng/ml) relative to the BonsmaraXAngus (26.4 \pm 5.7 ng/ml, $P<.06$), Brahman (21.7 \pm 5.7 ng/ml) and Angus steers (33.1 \pm 5.7 ng/ml, $P<.01$). At "Time 0" plasma CS was higher in the BonsmaraXAngus steers (36.0 \pm 5.5 ng/ml) relative to the Angus (18.8 \pm 5.5 ng/ml; $P<0.03$), Brahman (15.2 \pm 5.5 ng/ml; $P<0.01$), and Bonsmara steers (7.0 \pm 5.5 ng/ml; $P<0.0009$). Peak plasma concentration of CS after ACTH administration was higher for the Bonsmara steers (60.5 \pm 6.5 ng/ml), intermediate for the Angus (53.8 \pm 6.5 ng/ml) and BonsmaraXAngus (54.86 \pm 6.5 ng/ml) steers and lower for Brahman steers (40.0 \pm 6.5 ng/ml). The amplitude of the CS response was greater for Bonsmara steers (51.6 \pm 4.9 ng/ml) compared to the Angus (35.0 \pm 4.9 ng/ml), Brahman (24.8 \pm 4.9 ng/ml; $P<.0008$), and BonsmaraXAngus steers (18.9 \pm 4.9 ng/ml; $P<.0001$). After basal levels were reestablished post-ACTH, the Bonsmara steers maintained a lower plasma concentration of CS (4.7 \pm 3 ng/ml) when compared to the Angus (15.2 \pm 3 ng/ml, $P<.02$), Brahman (14.5 \pm 3 ng/ml, $P<.03$), and the BonsmaraXAngus steers (10.2 \pm 3 ng/ml) who did not differ from one another. In summary, plasma concentration of CS varied among breeds prior to and following administration of exogenous ACTH. The Bonsmara, a tropically adapted Sanga-influenced breed, had the lower basal levels of CS and the greater response to ACTH. These data are relevant in efforts to utilize various tropically adapted breeds of cattle.

Key Words: cortisol, breedtype, stress

260 Estrogen regulation of somatotrophic genes in livers of prepubertal ewes. T.M. Bryan^{*1}, C.A. Gray¹, S.K. Durham², T.E. Spencer¹, and T.H. Welsh, Jr.¹, ¹*Texas Agricultural Experiment Station, Texas A&M University, College Station*, ²*Diagnostic Systems Lab, Webster, TX*.

Estrogenic anabolic agents may promote growth by stimulation of somatotrophic hormones; therefore, the effect of an exogenous estrogen on liver weight and expression of growth-related genes was studied in sheep. Ewes were randomly assigned at birth to receive daily subcutaneous injections of corn oil vehicle (Control, $n=5$) or estradiol-17 β valerate (EV, $n=6$; 50 μ g per kg of body weight) to postnatal day (PND) 55. At 4-day intervals, body weights were recorded and blood samples collected by venipuncture. The ewes were euthanized on PND 56 at which time the livers were collected, weighed and frozen. Serum concentrations of estradiol-17 β and insulin-like growth factor-I (IGF-I) were determined by RIA and IRMA, respectively. Liver levels of growth hormone receptor (GH-R), IGF-I, IGF-II, IGF-IR, IGF-IIR and 18S rRNA mRNAs were quantified by slot blot analysis. Data were analyzed by the GLM procedure of SAS. Over the 56-day experiment, average serum concentrations of estradiol ranged from 5 to 22 pg/ml for the Control and from 290 to 1235 pg/ml for the EV-treated ewes. Serum IGF-I increased from PNDs 1 to 9 for both Control and EV ewes and did not differ between treatments. However, for the remainder of the sampling dates serum IGF-I was elevated ($P<0.01$) in EV-treated ewes (range: 267 to 385 ng/ml) relative to Control ewes (range: 154 to 261 ng/ml). Final body weight did not differ between Control and EV-treated ewes. Liver GH-R

mRNA was lower ($P < 0.04$) in EV-treated ewes relative to Control ewes. However, EV treatment increased liver content of IGF-IR ($P < 0.03$) and IGF-IIR ($P < 0.01$) mRNAs relative to Control ewes. EV treatment did not affect liver content of IGF-I or IGF-II mRNAs. Liver weight was correlated with serum concentration of IGF-I at termination ($r = 0.61$; $P < 0.05$) and with liver IGF-I mRNA ($r = 0.81$; $P < 0.01$). Liver IGF-I mRNA was not significantly correlated with average serum concentration of IGF-I over the 56-day study ($r = 0.51$; $P < 0.12$) though it was significantly correlated with final body weight ($r = 0.75$; $P < 0.01$). These data demonstrate the temporal changes in serum concentration of IGF-I during the initial 56 days of postnatal life and suggest that estrogens can modify liver expression of growth related genes in prepubertal ewes.

Key Words: sheep, liver, IGF

261 Metabolic responses to a glucose challenge in heifers with different body condition at calving and postpartum anoestrus interval. L.M. Chagas^{*1}, F.M. Rhodes¹, M.A. Blackberry², P.J.S. Gore¹, and G.A. Verkerk¹, ¹Dexcel limited, Hamilton, New Zealand, ²The University of Western Australia, Nedlands, Australia.

The objective of this study was to determine metabolic responses to a glucose challenge in heifers with different body condition (BC) at calving and the relationships between these responses and the interval from calving to first ovulation (PPAI). Forty Friesian heifers were managed during the last 5 months of gestation to achieve a BC of 4.0 (RES; $n = 27$) or 5.0 (FF; $n = 13$) by 6 weeks pre-partum. Half of the RES group then received ad libitum pasture feeding for the final 6 weeks until calving (RES+FF; $n = 12$). After calving all heifers were fully fed as a single herd. Liveweight (LW) and BC were assessed weekly. Two weeks after calving, animals received an intravenous infusion of glucose (300 mg D-glucose/kg LW) and blood samples were collected at #30, -15, -5, 0, 5, 10, 15, 20, 30, 40, 60 and 120 minutes relative to the time of the infusion for measurement of glucose, insulin, IGF-I and leptin. Concentrations of progesterone in milk were measured 3 times a week after calving to monitor time of ovulation. Differences in PPAI were examined using survival analyses, due to censored data. By 11 weeks after calving 8% (1/15) of the RES group had ovulated compared with 75% (9/12) of the RES+FF group and 69% (9/13) of the FF group and PPAI differed between groups ($P < 0.01$). Mean (\pm SEM) LW at calving was 448 ± 10 kg; 388 ± 6 kg and 346 ± 7 kg and BCS was 4.7 ± 0.07 ; 4.3 ± 0.08 and 3.5 ± 0.13 for FF, RES+FF and RES groups, respectively ($P < 0.001$). Both variables were correlated with PPAI ($P < 0.01$). Plasma concentrations of glucose, insulin, IGF-I and leptin following glucose challenge did not differ between the three groups ($P > 0.05$). In conclusion, the response of circulating glucose, insulin, IGF-I and leptin to a glucose challenge in heifers did not vary with differences in body condition at calving or with differences in the interval from calving to first ovulation.

Key Words: Dairy cattle, Anovulation, Glucose challenge

262 Characterization of reactions to intravenous immunoglobulin in neonatal calves. C. J. Hammer^{*1}, J. D. Quigley², J. A. Roth¹, and H. D. Tyler¹, ¹Iowa State University, ²APC Company, Inc.

Intravenous immunoglobulin (IVIG) products improve passive immunity in neonates. Unfortunately, adverse reactions can occur. This study was designed to determine if physiological changes occurring after IVIG administration were the result of rapid infusion of large molecular weight molecules, or from a more complex mechanism resulting in histamine release. The IVIG was concentrated from bovine abattoir blood and contained approximately 35 g IgG/L. A 50% dextran (75,000 MW) solution was prepared as a high molecular weight control. Holstein bull calves ($n = 15$) under 1 wk of age were assigned to one of three treatment groups: control calves received 500 ml of 0.9% NaCl; dextran calves received 500 ml of dextran; IgG calves received 500 ml of IVIG. Treatments were rapidly administered (less than 5 min) intravenously via jugular catheter. Heart rate, respiration rate, and blood pressure were measured prior to treatment, and at 1, 3, 5, 10, 15, 20, 25, 30, 45, 60, 75, and 90 min after start of infusion. Blood samples were obtained at the same sampling times, centrifuged, and the plasma immediately placed on ice for determination of histamine concentration using an enzyme immunoassay. Mean respiration rates were higher in calves treated with IVIG compared to calves in the other groups at all time periods measured. Mean heart rates were lower in calves treated with IVIG

compared to calves in the other groups through 45 min. Calves treated with dextran had higher mean heart rates than calves on the control treatment from 10 min through 30 min. Mean blood pressure tended to be higher in calves treated with IVIG compared to calves on the control treatment at 1 min, however, there were no differences between groups at any other time period. Mean histamine concentrations were higher in calves treated with IVIG compared to calves on the control treatment at 1 min, but were not different at any other time period. These data indicate that adverse reactions to IVIG in calves are not mediated by high molecular weight molecules nor by histamine release.

Key Words: Calf, Immunoglobulin, Histamine

263 The somatotrophic axis and lipid metabolism in transition dairy cows in relation to timing of first postpartum ovulation. A.L. Marr^{*1}, M.S. Piepenbrink¹, T.R. Overton¹, M.C. Lucy², and W.R. Butler¹, ¹Cornell University, Ithaca, NY, ²University of Missouri - Columbia.

Negative energy balance during early lactation is associated with uncoupling of the somatotrophic axis (ST) and low levels of insulin-like growth factor-I (IGF-I). IGF-I may be one of the signals communicating energetic state, thus regulating postpartum ovarian activity. The objectives of this study were to characterize changes in metabolic signals and the ST axis during the transition period from late pregnancy to early lactation in relation to timing of first postpartum ovulation. Dairy cows ($n = 46$) were studied from 21 d before until 21 d after parturition. Blood samples were analyzed for estradiol, progesterone, insulin, IGF-I, NEFA, and BHBA. Liver biopsies (d 1 and 21 postpartum) were analyzed for triglycerides (TG) and mRNA for growth hormone receptor 1A (GHR-1A) and IGF-I. The first dominant follicle (DF) ovulated (OV) in 30% of the cows during the first 3 weeks postpartum in response to higher ($P < 0.02$) estradiol levels than in cows with non-ovulatory (NOV) follicles. Plasma IGF-I and insulin levels were not different between OV and NOV cows, but OV cows had lower ($P < 0.03$) NEFA, BHBA, and TG. OV cows accumulated less TG in proportion to NEFA than NOV cows. Expression of GHR-1A and IGF-I mRNA were not related to ovulation of the DF. GHR-1A and IGF-I mRNA were highly correlated ($R^2 = 0.60$, $P < 0.001$). GHR-1A mRNA, IGF-I mRNA and plasma IGF-I were lower on d 1 compared to d 21. In the current study a relationship between recoupling of the ST axis for hepatic IGF-I production and timing of postpartum ovulation was not observed. The strong negative relationship of NEFA and BHBA concentrations with ovulatory status of the DF indicates that higher circulating levels may act to inhibit follicular estradiol production and ovulation. Potential sites of inhibition are at the hypothalamus on LH pulse frequency and on follicular sensitivity to metabolic stimuli (eg. insulin and IGF-I).

Key Words: Ovulation, Ketones, NEFA

264 Alterations of blood serum leptin concentrations in dairy cows treated with bovine somatotropin (bST). U. Heintges and H. Sauerwein^{*}, Bonn University, Germany.

To further elucidate the mode of action of somatotropin to increase milk yield, in particular its effects on feed intake, we aimed to characterize its potential effects on leptin blood concentrations. 21 lactating Brown Swiss cows received a 500 mg subcutaneous injection of sustained-release somatotropin (Posilac[®]). Two weeks before and 4 weeks after the injections, blood samples were collected every second day. Leptin was quantified by means of an enzyme immuno assay. A specific antiserum was raised in rabbits immunized against recombinant ovine leptin (a kind gift of A. Gertler, Revohot, Israel) and was bound onto microtiter plates via a secondary anti-rabbit sheep antiserum. In a competitive approach, biotinylated leptin or leptin from standard or sample were quantitatively bound to the antiserum, free leptin was removed by washing. Using the streptavidin peroxidase method, bound biotinylated leptin was then quantified. Assay validity in terms of recovery, parallelism, intra- and interassay variation was confirmed. Serum samples were also run in a IGF-1 RIA to identify the time during which bST was maximally effective to stimulate IGF-1. Statistical analyses using the SPSS program tested pregnancy versus non-pregnancy and calving number as potential effectors of basal leptin concentrations: pregnant cows (days 106–455 post partum, $n = 12$) had higher ($p = .023$) levels than non-pregnant cows (days 57 to 202, $n = 9$). Calving number had no effect. Comparing leptin levels before bST treatment and during the maximal effect phase, as identified by IGF-1 measurements (days 7 to 13 after bST injections),

within the two groups, leptin was decreased ($p=0.04$), but only in pregnant cows. Given the lipolytic effect of bST, a decrease of leptin blood concentrations has been expected; the lack of reaction in non-pregnant cows needs further investigation to elucidate whether metabolic and/or endocrine changes related to pregnancy do explain for it.

Key Words: Leptin, Growth hormone, Bovine

265 Plasma leptin concentrations during early pregnancy in the dairy cow. GE Mann^{*1}, MD Fray², and D Blache³, ¹University of Nottingham, School of Biosciences, Sutton Bonington, Loughborough, LE12 5RD, UK, ²Institute for Animal Health, Compton, Newbury, RG20 7NN, UK, ³Animal Science, Faculty of Agriculture, University of Western Australia, Nedlands 6907, Australia.

In dairy cows, poor progesterone secretion following mating is an important cause of early embryo mortality. The aim of the present study was to determine whether a link exists between circulating leptin concentrations and progesterone secretion at this critical time. In study 1, carried out in 20 normally cycling lactating Holstein - Friesian cows, a single plasma samples was collected on day 5 following first insemination. Progesterone concentration was lower in cows failing conceive than in those becoming pregnant (1.7 ± 0.1 vs. 2.4 ± 0.3 ng/ml; $p<0.05$) and increased significantly with increasing plasma leptin concentration ($r^2 = 0.40$; $p<0.005$). In study 2, daily plasma samples were collected from 33 non-lactating Holstein - Friesian cows commencing 72h after induction of luteolysis with prostaglandin (day 1) until day 16. Cows were inseminated 72 and 96h following prostaglandin ($n=23$) or remained as unseminated controls ($n=10$). On day 16, cows were slaughtered and the reproductive tract flushed to collect the embryo, if present, and to determine uterine concentrations of embryonic interferon tau. There was no change in plasma leptin concentration through the sampling period in any group. Furthermore, plasma leptin concentrations were not different between pregnant (2.8 ± 0.6 ng/ml), inseminated not pregnant (2.2 ± 0.3 ng/ml) and control (2.7 ± 0.6 ng/ml) cows. There was no correlation between plasma leptin and plasma progesterone. Furthermore, in the pregnant cows, there was no relationship between plasma leptin and embryonic production of interferon tau. The results demonstrate that while a relationship may exist between leptin and progesterone in lactating cows, in the absence of the high metabolic load of milk yield there appears to be no relationship between leptin and either plasma

progesterone or early embryo development. Supported by MAFF, MDC and Intervet UK.

Key Words: leptin, cow, progesterone

266 Study of histology and histochemistry of secretory structures of distal parts of digestive tract of Persian sturgeon *Acipenser persicus*. T. Sheibani*, Dept. of Basic Sciences, Faculty of Vet. Med. University of Tehran.

Regarding to the importance of the digestive system from the view of variety of secretions following the previous study of the author on anatomy and some microscopic studies on sturgeons and especially on this species, this study was carried out on a total number of ten fresh adult sturgeons from Caspian Sea. Specimens at one centimeter were taken from different parts of the tract. After fixation in phosphate- buffered formalin, they were transferred into the tissue processor, then thin sections of five microns were cut. The sections were subjected to routine and special staining methods such as; Hematoxylin and Eosin, P.A.S , orange G, Alcian blue and Toluidine blue or Johnson's methods. They were then studied under light microscope. The preintestinal regions including the secretory stomach and the pylorus possess an epithelium of pseudostratified columnar. Mucus secretions of columnar cells are shown by special staining methods such as P.A.S. -Hematoxylin - orange G which provide a protection from autolysis with a thick surface covering mucus. Such secretions with a less viscosity are seen in the mucus neck cells of gastric glands. These branched tubular glands synthesize and secrete gastric Juice containing hydrochloride acid and digestive enzyme, pepsin, which hydrolyses proteins into polypeptide fragments. Presence of gastric glands in forestomach suggest that here chemical digestion by pepsin with concentration of 25-35 units per miligrams of protein at pH 3-4 initiates. In pyloric caecum, intestines and rectum the epithelium of mucosa and their glands is of pseudostratified associated with secretory and goblet cells. Their cytoplasm have coarse eosinophilic granules synthesizing and secreting mucus due to presence of a thick glycocalyx. Numerous of mastocytes with metachromatic granules containing glycosaminoglycans and some neutral proteases showing by toluidine blue methods are present in intestinal mucosa.

Key Words: Histology, Sturgeons, Digestive tract

Ruminant Nutrition
Growing Cattle and Byproducts

267 The effect of feeding three milk replacer regimens on calf intake, body weight gain, and animal performance. C. S. Ballard^{*1}, H. M. Welford¹, C. J. Sniffen¹, M. P. Carter¹, P. Mandebvu¹, T. Sato^{1,2}, Y. Yabuuchi², and M. Van Amburgh³, ¹W. H. Miner Agricultural Research Institute, Chazy, NY, ²Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan, ³Cornell University, Ithaca, NY.

Sixty Holstein heifer calves at two farms were blocked at birth and randomly assigned to one of three treatments formulated on DM basis: 1) 27% CP/20% Fat fed at 1.5% BW for first week, 2.25% BW from 8 days through 5 weeks, and 1.25% BW from 6 weeks to weaning; 2) 27% CP/20% Fat fed at 200g 2x/day for 2 weeks, 250g 2x/day through weaning; or 3) 27% CP/15% Fat fed at 1.5% BW for first week, 2.25% BW from 8 days through 5 weeks, and 1.25% BW from 6 weeks to weaning. Milk replacer was reconstituted at 12-15% solids. Calf starter (22% CP) and water was available at all times and no forage was offered until weaning. Calves were weaned after consuming 0.7 kg starter for three consecutive days. Feed intake and growth parameters were measured weekly from birth through 10 weeks. Fecal scores and medical treatments were recorded daily. Results are shown in table. Calves fed milk replacer as a percent of BW had a higher total DMI and greater rate of growth for all parameters measured. Calves fed a fixed rate were weaned at an earlier age and had fewer days treated for illness.

Item		Treatment					Contrasts	
		1	2	3	SEM	P	2 vs	1 vs 3
							(1+3)	
Wt, kg	birth	42.4	41.2	42.6	0.92	0.884	-	-
	Wk 10	98.9	92.7	102.2	5.66	0.004	<0.001	0.100
WH ¹	Wk 10	91.3	88.8	91.5	0.56	<0.001	<0.001	0.557
HH ²	Wk 10	95.5	92.6	95.6	0.64	<0.001	<0.001	0.625
SP ³	Wk 10	96.6	93.6	97.8	0.74	<0.001	<0.001	0.131
Chest ⁴	Wk 10	39.7	38.7	40.0	0.34	0.007	0.002	0.272
Wean age, d		51.1	36.8	49.0	1.55	0.015	<0.001	0.331
Wean wt, kg		78.9	57.5	79.2	1.86	<0.001	<0.001	0.911
DMI ⁵ ,	Wk 4	2.08	1.86	2.31	0.10	0.021	0.014	0.135
	Wk 10	2.61	3.08	2.83	0.13	0.046	0.034	0.223
BCS	Wk 1	2.26	2.12	2.22	0.06	0.245	-	-
	Wk 10	2.76	2.70	2.96	0.09	0.055	0.086	0.076
Treatment	d ⁶	3.84	0.74	2.58	0.52	<0.001	<0.001	0.103

¹Wither height in cm; ²Hip Height in cm; ³Length from shoulder to pin in cm; ⁴Depth of chest in cm; ⁵Dry matter intake as %BW; ⁶Days calves treated with electrolytes/antibiotics.

Key Words: Calf, Milk replacer, Crude protein and fat

268 Plasma glucagon, IGF-1 and metabolite concentrations in Hereford and Senepol steers on orchardgrass or endophyte-infected tall fescue. . R. Browning, Jr., Y. G. Myles, and T. L. Payton, *Tennessee State University, Nashville, TN, USA.*

Yearling Hereford (n = 30; H) and Senepol (n = 28; S) steers were fed endophyte-infected tall fescue (TF) or orchardgrass (OG) to assess hormone and metabolite responses to endophytic fescue in heat sensitive and heat tolerant breeds. All steers were fed OG hay before being placed on TF hay and seed or a different source of OG hay with OG seed. The study was conducted from mid-June to mid-October, 2000 with experimental diets started in mid-July. Blood was sampled every 2 wk for 4 mo. Weight changes and insulin concentrations were presented previously [Browning et al., 2001. J. Anim. Sci. 79(Suppl. 1):118]. Glucagon concentrations were not affected by a breed×diet×time interaction (P > 0.7). Glucagon was affected (P < 0.01) by a diet×time interaction. Plasma glucagon increased (P < 0.01) for OG steers from 95 ± 3 pg/mL pretreatment to 115 ± 3 during 1 and 2 mo of treatment. For TF steers, glucagon did not change from pretreatment to 1 and 2 mo on treatment (90, 88, and 98 ± 3 pg/mL, respectively). Plasma IGF-1 was unaffected (P > 0.5) by breed×diet×time or diet×time interactions. Breed influenced (P < 0.01) IGF-1 as S had higher concentrations than H (171 vs. 88 ± 6 ng/mL). Plasma glucose was not affected (P > 0.45) by breed×diet×time or diet×time interactions. Breed influenced (P < 0.01) plasma glucose as S had higher concentrations than H (74 vs. 69 ± 1 mg/dL). A moderate breed×diet×time interaction affected (P = 0.14) triglyceride concentrations. Plasma triglyceride increased (P < 0.01) from pretreatment to 1 mo of treatment for HOG (81 vs. 90 ± 2 mg/dL). Triglycerides during the same periods did not differ for HTF (83 vs. 79), SOG (87 vs. 84), or STF (83 vs. 80 ± 2 mg/dL). Total cholesterol was affected (P < 0.01) by a breed×diet×time interaction. Plasma cholesterol from pretreatment to 1 mo of treatment did not change for HOG (115 vs. 122 ± 3 mg/dL). Cholesterol during the same periods decreased (P < 0.01) for HTF (122 vs. 100), SOG (117 vs. 106), and STF (112 vs. 100 ± 3 mg/dL). Shifts in metabolic function may play a role in reduced steer performance on endophyte-infected tall fescue, particularly in heat sensitive breeds.

Key Words: Fescue Toxicosis, Cattle Breeds, Metabolites

269 Pearl millet grain supplements for growing beef cattle. G. M. Hill*¹, W. W. Hanna², A. C. Coy¹, B. C. Hand¹, W. B. Forlow¹, and B. G. Mullinix¹, ¹University of Georgia, Tifton, GA/USA, ²USDA-ARS, Tifton, GA/USA.

Growing cattle were fed either corn silage (S) or Tifton 85 bermudagrass hay (H) with pearl millet grain (PM) supplement treatments (TRT) to determine effects on post-weaning performance. Supplements (SUP) contained rolled corn, soybean meal, PM (89% DM, 12.5% CP; finely ground), and premix, respectively (%): CSB=87.8, 10.0, 0.0, 2.2; CPM=43.8, 5.0, 49.0, 2.2; PM=0.0, 0.0, 97.8, 2.2. The SUP contained DM, CP, and TDN (% DM), respectively: CSB=89.8, 14.7, 84; CPM=89.8, 13.8, 84; PM=89.6, 13.2, 83. Each SUP had salt (0.75%), CaCO₃ (0.75%), and provided premix vitamins A, D and E (24,000, 8,000, and 400 IU/d, respectively), lasalocid (150 mg/d) and Se (2.0 mg/d). Cattle were ranked by BW, randomly assigned to TRT, and initial and final BW were means of consecutive daily unshrunk weights. Exp.1. Steers (n=48; 16/TRT; age 9 mo; BW 322.5 ± 17.9 kg) of British, Charolais × British (C×B), British × Brahman breeding (C×B higher initial BW, P < .10) were fed each SUP (2.29 kg DM/d) with free-choice S (32.7% DM; 8.5% CP) in a feedlot. Although DMI was higher on PM than CSB, higher ADG and lower DM/gain occurred on CSB than on CPM and PM (see table). Exp 2. Heifers (n=60; 20/TRT; age 8 mo; BW 245.6 ± 31.1 kg) of C×B or Angus and Hereford breeding (C×B higher initial BW, P < .08) grazed six dormant pastures in autumn. Each SUP (2.04 kg DM/d) was fed with free-choice H (93% DM, 12.9% CP). Heifer ADG and DMI tended to be lower, and DM/gain was higher for PM than for CSB and CPM (see table). Higher cattle performance occurred with CSB than with PM SUP in both corn silage and hay diets.

	Exp. 1 Steers fed silage (42-d)					Exp. 2 Heifers fed hay (85-d)				
Item	CSB	CPM	PM	SE	P<	CSB	CPM	PM	SE	P<
Initial										
BW, kg	321	322	322	4.64	ns	246	245	246	6.56	ns
ADG, kg	0.94	0.70	0.71	0.08	0.24	0.70	0.70	0.54	0.04	0.14
DMI, kg	6.84	7.23	7.56	0.03	0.01	6.18	6.18	6.06	0.24	0.93
DM/gain	7.30	10.46	10.63	1.01	0.23	8.90	8.80	11.34	0.55	0.13

Key Words: Cattle, Gain, Hay

270 Using allantoin in spot urine samples to predict bacterial protein production in finishing heifers. R.A. McDonald*, T.J. Klopfenstein, G.E. Erickson, C.N. Macken, and K.M. Whittet, *University of Nebraska-Lincoln, Lincoln, NE.*

A trial was conducted to determine if differences in bacterial crude protein (BCP) production could be predicted by measuring allantoin in spot urine samples. One hundred twenty heifers were blocked by initial weight (BW=349 kg) and individually fed in a 3 x 5 factorial arrangement of treatments. The high-moisture corn (HMC) diet (DM basis) consisted of 88.3 percent HMC, 6.7 percent cottonseed hulls, and 5.0 percent dry supplement. The BRAN diet was identical to the HMC diet except 20.0 percent corn bran replaced HMC. Five levels of urea were fed with these two diets at 0, 0.45, 0.90, 1.35, and 1.8 percent of the diet. The BRAN diet was also fed with five levels of SBM at 0, 3.89, 7.78, 11.67, and 15.56 percent of the diet. Spot urine samples were collected on days 19, 20, and 21 and on days 61, 62, and 63 and analyzed for both allantoin and creatinine with the average used in statistical analyses. There were no significant interactions or main effects of level for any of the response variables. Main effects of diet are included in the table. Diet affected (P<0.05) ADG, DMI, feed efficiency (ADG/DMI), allantoin in mmol/day, and allantoin in mmol/kg DMI. Heifers fed HMC gained more (P=0.02) compared to heifers fed BRAN but not (P=0.74) SBM with SBM being higher (P=0.01) than BRAN. Heifers consumed less of the HMC diet than BRAN (P=0.04) or SBM (P<0.01) diets. Feed efficiency (ADG/DMI) was higher for HMC than for BRAN (P<0.01) or SBM (P=0.07) with SBM being higher (P=0.01) than BRAN. Allantoin in mmol/d or mmol/kg DMI was higher for HMC compared to BRAN (P=0.01 and P<0.01) and SBM (P=0.02 and P<0.01). BRAN and SBM were similar for both allantoin variables. These data show that allantoin follows feed efficiency and may predict differences in BCP production due to energy.

Variable	HMC	BRAN	SBM	SEM
ADG, kg/d	1.28	1.17	1.30	.03
DMI, kg/d	8.39	8.78	9.01	.13
ADG/DMI	.152	.133	.144	.003
Allantoin, mmol/d	149	134	136	4
Allantoin, mmol/kg DMI	15.9	14.2	14.1	.5

Key Words: Allantoin, Bacterial Crude Protein, Cattle

271 Effect of previous liveweight gain on acid/base balance, blood flow, and oxygen consumption by splanchnic tissues during adaptation to a high-grain diet in steers. M. J. Hersom*, C. R. Krehbiel, G. W. Horn, and J. G. Kirkpatrick, *Oklahoma State University, Stillwater, OK.*

Ten fall weaned Angus x Hereford steers (BW = 324 ± 45 kg, age = 395 ± 11 d) were used in a completely random design to determine the effect of compensatory growth on blood gas, blood flow, and oxygen consumption across splanchnic tissues during adaptation to a high-grain diet. Treatments were high (HG; 1.25 ± 0.14 kg/d) or low (LG; 0.73 ± 0.13 kg/d) daily BW gain while grazing wheat pasture. After steers were grazed for 69 d, surgery was performed to place chronic catheters in the portal vein, a hepatic vein, and a mesenteric artery and vein. Blood flow and oxygen consumption by portal-drained viscera (PDV) and liver were measured on 0, 14, 28, 42, 64, and 92 d of a high-grain feeding period. Compensatory growth was evident in LG steers (30% by d 28); ADG was greater (P=0.01) during the first 28 d (2.13>1.31 ± 0.18 kg/d) and was greater (P=0.06) during the entire feeding period (1.28>1.06 ± 0.07

kg/d). Similarly, ADG:DMI was greater ($P=0.01$) for LG steers during the entire feeding period ($0.19 > 0.14 \pm 0.01$ kg ADG/kg DMI). Arterial blood pH did not differ and was 1.5 and 1.3% greater than portal and hepatic blood pH. Arterial base excess tended to be greater ($P=0.08$) in LG steers than HG steers ($3.83 > 2.94 \pm 0.32$ mmol/L) but calculated $^{-}\text{HCO}_3$ (mmol/L) was similar ($P=0.17$) between treatments. Hepatic blood flow in LG steers was greater ($P=0.05$) than HG steers ($756 > 654 \pm 40$ L/h) and increased ($P<0.001$) with days on feed. Arterial O_2 concentration did not differ among treatments but increased ($P<0.001$) with DOF. Across the feeding period, total splanchnic tissue (TST) oxygen consumption was greater ($P=0.03$) in LG than HG steers ($780 > 603 \pm 68$ mmol/h). Steers that had low BW gain prior to high-grain feeding exhibited increased hepatic blood flow and increased TST oxygen consumption when adapted to high-grain diet. This increase in energy demand by TST did not prevent compensatory growth by LG steers.

Key Words: Blood flow, Oxygen consumption, Cattle

272 Increasing intake of milk replacer by preruminant Holstein calves increases body tissue gain without affecting composition of gain. K. S. Bartlett*, F. K. McKeith, and J. K. Drackley, *University of Illinois, Urbana, IL.*

Male Holstein calves were used to quantify responses of body composition and component gains to increasing energy intake from milk replacer. Calves purchased during the first week of life were fed whole milk at 10% of body weight (BW) for a 2-wk adaptation period. Calves then were randomly assigned to either an initial slaughter group or to experimental diets. In this portion of the study, 20 calves were fed an all-milk-protein milk replacer (reconstituted to 12.5% solids) that contained 24.8% CP, 18.9% fat, and 4.6 Mcal ME/kg at 10% ($n = 6$), 14% ($n = 6$), or 18% ($n = 8$) of BW, adjusted weekly as calves grew. No starter was offered but calves had free access to water. Calves remained on experiment for 5 wk. Intake of milk replacer dry matter (0.65, 0.99, and 1.28 kg/d), average daily gain (0.36, 0.70, 1.03 kg/d), and gain:feed (0.55, 0.71, 0.81) increased linearly ($P < 0.001$) as feeding rate increased from 10 to 14 to 18% of BW, respectively. Increasing feeding rate resulted in linear increases ($P < 0.001$) in total gains of water, protein, fat, ash, and energy. Increasing feeding rate resulted in the final body containing slightly greater percentages of fat (5.1, 6.6, 7.6%; linear, $P < 0.001$) and slightly less water (73.2, 71.5, 71.3%; linear, $P < 0.001$) and protein (18.2, 18.0, 17.6%; linear, $P < 0.03$). The composition of whole-body gain was not altered significantly ($P \geq 0.18$); fat was 11.9, 12.8, and 13.0% and water was 65.2, 64.7, and 66.5% of gain, respectively. The concentration of urea in plasma (11.6, 8.9, 8.3 mg/dl) decreased linearly ($P < 0.05$) as feeding rate increased. We reported previously (J. Dairy Sci. 84:1560) that increasing the crude protein content of milk replacer from 14% to 24.8% had marked effects on composition of whole-body gain. We conclude that increasing the feeding rate of a milk replacer with adequate crude protein content exerts pronounced effects on growth rate and feed efficiency but has little impact on composition of gain.

Key Words: Body Composition, Milk Replacer, Dairy Calves

273 Soybean hulls for replacing corn silage in total mixed rations of lactating cows. J. Miron*, E. Yosef, E. Maltz, and D. Ben-Ghedalia, *ARO, Bet Dagan, Israel.*

The potential of soybean hulls for replacing forage NDF in TMR of lactating cows was examined in this study. Forty lactating cows were divided into two groups and individually fed ad libitum for eight weeks one of two experimental diets: (I), a TMR containing 18% forage NDF, the corn silage - CS TMR; and (II), a similar TMR in which the corn silage component (16.5% of the DM) was replaced by soybean hulls - the SH TMR, that contained only 12% forage NDF. Total NDF content was 39% and 36% in the SH and CS TMR, respectively. Average voluntary DMI was 25.8 and 25.1 kg for the CS and SH groups, respectively; the SH group ingested more NDF than the CS group ($p<0.1$). Average milk fat, 3.5% FCM and ECM yields were higher in the SH than in the CS group ($P<0.05$). Efficiency of feed utilization for milk and FCM production was slightly better in the SH group. In vitro digestibility data showed higher digestibility ($P<0.05$) of organic matter, NDF, hemicellulose and cellulose components in the SH TMR as compared to the CS diet. Despite the digestibility differences, milk fatty acids profiles, including the conjugated linoleic acid (CLA), were similar in both treatments. Thus, NRC (2001) recommendations regarding minimal forage NDF inclusion

in TMR of cows, can be extended even to diets containing as low as 12% forage NDF, under conditions similar to that of the SH TMR.

Key Words: Soybean hulls, Forage NDF replacement, Dairy cows performance

274 Feeding high free fatty acids cottonseed to lactating dairy cows. H. M. Sullivan*, J. K. Bernard², H. E. Amos¹, and T. C. Jenkins³, ¹*University of Georgia, Athens, GA/USA*, ²*University of Georgia, Tifton, GA/USA*, ³*Clemson University, Clemson, SC/USA.*

Twenty-four cows were used in a 10 wk randomized block design trial to evaluate the effects of feeding whole cottonseed containing elevated concentrations of free fatty acids (FFA) on DM intake, milk yield and composition, fatty acid composition of milk, and nutrient digestibility. After a 2-wk preliminary period, cows were assigned randomly to one of four treatment diets, differing in free fatty acid concentrations, for 8 wk. Whole cottonseed containing either 3 or 12% free fatty acids were blended to provide 3, 6, 9, or 12% free fatty acids and fed at the rate of 12.5% of dietary DM. Experimental diets were fed twice daily as a TMR behind Calan doors. Intake and digestibility were determined during wk 5 of the experimental period. There were no differences ($P > 0.10$) in DMI, milk yield and percentage of milk protein, lactose, or SNF. Percentage milk fat was lower ($P < 0.01$) for the diet containing 6% FFA, likely due to the numerically higher milk yield for this diet. Concentrations of C6:0 decreased linearly whereas C16:1 increased linearly ($P < 0.02$) as FFA increased. Concentrations of C8:0 ($P < 0.05$), C10:0 and C12:0 ($P < 0.01$) exhibited a cubic response with concentrations highest for 6% FFA and lowest for 9% FFA compared with 3 or 12% FFA. Intake of ADF increased linearly ($P < 0.02$) as FFA increased, but no differences were observed in DM, CP, or NDF intake. Apparent digestibility of DM was similar for all treatments, but CP digestibility was highest ($P < 0.01$) for 3 and 9% FFA where as NDF digestibility was highest ($P < 0.05$) for 6 and 12% FFA. Digestibility of ADF increased linearly ($P < 0.01$) as FFA increased. Results of this study indicate that feeding whole cottonseed containing up to 12% FFA does not negatively impact intake or production. Differences in milk fatty acid composition and nutrient digestibility suggest potential changes in ruminal fermentation, however these changes did not impact production at the FFA levels fed in this experiment.

Key Words: Cottonseed, Free Fatty Acids, Milk Yield

275 Effect of feeding wet corn gluten feed and a raw soybean hull-corn steep liquor pellet on the performance of lactating dairy cows. E.E. Ferdinand*, J.E. Shirley, E.C. Titgemeyer, J.M. DeFraen, and A.F. Park, *Kansas State University, Manhattan, KS.*

Forty-six multiparous Holstein cows were used in a randomized incomplete block design to evaluate the effect of wet corn gluten feed (WCGF) and a raw soybean hull-corn steep liquor pellet (SHSL) on the performance of lactating dairy cows. Cows were blocked by calving date and assigned to control (C), WCGF (20% of diet DM), or SHSL (20% of diet DM). Diets were administered at the first feeding postpartum. C contained (DM basis) 30% alfalfa hay, 15% corn silage, 32% corn, 9.3% whole cottonseed, 4.4% solvent soybean meal (SBM), 3.3% expeller SBM, 1.3% fish meal, 1% wet molasses, and 3.7% vitamins/minerals. WCGF replaced 10% alfalfa hay, 5% corn silage, 5% corn grain, and expeller SBM replaced solvent SBM to maintain diet RUP. SHSL replaced 10% alfalfa hay, 5% corn silage, 3% solvent SBM, and 2% corn. Diet CP% and energy density (Mcal/kg, NEI) for C, WCGF, and SHSL were 18.5, 1.70; 18.3, 1.76; 19.1, 1.74; respectively. Data were analyzed using PROC MIXED of SAS with previous mature milk equivalent as a covariate. Milk, ECM, DMI, and production efficiency (ECM/DMI) were not affected by diet during the first 91 d of lactation, but there was a diet by week interaction ($P < 0.05$) for production efficiency. Cows fed C were more efficient during the first two weeks postpartum than cows fed WCGF and SHSL, likely due to increased fat mobilization from adipose tissue. Milk fat, SNF, protein, and lactose yield and percent, and MUN were similar among diets. Plasma albumin, glucose, NEFA, total amino acids, triacylglycerol, and urea were not affected by diet. WCGF and SHSL can successfully replace a portion of the alfalfa hay, corn silage, and corn grain in lactating dairy cattle diets.

Key Words: Wet corn gluten feed, Soybean hulls, Steep liquor

276 Effects of dietary sunflower seeds (SS) and protein on digesta physico-chemical parameters in small intestine and on plasma cholecystokinin (CCK) in lambs. P.S. Mir*, M. Ivan, G.J. Mears, C.M. Ross, and Z Mir, ¹*Agriculture and Agri-Food Canada, Lethbridge, AB.*

A 2 x 2 factorial experiment with 12 lambs per treatment was conducted to measure the effects of dietary SS and protein on plasma CCK, and on digesta viscosity, protein, fat and amylase activity in different parts of the small intestine. The experiment lasted 140 d and comprised of four treatments, two with low protein (12%) and two with high protein (16%) diets. Within each protein level one diet was without (control) and one with SS supplement (14% of dietary DM). The diets were based on corn silage and rolled corn grain, with soybean meal used to achieve desired dietary protein. Concentrations of CCK were determined in jugular plasma in samples obtained from each lamb (4 h after feeding) six weeks after the initiation of the experiment. After the end of the experiment all lambs were killed and digesta sampled 15 min later from 50-cm sections of proximal, mid jejunal and distal small intestine. Dietary SS increased ($P < 0.05$) plasma CCK concentrations and reduced ($P < 0.05$) digesta viscosity in the proximal section. The viscosity remained lower ($P < 0.05$) in the jejunal and distal sections of lambs fed the SS in low protein diet, but SS increased the viscosity with the high protein diet. In lambs fed the low protein diet with SS digesta fat content was increased ($P < 0.05$) in jejunal but not in the proximal or distal sections. Dietary SS increased ($P < 0.05$) digesta protein by 41 and 36% in lambs fed the low and high protein diets, but amylase activity was increased (19%) due to SS only in lambs fed the high protein diet. Dietary SS, was effective in altering digesta factors such as viscosity and protein in lambs irrespective of protein content of the diet, but the activity of the amylase was substantially increased by higher dietary protein.

Key Words: Sheep, Sunflower seed, Intestinal digesta, Viscosity, amylase activity

277 The effect of feeding wet corn gluten feed and a raw soybean hull-corn steep liquor pellet on digestibility and rumen parameters. E.E. Ferdinand*, J.E. Shirley, E.C. Titgemeyer, J.M. DeFraín, and A.F. Park, *Kansas State University.*

Four ruminally cannulated and two intact multiparous Holstein cows were used in a 3 x 3 replicated Latin square design to evaluate the effect of feeding wet corn gluten feed (WCGF) and a raw soybean hull-corn steep liquor pellet (SHSL) on diet digestibility and rumen parameters. Cows were fed control (C), WCGF (20% diet DM), or SHSL (20% diet DM) as a TMR at 0700 and 1800. C contained 30% alfalfa hay, 15% corn silage, 32% corn, 9.3% whole cottonseed, 4.4% solvent soybean meal (SBM), 3.3% expeller SBM, 1.3% fish meal, 1% wet molasses, and 3.7% vitamins/minerals. WCGF replaced 10% alfalfa hay, 5% corn silage, 5% corn grain, and expeller SBM replaced solvent SBM to maintain diet RUP. SHSL replaced 10% alfalfa hay, 5% corn silage, 3% solvent SBM, and 2% corn. Periods were 14 d (10 d adaptation, 4 d collection). Diet and ort samples were collected and composited on d 10 to 12 and d 11 to 13, respectively. Fecal grab samples were collected every 6 h, advanced by 2 h each d, beginning at 0700 on d 11 and ending at 0500 on d 14. Acid insoluble ash was used to estimate fecal output. Cows were pulse dosed with Co-EDTA at 0700 on d 11 for estimation of liquid dilution rate, and rumen fluid samples were obtained just prior to dosing and 3, 6, 9, 12, and 24 h following. DMI and total tract digestibilities of DM, OM, NDF, ADF, and CP were not different among diets and averaged 17.2 kg/d, 71.7%, 73.2%, 63.1%, 58.5% and 73.0%, respectively. Liquid dilution rate, ruminal pH, and ruminal concentrations of total VFA and ammonia were not influenced by diet and averaged 13%/h, 6.2, 100.3 mM, and 8.9 mM, respectively. The molar ratio of acetate to propionate was higher ($P < 0.05$) for C (3.38) than for WCGF (2.79) and SHSL (2.89). These data show that our substitution of WCGF and SHSL into diets did not greatly affect digestibility and rumen parameters.

Key Words: Wet corn gluten feed, Soybean hulls, Steep liquor

278 Effects of level of substitution of pelleted beet pulp for high-moisture corn on production and digestion in lactating dairy cows. J. A. Voelker* and M. S. Allen, *Michigan State University.*

Effects of increasing levels of dried, pelleted beet pulp substituted for high-moisture corn were evaluated with 8 ruminally and duodenally cannulated multiparous Holstein cows in a duplicated 4x4 Latin square design with 21-d periods. Cows were 79 ± 17 (mean \pm SD) DIM at the beginning of the experiment. Experimental diets with 40% forage (corn silage and alfalfa silage) and 60% concentrate contained 0%, 6.1%, 12.1%, or 24.3% beet pulp (0BP, 6BP, 12BP, and 24BP, respectively) substituted for high-moisture corn on a DM basis. Diet contents of NDF and starch were 24.3% and 35.4% (0BP), 26.2% and 31.2% (6BP), 28.0% and 27.0% (12BP), and 31.6% and 18.6% (24BP), respectively. Substituting BP for corn tended to cause a quadratic response in 3.5% FCM yield ($P = 0.07$), with treatment means of 37.4, 38.4, 38.0, and 36.8 kg/d as BP increased. Treatment did not affect mean rumen pH (5.96), daily minimum pH, or daily variation in pH ($P > 0.60$). Increasing BP in the diet caused a linear decrease in DMI ($P < 0.05$) though rumen DM pool decreased ($P < 0.05$). As BP increased, potentially digestible NDF was digested more extensively ($P < 0.01$) and at a faster rate ($P < 0.001$) in the rumen, resulting in increased total tract NDF digestibility ($P < 0.0001$) and decreased NDF turnover time ($P < 0.001$). Passage rate of indigestible NDF increased with added BP ($P < 0.05$), but passage rate of potentially digestible NDF was unaffected ($P > 0.60$). Although true rumen starch digestibility decreased when more BP was fed ($P < 0.01$), whole tract starch digestibility was not affected ($P > 0.10$) because of compensatory digestion of starch in the small intestine. Because of more thorough digestion of fiber as BP increased, total tract digestibility of DM tended to increase ($P < 0.10$) and intake of digestible DM was not affected ($P > 0.40$). Partial substitution of high-fiber beet pulp for high-starch high-moisture corn can improve milk production by increasing fiber digestibility without reducing starch digestion.

Key Words: Beet pulp, High-moisture corn, Fiber digestion

279 Effects of increasing level of dietary soybean hulls on ruminal characteristics and serum urea nitrogen of Boer-cross goats. J. A. Moore, A. T. Maye, M. H. Poore*, and J-M Luginbuhl, *North Carolina State University, Raleigh.*

Soybean hulls or husks (soyhulls) contain highly digestible fiber and may be an economical substitute for high-quality hay in diets for meat goats. This study evaluated diets containing 0, 25, 50, or 75% soyhulls (20 %CP, 54% NDF, 37% ADF) fed to 8 ruminally cannulated Boer-cross does (BW = 46 kg) with 10% refusal (ad libitum). The remaining portion of the diet was orchardgrass hay (13.2 %CP, 67% NDF, 36% ADF) chopped to an average length of 10 cm and offered in a hay feeder above the soyhull feeder. The 14-d periods in the double 4x4 Latin square design had 9-d adaptation followed by 4 d of intake measurement and 1 d of sampling. Ruminal fluid was removed via the cannula at 0, 4, 8, 12, 16, 20, and 24 hr postfeeding. Blood was collected via jugular venipuncture at 0, 4, and 8 h postfeeding. One doe had problems throughout the study and was eliminated, leaving 7 goats; least squares means are presented. Hay DMI decreased linearly ($P < .01$) from 960 to 190 g/d as soyhull intake increased (linear, $P < .01$). Total DMI increased linearly ($P < .01$) from 970 to 1280 g/d. Ruminal pH decreased linearly ($P < .05$ except 12 h, for which $P = .07$) at all time points, averaging 6.47, 6.32, 6.25, and 6.15 for the 0, 25, 50, and 75% soyhull diets, respectively. Ruminal NH_3 increased linearly ($P < .04$) at all times after 0 h, averaging 6.8, 8.9, 12.7, and 14.2 mM; the increase is most likely due to the elevated CP in the soyhulls used in this study. Serum urea nitrogen increased linearly ($P < .02$) at 4 and 8 h, averaging 2.9, 3.2, 4.6, and 4.3 mM for the 0, 25, 50, and 75% soyhull diets, respectively. Total VFA increased linearly ($P < .04$) at all time points, averaging 86, 93, 110, and 114 mM. Acetate:propionate ratio showed a quadratic response ($P < .04$) for hours 4 through 20, with the average for those 5 time points being 3.3, 4.1, 4.0, and 3.6 for the 0, 25, 50, and 75% soyhull diets, respectively. Data indicate soyhulls are readily consumed and produce a ruminal environment that would not promote acidosis.

Key Words: Soybean Hulls, Goats, Ruminal Environment

280 Effects of feeding raw and roasted sunflower seed on rumen fermentation and total tract nutrient utilization by lactating dairy cows. P. Sarrazin^{*1}, A. F. Mustafa¹, P. Y. Chouinard², and V. Raghavan¹, ¹*McGill University, Ste-Anne-De-Bellevue, QC, Canada*, ²*Universite Laval, Pavillon Paul-Comtois, QC, Canada*.

Three multiparous ruminally cannulated lactating Holstein cows (DIM 169 34 d) were used in a 3x3 Latin square experiment to determine the effects of feeding raw and roasted sunflower seeds on ruminal fermentation and whole-tract digestibility of dairy cows. Treatments were a control diet with no added sunflower seed, raw sunflower seed diet, and roasted sunflower seed diet. Sunflower diets contained 7.5% (DM basis) raw or roasted sunflower seed. All diets were fed ad libitum as TMR. Ether extract content was 2.5% for the control, 5.5% for the raw sunflower and 5.6% (DM basis) for the roasted sunflower diet. Results showed that dietary treatments had no effect on ruminal pH or ruminal ammonia nitrogen concentrations. Dry matter intake tended ($P = 0.07$) to be lower for cows fed the sunflower diets than the control diet. Apparent DM (average 75.6%), OM (average 72.6%), CP (average 73.5%), NDF (average 53.1%), starch (average 94.0%) and gross energy (71.2%) digestibilities were similar among dietary treatments. Apparent ether extract digestibility was higher for cows fed the sunflower diet relative to those the control diet. We concluded that the inclusion of raw or roasted sunflower seeds in dairy cow diets up to 7.5% of the diet DM has no adverse effects on ruminal fermentation or total tract nutrient utilization.

Key Words: Sunflower seed, Rumen fermentation, Total tract nutrient utilization

281 Effects of feeding glyphosate-tolerant canola meal on lamb growth, meat quality and apparent feed digestibility. K. Stanford^{*1}, T.A. McAllister², J. Aalhus³, M. Dugan³, and R. Sharma², ¹*Alberta Agriculture, Food and Rural Development, Lethbridge, AB*, ²*Agriculture and Agri-Food Canada, Lethbridge, AB*, ³*Agriculture and Agri-Food Canada, Lacombe, AB*.

Consumer awareness of transgenic crops in the food chain is increasing. This study evaluated the effects of including meal from glyphosate-tolerant (Roundup-Ready[®]) canola (RRC) in barley-based diets (6.5%, DM basis) for lambs. Four diets were prepared, differing only in the type of canola meal they contained (two commercially available sources, COM1 and COM2; the parental line from which the glyphosate-tolerant canola was derived, PAR; or the transgenic RRC). The diets were isonitrogenous and formulated to exceed the lambs' nutritional requirements. Experiment 1 involved 60 early-weaned Canadian Arcott lambs (30 ewes; 30 wethers; initial age approximately 2 mo; initial weight 21.5 ± 1.0 kg). The lambs were individually penned, blocked by weight and gender for assignment to treatments ($n = 15$), and fed the diets until reaching or exceeding 45 kg BW. Intake of DM by the lambs was similar among COM1, COM2 and PAR diets, and among COM2, PAR and RRC (COM1 > RRC, $P < 0.05$). Diet did not affect ($P > 0.05$) ADG or feed efficiency. Carcass yield grade was higher ($P < 0.05$) for COM1 or COM2 diets than for PAR or RRC, although saleable meat yield did not differ ($P > 0.05$) among treatments. Canola source did not affect ($P > 0.05$) meat tenderness, as determined by shear force, or intramuscular fat content. Meat color differences were not detected between RRC-fed lambs and those in the other three groups. In Exp. 2, apparent digestibilities of the four diets were determined using eight mature wethers (67.8 ± 2.3 kg) in a replicated Latin square. No aspect of digestibility (DM, fibre, or nitrogen balance) was influenced by canola source. In this study, including canola meal prepared from glyphosate-tolerant canola did not alter diet digestibility, feed efficiency or growth performance of the lambs, carcass characteristics or meat quality.

Key Words: Transgenic Canola, Lamb Growth, Meat Quality

Ruminant Nutrition Protein

282 Quantifying the metabolisable methionine contribution of a liquid or powder presentation of 2-hydroxy-4 (methyl thio) butanoic acid isopropyl ester (HMBi). J.C. Robert, T. d'Alfonso, G. Etave, E. Depres, and B. Bouza, *Aventis Animal Nutrition, Antony, France*.

Three products were tested : HMBi (L) containing 93% of HMBi monomers, liquid form ; HMBi (P) : HMBi (L) mixed with a clay (powder presentation : 31.5% HMBi monomers) and a coated methionine : SmartamineTM M(Sm M). Four non lactating rumen cannulated Holstein cows were used. The four treatments were randomly assigned in a latin square design (4 x one week periods). Each product was given orally as a single dose at the start of each experimental period : T1 : 69.6g HMBi (L) ; T2 : 220.8g HMBi (P) ; T3 : 353.5g HMBi (P) ; T4 : 68.1g Sm M. T4 was supplied at 1600h the first day (D1) of each experimental period and T1, T2 and T3 the second day (D2) at 0800h. Blood samples for blood plasma methionine determination (BPMC mg/100g) were obtained for T1, T2 and T3 on D2 of each experimental period, every 30 mn, starting at 0800 until 1100h, then at 1300, 1500, 1800 and 2200h and on D3 at 0600, 0800, 1100 and 1500h. For T4, blood samples were collected, every 2 hours, on D2 starting at 0600 until 2200h and thereafter every 3 hours from 0600 until 1500h on D3 and D4. BPMC basal line values were measured on D1. The metabolisable methionine contribution (Y) was determined using the equation : $Y = 26.14 \ln(1 + X/15.94)$ (Robert et al, 2001)*** where X= Area Under the Curve (AUC **). Metabolisable methionine contribution from an oral single dose was 50% for HMBi (L) and 56.5% for HMBi (P). The bioavailability of methionine from Sm M : 81%, is in good agreement with literature values.

Treatment	T1	T2	T3	T4	SED	source p<
Methionine equivalent g*	50	50	80	50		
Base line BPMC (mg/100g)	0.29	0.32	0.30	0.30	0.02	NS
AUC**	25.5b	32.2b	69.6a	59.4a	6.2	0.001
Metabolisable methionine g.***	24.9b	28.8b	43.9a	40.3a	2.0	0.0002
Bioavailability****	50b	58b	55b	81a	3.5	0.0005

*based on methionine equivalent concentration in HMBi monomers : 0.78

**taking into account base line

****metabolisable methionine/methionine equivalent ingested

Key Words: Ruminants, Dairy cows, Methionine, Bioavailability

283 Effects of metabolizable undegradable protein and methionine and lysine on production parameters and nitrogen efficiency of Holstein cows in early and mid-lactation. Sarah Ivan^{*} and Normand St-Pierre, *The Ohio State University, Columbus, OH*.

Excessive N excretion by dairy cows can have a negative effect on the environment. We hypothesized that targeted dietary changes to the N-intake pools, or the N available in the feed, would improve N efficiency by dairy cows, thus reducing negative environmental impact from milk production. Forty multiparous and 22 primiparous Holstein cows were used in a 2 x 2 factorial arrangements of treatments to determine the effects of 1) metabolizable rumen undegradable protein (M-RUP): 100% (LoM-RUP) or 110% (HiM-RUP) of the requirements stated by the National Research Council (2001), and 2) Met and Lys supplementation: control levels of 6.15% and 1.80% Lys and Met (LoAA), respectively, or supplementation at 6.65% and 2.22% Lys and Met (HiAA), respectively. The Lys to Met ratio was set at 3.0:1.0 in the HiAA diets and 3.4:1.0

in the LoAA diets. Cows were assigned randomly to one of four dietary treatments 14 to 21 d postpartum and continued on their assigned diet for 25 wk. There was no effect ($P > 0.05$) of treatment on DMI, milk yield, or milk true protein production. Lys and Met supplementation in the HiAA diets significantly ($P = 0.042$) increased milk true protein concentration from 3.02% to 3.14%. High M-RUP levels significantly depressed milk fat concentration ($P = 0.022$) and production ($P = 0.036$) from 3.35% to 3.03% and 1.45 kg/d to 1.32 kg/d, respectively. Lower levels of M-RUP, combined with lower Lys and Met supplementation, significantly ($P < 0.05$) decreased MUN and urinary N excretion. Cows were numerically more efficient at converting intake N to milk N in the HiAA diets with a higher quality Lys to Met ratio. Dietary manipulation of N fractions can reduce the impact of intensive dairy production on the environment without adversely affecting milk or component production.

Key Words: Metabolizable undegradable protein, Methionine, Lysine

284 Lactational responses of early lactation cows to two crude protein levels in corn silage and alfalfa silage based diets. K.L. Karg* and M.A. Wattiaux, *University of Wisconsin-Madison*.

Forty eight multiparous Holstein cows were used to evaluate the effects of primary forage source (alfalfa silage (AS) or corn silage (CS)) and CP level (16.5% (LP) or 17.9% (HP)) to test the hypothesis that lower dietary CP may not be detrimental to early lactation cows performance. Cows were blocked by calving date and assigned to dietary treatments in a 2 x 2 factorial. A covariate diet was fed the first 3 weeks of lactation and treatment effects were measured for the following 11 weeks. Diets were fed as TMRs including 55% forage (DM basis; 14% CS and 41% AS or 14% AS and 41% CS). A variety of non structural carbohydrates and protein sources were used to complement forage nutrients. According to NRC 2001, the ME allowable milk was 45 kg/d for all diets, and MP allowable milk was 45 kg/d on LP diets and 50 kg/d on HP diets. Predicted MP balance was 14, 229, 47 and 256 g/d for ASLP, ASHP, CSLP, and CSHP diets respectively. Milk production and DMI were recorded daily. Milk samples were taken weekly for composition analysis. Cows were weighed and body condition scored at the beginning and at the end of the trial. Data were analyzed with the MIXED procedure of SAS and differences between forage sources and protein levels were tested with orthogonal contrasts. Protein level did not influence production parameters (see Table). However, cows on CS diets produced higher milk yields than those on AS diets ($P=.03$). There was a tendency for fat yield to be greater in AS diets ($P=.07$), but protein yield tended to be higher in CS diets ($P=.06$). In this trial, cows produced as much milk on 16.5% than 17.9% CP diets; the proportion of AS and CS in the diet had a greater impact on lactation response than dietary protein level.

Item	Treatments					p-value		
	ASLP	ASHP	CSLP	CSHP	SEM	For-age	Pro-tein	FxP
DMI (kg)	24.4	25.2	24.1	23.9	0.6	.16	.62	.42
Milk (kg)	45.0	45.3	48.8	46.6	1.2	.03	.44	.30
Fat (g/d)	1576	1558	1418	1460	70	.07	.88	.66
Protein (g/d)	1246	1228	1289	1291	29	.06	.78	.74
BW change (kg)	-17.1	-16.1	+17.3	-20.4	20.2	.45	.35	.33
BCS change	-.12	-.29	-.14	-.18	.07	.55	.16	.34

Key Words: Forage, Environment

285 Urea-nitrogen recycling and nitrogen balance in lambs fed a high-concentrate diet and infused with differing proportions of casein in the rumen and abomasum. K. C. Swanson*, H. C. Freely, and C. L. Ferrell, *USDA, ARS, U.S. Meat Animal Research Center*.

Twenty-five wether lambs (34 ± 0.9 kg) fitted with ruminal and abomasal infusion catheters were used in a completely randomized design to determine the effects of differing proportions of ruminal and abomasal casein infusion on urea-N recycling and N balance in lambs fed a high-concentrate diet (1.6% N, DM basis) for ad libitum intake. Wethers were infused with 0 (control) or 10.4 g/d of N from casein with ratios of ruminal:abomasal infusion of 100:0, 67:33, 33:67, or 0:100%, respectively, over a 14-d period. Over the last 4 d, urea kinetics were examined

by continuous infusion of [15N15N]-urea into the jugular vein and measurement of [15N15N]-urea enrichment in urine using gas chromatography/mass spectrometry. Feed, ors, feces, and urine were collected over the last 5 d. Total nitrogen intake, N excretion, urea-N production, and urea-N recycled to the gastrointestinal tract was greater ($P < 0.01$) in lambs infused with casein as compared to controls. Nitrogen retention, however, did not differ ($P = 0.66$; 6.9, 5.5, 7.6, 9.0, and 7.2 g/d; pooled SEM = 0.9) in lambs infused with casein as compared to controls, suggesting N requirements were met without casein supplementation. Total nitrogen intake (24.7, 25.3, 26.9, and 25.1 g/d; pooled SEM = 1.3) and total N excretion (19.2, 17.7, 17.9, and 17.9 g/d; pooled SEM = 1.2) did not differ ($P > 0.10$) between casein infusion treatments. Urinary N excretion decreased linearly ($P = 0.07$; 14.2, 12.6, 12.1, and 11.7 g/d; pooled SEM = 0.9) with decreasing ruminal infusion of casein. Urea-N recycled to the gastrointestinal tract increased ($P = 0.01$; 16.8, 17.2, 22.6, and 23.1 g/d; pooled SEM = 2.0) with decreasing ruminal infusion of casein. These data indicate that decreasing the rumen degradability of supplemental protein, above that required to maximize N retention, results in decreased urinary excretion of N and increased urea-N recycling to the gastrointestinal tract.

Key Words: Sheep, Nitrogen, Urea Recycling

286 Use of 2-hydroxy-4-[methylthio]-butanoic acid (HMB) by lactating dairy cows. H. Lapierre*¹, J.J. Dibner², M. Vazquez-Anon², D. Parker², P. Dubreuil³, M. Babkine³, G. Zuur⁴, and G.E. Lobley⁵, ¹*Dairy and Swine R&D Centre, Lennoxville, QC, Canada*, ²*Novus International Inc, St Louis, MO, USA*, ³*Coll. Vet. Med., U. Montreal, St-Hyacinthe, QC, Canada*, ⁴*Biomathematics and Statistics Scotland, Aberdeen, UK*, ⁵*Rowett Research Institute, Aberdeen, UK*.

Four multicatheterized cows (31.3 kg milk/d; 17.7 kg DMI/d) were used in a cross-over design each of 2 1-week periods to determine the effect of HMB on HMB and methionine (MET) metabolism. Over the last 2 d, cows were infused (intra-jugular) with saline or HMB (Alimet® feed supplement, Novus International Inc.) at the rate of 1.5 g/h. During the last 8 h, the HMB infusion was substituted by equimolar [1-¹³C]HMB plus [methyl-²H₃]MET (200 mg/h). During the last 4 h, hourly samples were collected to determine plasma flows plus the isotopic enrichments (IE) and concentrations of HMB (¹³C) and MET (both ¹³C and ²H₃) in plasma from the artery, portal, hepatic and mammary veins. The IE of [¹³C] and [²H₃] MET were also determined in milk protein taken over the last h of infusion. In HMB-infused cows, whole body plasma flux of MET increased (17.9 vs 24.4 1.53 mmol/h, $P=0.03$) with 15% of the flux (3.7 mmol/h; 42% of the HMB dose infused) derived from HMB (assessed by synthesis of [1-¹³C]MET). Although the portal-drained viscera (PDV), liver and mammary gland (MG) extracted 11, 37 and 3.5% respectively of the infused HMB, tissue net MET fluxes were unchanged across the PDV and the MG while liver removal increased (-8.4 vs -15.3 0.72 mmol/h; $P < 0.01$). HMB infusion decreased ($P = 0.05$) net post-splanchnic supply of MET from 7.0 to 2.9 mmol/h, compared with needs for milk output of 7.6 and 8.1 mmol/h, respectively. HMB provided the equivalent of 22% of the total MET utilization by the MG (0.9 mmol/h from synthesis within the gland and 2.0 mmol/h from extraction of MET produced in other tissues). Intracellular conversion of HMB in other tissues spared their needs for dietary MET which was then used by the MG to support milk protein output. Absorbed HMB therefore produces and spares MET for use by the MG.

Key Words: lactating cows, HMB, methionine

287 Effect of a jugular infusion of essential amino acids on splanchnic metabolism in dairy cows fed a protein deficient diet. R. Berthiaume*¹, M.C. Thivierge², G.E. Lobley³, P. Dubreuil⁴, M. Babkine⁴, and H. Lapierre¹, ¹*Dairy and Swine R&D Centre, Lennoxville Quebec, Canada*, ²*Universit Laval, Quebec, Canada*, ³*Rowett Research Institute, Aberdeen, UK*, ⁴*Coll. Vet. Med., U. Montreal, St-Hyacinthe Quebec, Canada*.

Six lactating Holstein cows were used to measure the effect of a jugular infusion of essential amino acids (AA) on splanchnic metabolism in dairy cows fed a protein deficient diet, according to a cross-over design. A total mixed ration was fed in twelve equal meals per d (mean DMI = 17.0 kg/d). Indwelling catheters had been surgically implanted in the mesenteric artery, the portal and hepatic veins for blood collection, and in two distal branches of the mesenteric vein to allow infusion of ρ -aminohippurate to determine blood flow. After five days of infusion

of saline or of AA, six hourly blood samples were collected to determine plasma concentrations of AA. Yields of milk (29.2 vs 31.3 ± 0.46 kg/d) and protein (912 vs 1047 ± 21.7 g/d) were increased ($p \leq .05$) with AA infusion. Infusion of AA increased arterial concentrations of infused AA. The net flux across the portal-drained viscera was not affected but the infusion of AA increased hepatic extraction by more than the level of infusion. Why in such a case did milk production increase with AA infusion remains unclear. Although the demand of peripheral tissues has an effect on liver catabolism of AA, the regulation of AA extraction by the liver seems also regulated by factors independent of the demand by the mammary gland and related to high concentrations of AA in peripheral circulation.

Key Words: Amino acid, Splanchnic metabolism, Protein

288 Minimum dietary protein required for lactating dairy cows fed different amounts of alfalfa and corn silage. E. B. Groff* and Z. Wu, *Pennsylvania State University, University Park, PA.*

The response of lactating dairy cows to dietary protein level under various alfalfa to corn silage programs was determined. Three trials were conducted using 100 : 0, 50 : 50, or 25 : 75 alfalfa to corn silage ratios. Each trial used 16 Holsteins (117 ± 33 DIM) in a replicated 4 X 4 Latin square design with 3-wk periods (2-wk adjustment followed by 1-wk collection). All diets consisted of 50 : 50 forage : concentrate and were formulated to contain 15.00, 16.25, 17.50, or 18.75% CP. Increasing dietary CP did not affect milk yield, but increased milk urea nitrogen (MUN). Cows yielded more milk when corn silage constituted more of the forage. Reducing dietary CP and optimizing alfalfa to corn silage ratio can be used to improve N utilization.

Item	15.00	16.25	17.50	18.75	SEM	P
Alfalfa : corn silage = 100 : 0						
DMI, kg/d	22.9	23.3	22.6	23.1	0.34	0.59
Milk, kg/d	31.5	32.0	32.2	32.5	0.58	0.68
MUN, mg/dl	9.8	10.2	11.8	13.3	0.53	0.01
Alfalfa : corn silage = 50 : 50						
DMI, kg/d	24.8	24.4	24.5	24.0	0.40	0.65
Milk, kg/d	37.4	35.5	36.5	36.5	1.53	0.86
MUN, mg/dl	12.2	13.0	12.6	14.0	0.39	0.02
Alfalfa : corn silage = 25 : 75						
DMI, kg/d	25.8	26.4	25.9	25.7	0.40	0.57
Milk, kg/d	39.3	38.4	39.8	38.8	0.50	0.22
MUN, mg/dl	11.2	12.7	14.2	15.1	0.33	0.01

Key Words: Protein, Milk urea nitrogen, Forage

289 Amino acid profiles of tropical forages and of their residues after incubation in the rumen, phosphate-borate buffer and intestinal digestion. L. F. Miranda*¹, N. M. Rodriguez¹, R. D. Sainz², E. S. Pereira³, C. M. Veloso⁴, and M. M. Gontijo Neto⁵, ¹Universidade Federal de Minas Gerais, Brazil, ²University of California, Davis, USA, ³Universidade Estadual Oeste Paraná, Brazil, ⁴Universidade Itapetinga, Brazil, ⁵EMBRAPA Gado de Corte, Brazil.

Amino acid (AA) profiles of several feed protein fractions were determined for foliage from leucaena (*Leucaena leucocephala*), perennial soybean (*Neonotonia wightii*), manioc (*Manihot esculenta*), ramie (*Boehmeria nivea*), and guandu (*Cajanus cajan*) using *in situ* and *in vitro* procedures. Fractions included total feed protein; (rumen) undegradable intake protein (UIP), the residue after an 18h rumen incubation in nylon bags; phosphate-borate buffer (PBB) insoluble residue; and (intestinal) indigestible protein, the residue after a three-stage procedure. These were analyzed by HPLC after acid hydrolysis or peroxidation followed by acid hydrolysis. There was no difference ($P > 0.05$) in the AA profile of any of the protein fractions of guandu and ramie. For leucaena, several AA (Lys, Met and Thr) contents differed between the total protein and the PBB residue. The same was true for perennial soybean (Iso, Leu, Met, Thr, and Val) and manioc (Arg, Iso, Leu and Lys). The essential AA profile of the total feed protein was similar to the essential AA available for intestinal absorption for ramie and guandu, but not for leucaena, perennial soybean and manioc leaves. The use

of the AA profile of the feed to formulate rations must be viewed with caution.

Key Words: amino acids, protein fractions, tropical forages

290 Effects of a slow-release urea product on nitrogen metabolism in lactating Holstein dairy cattle. E. Galo*¹, S.M. Emanuele², C.J. Sniffen³, J.H. White¹, and J.R. Knapp¹, ¹U. of Vermont, ²Land O' Lakes, Inc., ³W.H. Miner Institute.

The purpose of this study was to evaluate the impact of polymer-coated urea (Optigen 1200) on nitrogen retention, rumen microbial growth, and milk production and composition. Slow-release urea has the potential to be incorporated more efficiently than unprotected urea by rumen microorganisms because it is released in synchrony with available carbohydrates. Thus, slow-release urea would be expected to improve efficiency of N utilization and reduce N excretion in dairy cows. Eight cows were offered each of three diets in a randomized cross-over design. Diets consisted of corn silage, mixed grass/legume haylage, alfalfa hay, corn meal, protein, vitamin and mineral supplements and were fed *ad libitum*. Diets 1, 2, and 3 contained 17.9%, 18.1% and 16.4% crude protein (CP) and 0%, 0.77%, and 0.77% Optigen 1200, respectively. Individual feed intakes were measured, and a total fecal and urine collection was conducted. Cows were milked twice daily and the milk sampled for composition and milk urea N analysis. Dry matter intakes averaged 23.5 ± 0.2 kg/d and were not altered by diet ($p > .05$). Also, milk fat and true protein were not altered by diet ($p > .05$) and averaged $3.72 \pm .05\%$ and $3.07 \pm .02\%$, respectively. Milk yields were 35.6, 34.8, and 33.8 kg/d for cows consuming diets 1, 2, and 3 respectively (S.E. = 0.44). Significant differences were observed in N intake and excretion in urine, feces, and milk between dietary treatments. Cows fed diet 3 consumed 11% less N than in treatment 1. Cows fed diet 2 showed the highest excretion of N in urine, and together with treatment 3, the lowest N excretion in feces. N excretion in milk was lower for cows fed diet 3. Calculated N balances were not significantly different between treatments, nor were they significantly different from zero. Efficiency of N capture in milk protein as a function of N intake was higher for animals on treatment 3. Urinary excretion of purine derivatives was used to estimate microbial CP flows to the duodenum, which were similar between diets. Optigen 1200 was not effective at reducing nitrogen excretion by dairy cattle.

Key Words: Nitrogen excretion, Nitrogen balance, Urea

291 Effects of protein supplementation during lactation on milk yield of primiparous Holstein cows. L. A. Torbert*¹, J. G. Linn¹, M. L. Raeth-Knight¹, and K. S. Davis², ¹University of Minnesota, St. Paul, MN, ²Chippewa Valley Ethanol Company, Benson, MN.

Corn distillers solubles (CDS) is a liquid byproduct of the dry corn milling process. A commercial liquid supplement, Alcomp[®], includes CDS with additions of urea, ethyl alcohol, and minerals being added. Corn distillers solubles and Alcomp[®] can be used as protein sources in livestock diets. The objective of this study was to compare feeding CDS with ethyl alcohol, Alcomp[®], and a control SBM-urea protein mix to primiparous cows from 1 to 182 days in milk. Cows were assigned to 1 of 3 dietary treatments by calving date and housed in a tie-stall barn. Feed intake, health, and milk production data were recorded daily. Milk composition was determined biweekly. The diet composition was: 39% corn silage, 12% chopped alfalfa hay, and 49% concentrate, on a dry matter basis. The protein supplements were added to their respective diet treatment to achieve an isonitrogenous diet (17.2% crude protein). Alcomp[®] and CDS were included in their respective diets at 2% of the diet dry matter. Nutrient composition of the diets (dry matter basis) was: 32.1% neutral detergent fiber, 18.2% acid detergent fiber, 3.4% ether extract, and 37.7% nonfibrous carbohydrate. Dry matter intake (DMI), body weight (BW), body condition score (BCS), milk production, and milk components were not different ($P > 0.1$) for the 3 dietary treatments. Body weight average was numerically highest for cows fed Alcomp[®], but not different ($P > 0.05$) than cows fed CDS or control SBM-urea diets.

	Alcomp [®]	CDS	SBM	P-value
N	14	16	14	
DMI, kg/d	20.0	19.5	20.1	0.603
BW, kg	537.3	531.9	507.1	0.098
BCS	2.9	3.0	2.9	0.580
Milk, kg/d	34.3	31.4	33.1	0.134
Fat, kg/d	1.1	1.0	1.0	0.288
Protein, kg/d	1.0	0.9	1.0	0.107
Lactose, kg/d	1.7	1.6	1.7	0.143
Fat, %	3.4	3.3	3.2	
Protein, %	3.0	3.0	3.0	
Lactose, %	4.9	4.9	4.9	

Key Words: Corn distillers solubles, Ethyl alcohol, Dairy

292 Effects of replacing soybean meal with secondary protein nutrients in silage-based diets for growing beef steers. S.R. Freeman^{*1}, M.H. Poore¹, G.B. Huntington¹, and T.F. Middleton², ¹North Carolina State University, Raleigh, NC, ²AgPro Visions, LLC, Kenansville, NC.

Because nutrient recycling is a prime concern for the poultry processing industry, the feeding value of secondary protein nutrients (SPN, preliminary analysis: 92.9% DM, 47.4% CP, 11.5 % ash, 26.7% EE), a byproduct of wastewater treatment, was examined in an 84-day feeding trial. Sixty Angus steers averaging 255 kg were blocked by weight into groups of 12 and fed individually with Calan gates. Two steers per pen were randomly assigned to one of six corn silage-based diets containing graded levels of SPN, giving ten steers per treatment. One treatment group received no supplemental CP and served as a negative control (NC). The other groups received diets containing 0, 25, 50, 75, or 100% of their supplemental CP as SPN with the remaining portion being supplied by soybean meal. This resulted in SPN being 0, 2.5, 5.0, 7.6, and 10.0% of diet dry matter, respectively. The steers were weighed following the removal of feed and water overnight at the beginning and end of the trial. Blood from each animal was sampled two hours after feeding via jugular venipuncture for determination of blood urea nitrogen. Analysis of diets NC, 0, 25, 50, 75, and 100% SPN showed that they contained 7.6, 10.4, 10.4, 11.0, 10.5, and 11.1% CP, respectively, on a dry basis. DMI, ADG, feed:gain ratio, and BUN were all different ($P < .01$) when NC steers were compared to protein-supplemented steers. DMI and ADG responded linearly ($P < .01$) and quadratically ($P < .01$; $P < .02$, respectively) to the replacement of soybean meal with SPN. LS means and SEM for DMI were 5.31, 6.77, 7.33, 6.89, 6.05, and 5.22 ± 0.20 kg/d, respectively for the NC, 0, 25, 50, 75, and 100% SPN diets. ADG were 0.54, 1.26, 1.21, 1.11, 0.94, and 0.66 ± 0.05 kg/d, respectively. Feed:gain and BUN showed a linear relationship ($P < .01$) when SPN replaced soybean meal in the diet. LS means for feed:gain were 10.13, 5.37, 6.12, 6.32, 6.62, and 8.28 ± 0.418 for the respective diets. LS means for BUN levels were 1.12, 5.75, 4.83, 4.24, 3.49, and 3.45 ± 0.363 mM, for the respective diets. These results indicated that SPN shows potential as a protein source in silage-based diets.

Key Words: Protein Supplements, Cattle, Poultry Processing Byproducts

293 Comparative evaluation of the protein values of soybean and rapeseed meals by *in vivo*, *in situ*, and laboratory methods. K.-H. Suedekum^{*1}, D. Nibbe¹, P. Lebzien², H. Steingass³, and H. Spiekens⁴, ¹University of Kiel, Germany, ²Federal Agric. Res. Center, Braunschweig, Germany, ³Hohenheim University, Stuttgart, Germany, ⁴Chamber of Agric. for Rhineland, Bonn, Germany.

The protein values of soybean (SBM) and rapeseed meals (RSM) were compared. Ten samples of RSM were taken from German oil mills and 7 samples of SBM, 4 of which were produced in German oil mills and one each from Brazilian, Argentine and Dutch oil mills. Protein value characteristics (total flow of crude protein [CP] to the duodenum and ruminally undegraded CP [RUP]) were estimated for all 17 meals using the following methods: *in situ*; *in vitro* with ruminal fluid using either the ammonia concentration and gas production or a modification of the first stage of the Tilley and Terry procedure; *in vitro* with a protease from *Streptomyces griseus*; and chemically, using fractionation of the CP based on the Cornell Net Carbohydrate and Protein System. Two samples each of RSM and SBM, which after the first *in vitro* findings

displayed the highest and lowest extent of CP degradation in the rumen, were selected for *in vivo* experiments on dairy cows with duodenal cannula in Braunschweig. The CP contents of RSM ranged from 37.6 to 42.9% of dry matter and those of SBM from 47.5 to 51.8%. The methods used to estimate the RUP content produced uniform results to the effect that the average RUP content of RSM was higher (35% of CP at 0.05 h^{-1} ruminal outflow rate) and that of SBM lower (23%) than previously reported. The experiments performed *in vivo* to determine the total CP flow to the duodenum and the RUP proportions of the four meals yielded hardly plausible values. There was a high compliance with the other methods to the extent that *in vivo* too, the RSM samples displayed a RUP content of the CP at least as high as that of the SBM samples, the classification of 'higher' and 'lower' RUP contents within RSM and SBM could be confirmed, and the overall protein value confirmed the smaller difference between RSM and SBM derived from the laboratory methods. In conclusion, current commodities of RSM are a better protein feed than previously reported.

Key Words: Protein, Degradation, Rumen

294 Estimating the protein value of protected protein feeds by *in situ* and laboratory methods. K.-H. Suedekum^{*}, University of Kiel, Germany.

Several chemical and physical methods have been identified as being efficient in increasing the proportion (% of total crude protein [CP]) of ruminally undegraded feed protein (RUP) of a feedstuff, yet there is a continuing need for methods to be established that allow degree of protein protection from ruminal degradation to be estimated with acceptable expenditure of labor and other costs. In this study, 12 protein feeds (number of samples in brackets: soybean meal [5], soybeans [1], rapeseed meal [4], rapeseed expeller [1], fishmeal [1]), eight of which had been processed by different technical treatments to elevate the proportion of RUP of total CP, were subjected to standardized ruminal *in situ* incubations and four different laboratory methods to estimate the proportion of RUP as one of the key variables that determine the overall protein value of feedstuffs. Laboratory methods included those with and without the use of rumen fluid as an inoculum. Additionally, intestinal digestibilities of the CP and RUP of each feedstuff were estimated using a mobile bag technique. As a general observation, all treated feeds contained more RUP as a proportion of total CP than the four feeds that were only subjected to standard treatments, i.e., extraction of oil and drying ('toasting'). The *in situ* RUP values (0.05 h^{-1} ruminal outflow rate) of the protected protein feeds ranged from 62 to 80% of CP, whereas those of the conventionally treated feeds ranged from 39 to 55%. All laboratory methods were capable to distinguish treated and untreated feeds. Moreover, ranking of feeds in terms of RUP content was similar among laboratory and *in situ* methods. There is a choice of laboratory methods available which appear similarly useful for estimating the RUP of differently treated soybean and rapeseed (meal, seeds, expeller) commodities. Intestinal digestibilities of all but two feedstuffs were greater than 80%, indicating that no major impairment of post-ruminal CP digestion had occurred due to technical treatments of the feedstuffs.

Key Words: Protein, Degradation, Rumen

295 Effects of degradable intake protein on plasma hormone and metabolite concentrations in periparturient beef cows fed native prairie hay. W.W. Dvorak^{*}, M.L. Bauer, G.P. Lardy, and J.S. Caton, North Dakota State University, Fargo.

Thirty-two Angus crossbred cows (670 ± 60 kg initial wt) were used to evaluate effects of degradable intake protein (DIP) supplementation on plasma hormone and metabolite concentrations in beef cows fed native prairie hay. Treatments were control (C; corn-based supplement), urea (U), steep liquor (L), and sunflower meal (S) based supplements. Supplements were fed at 0.280, 0.283, 0.296, and 0.296% of BW during gestation, and 0.589, 0.598, 0.625, and 0.633% of BW during lactation for C, U, L, and S, respectively. Supplements provided similar NE_m during gestation (5.85 Kcal/kg BW) and lactation (12.31 Kcal/kg BW). Control supplements provided 44.0 g DIP/kg DM during gestation and 44.9 g DIP/kg DM during lactation. Protein supplements were formulated to provide 131.6 g DIP/kg DM during gestation and 116.2 g DIP/kg DM during lactation. Prairie hay (7.2% CP) was offered daily in Calan gates for ad libitum consumption. Jugular plasma samples were obtained daily during six 7-d collection periods, for mo 7, 8, and 9

of gestation and mo 1, 2, and 3 of lactation. Samples were composited for each cow within period. Glucose was similar among treatments ($P > 0.10$) and greater ($P < 0.001$) during gestation compared with lactation (4.33 vs 3.88 ± 0.09 mM). NEFA was unaffected by treatment ($P > 0.10$), however NEFA was greater ($P = 0.001$) during gestation compared with lactation (641.51 vs 534.98 ± 40.93 μ Eq/L). There was a period \times treatment interaction ($P = 0.01$) for plasma urea nitrogen (PUN). PUN was higher ($P < 0.05$) for U, L, and S compared to C for

mo 8, 9, 1, 2, and 3. Insulin was similar among treatments and tended to be greater ($P = 0.07$) during lactation compared with gestation (1.51 vs 1.33 ± 0.13 μ IU/mL). These data suggest that DIP supplementation had no effect on blood metabolites, with the exception of PUN which was higher for U, L, and S, and insulin in beef cows consuming native prairie hay.

Key Words: Degradable Intake Protein, Beef Cows, Plasma Metabolites

Sheep Species

296 Pregnancy rates in sheep after traversing the cervix with a new transcervical artificial insemination instrument. M. C. Wulster-Radcliffe¹ and G. S. Lewis², ¹Fort Dodge Animal Health, ²USDA, ARS, U.S. Sheep Experiment Station.

The difficulty of traversing the cervix limits the use of transcervical (TC) AI in sheep. So we developed a new TC AI instrument to help remedy this. The instrument does not affect pregnancy rates through d 3 of pregnancy, but its effects on pregnancy rates after d 3 are not known. Thus, we determined whether the TC AI instrument or using the instrument for TC AI affects pregnancy rate. At 48 to 52 h after removal of progestogenated pessaries and eCG injection, estrus ewes were artificially inseminated with fresh, diluted semen, or each ewe was mated with one of several rams. Experiment 1 had three groups: 1) TC intrauterine AI using the new TC AI instrument + sham intrauterine AI via laparotomy ($n = 29$ ewes); 2) sham TC AI + intrauterine AI via laparotomy using a laparoscopic AI instrument ($n = 29$); and 3) sham TC AI + intrauterine AI via laparotomy using the new TC AI instrument ($n = 30$). Uteri were flushed approximately 14 d after AI. Transcervical intrauterine AI reduced pregnancy rate (17 vs 61% ; [ewes with conceptus \div number ewes] $\times 100$; $P < 0.05$), but intrauterine AI via laparotomy using the TC AI instrument improved pregnancy rate (77 vs 45% ; $P < 0.05$). Experiment 2 had two groups: 1) sham cervical manipulation ($n = 40$) and 2) cervical manipulation via simulated TC AI ($n = 40$). Immediately after treatment, rams were allowed to breed ewes. Experiment 3 had two groups: 1) TC AI ($n = 99$) and 2) laparoscopic AI ($n = 99$). On approximately d 25 and 56 in Exp. 2 and 3, pregnancy was diagnosed ultrasonically. In Exp. 2, the TC AI instrument did not affect pregnancy rate (overall mean = 66%). In Exp. 3, pregnancy rate was less after TC AI (5 vs 45% ; $P < 0.01$). In summary, simulated TC AI before natural service, when large numbers of undiluted sperm cells are deposited, did not affect pregnancy rate, but TC intrauterine AI, with diluted sperm, reduced pregnancy rate. Thus, TC AI with our new TC AI instrument seems to increase sperm numbers required for acceptable pregnancy rates.

Key Words: Artificial Insemination, Cervix, Sheep

297 Reproductive performance of anestrus ewes treated with used-CIDR devices and estrogen. M. Knights*, Q. S. Baptiste, and P. E. Lewis, West Virginia University, Morgantown, West Virginia.

Inadequate amounts or duration of progestogen pre-treatment increase the amount or estrogen required for inducing estrous behavior. Two experiments were conducted to evaluate the effects of estrogen (E) and weaning (W) on reproductive performance of ewes during the non-breeding season (early July) pre-treated with a used-controlled internal drug releasing (CIDR) device. In experiment 1, used CIDR devices (5 days) were applied to ewes for five days before introduction to rams (15:1 ewe to ram ratio). Weaned ($n = 105$) and lactating ewes (2-3 months; $n = 53$) received either 0 (corn oil) or 30 μ g estrogen (estradiol benzoate) 1 day after insert removal/ram introduction (IRRI). Pregnancy diagnosis was conducted by transrectal ultrasonography on d 25-30 after IRRI. Pregnancy rate to the first (PR1; 59.5 and 38.7 %) and second (PR2; 74.7 and 44.8 %) service period, percentage of ewes lambing (81.4 and 44.6 %) and lambing rate (LR; lambs born per ewe exposed, 1.26 .08 and 0.61 .11) was significantly higher in weaned ewes ($P < 0.05$) than in lactating ewes, respectively. LR was higher ($P < 0.05$) in estrogen treated than ewes treated with corn oil only, 1.1 0.1 and 0.8 0.1, respectively. Experiment 2 was similar to experiment 1 except weaned ewes ($N = 106$) were treated with 0, 15 or 30 μ g of E and lactating ewes ($N = 44$) were treated with either 15 or 30 μ g of E. The estrous response, PR1 and percent ewes lambing and LR was significantly higher in weaned ($P < 0.05$) than in lactating ewes 95.5 and 73.6 %; 76.8 and 27.9 %; 82

8 and 27.9 %; 1.25 0.14 and 0.31 16, respectively. Dose of E did not modify any of the variables measured in lactating ewes. In weaned ewes E increased PR1 and percent of ewes lambing ($P < 0.05$). Weaning, and the use of small doses of estrogen can improve reproductive performance of ewes bred out-of-season.

Key Words: Anestrus Ewe, CIDR, Estrogen

298 Effect of dosage of Follicle Stimulating Hormone (FSH), vehicle and time of injection on ovulation rate and prolificacy in anestrus ewes. M. Knights*, Q. S. Baptiste, A. B. Dixon, E. K. Inskeep, and P. E. Lewis, West Virginia University, Morgantown, WV.

The effects of dosage of FSH, vehicle and time of injection on ovulation rate and prolificacy in ewes bred during the anestrus period was evaluated. During May to July, 2000, ewes ($N = 445$) of mixed breeding on 4 farms were treated with a CIDR-G device for 5 days and exposed to raddled rams upon removal of the insert. A 3 X 2 X 2 factorial arrangement of treatments was used to test the main effects of dosage of FSH (Folltropin; 0, 42 or 68 mg NIH-FSH-P1), vehicle (saline/propylene glycol 1:4, v:v (PGL), or 50 % polyvinylpyrrolidone K 29-32, (PVP)) and time of injection (12 or 36 h before CIDR withdrawal/ram introduction, IRRI, d0). Growth and development of follicles were monitored by transrectal ultrasonography in a randomly selected group of ewes ($n = 4$ /treatment group) at injection of FSH, at IRRI, and on days 1, 2, and 3 post IRRI. All ewes marked by rams were examined by transrectal ultrasonography on Days 10 to 14 and 26 to 31 to determine ovulation rate and pregnancy, respectively. Ewes were reexamined 20 to 25 days later (Days 46 to 51 after IRRI) to detect pregnancies from the second service period. The number of small follicles (< 4 mm) did not change over the scanning period and was not affected by any treatment. The number of medium follicles (5 mm) declined ($P < 0.05$) between FSH injection (1.5 0.2) and Days 1 (0.8 0.2), 2 (0.9 0.2) and 3 (0.5 0.2). The number of large follicles (> 5 mm) increased from FSH injection (0.6 0.3) to IRRI (1.4 0.3; $P < 0.05$), and increased further between IRRI and Day1 (2.3 0.3; $P < 0.05$), then declined between Days 1 and 3 (0.6 0.3; $P < 0.05$). The number of large follicles was greater in ewes given 68 (1.9 0.2; $P < 0.01$) or 42 (1.5 0.2; $P < 0.05$) mg of FSH than in ewes not receiving FSH (0.8 0.3). Mean ovulation rate was (2.12 0.05) and was increased by increasing dosages of FSH when given 12 but not 36 h before CIDR removal (Dosage X Time, $P < 0.05$). Fertility variables (estrous response, conception rate, percentage of ewes lambing or prolificacy) was not affected by treatment. Dosages of FSH previously shown to induce superovulation in a portion of ewes during the breeding season failed to increase ovulation rate in different time and vehicle combinations during anestrus.

Key Words: Ovulation rate, Anestrus, FSH

299 Libido and biological parameters of mature Awassi, Awassi x Charollais and Awassi x Romanov rams. R. T. Kridli¹, M. Momani Shaker², A. Y. Abdullah¹, and I. Sada², ¹Jordan University of Science and Technology, Irbid/Jordan, ²Czech University of Agriculture, Prague/Czech Republic.

This study was conducted in September to compare sexual performance and biological parameters of 2-yr-old, sexually nave rams of different genotypes. Charollais and Romanov rams were imported to Jordan to improve meat production and fertility of Awassi sheep. Four rams of each Awassi (A), F1 Awassi x Charollais (AC) and F1 Awassi x Romanov (AR) genotype were subjected to sexual performance tests by being individually exposed to two estrous Awassi ewes for five 20-min periods, each 2 d apart. Body weight, body condition score (BCS) and

scrotal circumference (SC) were recorded every 2 wk for 2 mon. Rams of the AC genotype had greater BW ($P < 0.01$) than AR and A (78.7, 71.6, and 70.3 kg, respectively). Additionally, AC rams had greater SC ($P < 0.01$) than A rams and better BCS ($P < 0.01$) than AR rams. Significant correlations existed ($P < 0.001$) between BW and BCS ($r = 0.67$), BW and SC ($r = 0.79$) and between BCS and SC ($r = 0.59$). Similar leg-kicking bouts ($P > 0.05$) were observed in A and AC rams, while A rams engaged in more leg-kicking bouts ($P < 0.01$) than AR rams. Mounting frequency, raising the fat tail of females and ejaculation rate were greater ($P < 0.005$) in A than AC and AR rams. No genotype \times test day interactions were detected ($P > 0.05$), however, test day influenced ($P = 0.05$) ejaculation rate. Awassi rams have more libido and showed better abilities to mate with fat-tailed females than AC and AR rams. The performance of AC and AR rams may have been improved had they been mated with docked females.

Key Words: Sheep, Sexual performance, Behavior

300 Breeding scheme for “merino branco” sheep ram lambs selection index. José Avó* and José Castro, *Universidade de Évora*.

“Merino Branco” sheep’ breed is the most important of portuguese flock, and its main production is meat. The animals are well adapted to the range conditions, in the south of Portugal, showing a great variability in economical traits. In an Open Nucleus scheme, the ewes are selected by an index and the ram lambs by another index. To built the selection index for ram lambs, we used the traits: average daily gain during performance test (AVG), adjusted for individual weight at the beginning of the test, average of three depth measures of “longissimus dorsi” at 3th lumbar vertebra and 13th rib (LDD), average of three measures of subcutaneous fat above “longissimus dorsi” (FAD), estimated carcass lean weight (CLW) and estimated carcass fat weight (CFW), at 34 Kg of live weight. We used phenotypic standard deviations and phenotypic correlations between traits from collected data and the heritabilities and genetic correlation between traits utilised by Simm and Dingwall (1987). We calculated the economic weights for (CLW) and (CFW) with economic penalty for fat and economic gain for lean. To estimate lean and fat weights in the carcasses we used regression equations based on ultrasonic measurements. We obtained the index equation: $I = 2.85AVG - 30.841LDD - 196.85FAD + 334.885CLW - 647.72CFW$ with a correlation between the index and the individual genetic value $r_{Ti} = 178.5$, a standard deviation of 178.5 and a coefficient of determination $CD = 60\%$. The carcass lean weight (CLW) is responsible for 93.4% of selection response and carcass fat weight (CFW) is only responsible for 6.6%. The other traits: (AVG), (LDD) and (FAD) don’t contribute directly for selection response, but may stay in the index, because they show a selection response according the objectives of selection. For each standard deviation of the index above the mean of the group of selection candidates, we expect to have an annual genetic progress of 6.8 g on (AVG), 0.09 cm increasing on (LDD), -0.08 mm on (FAD), 0.214 Kg on (CLW) and -0.024 Kg on (CFW).

Key Words: ram lambs, index, genetic progress

301 An analysis of lamb price differences for West Virginia producers. D Singh*, M Knights, and D Smith, *West Virginia University, Morgantown, WV*.

The seasonal nature of reproduction in sheep results in annual production cycles that might influence supply of and prices received for lamb. To characterize the marketing environment in which WV producers operate data collected over a 7 year period (1994-2000) from 13 markets in WV was analyzed to determine the effect of year (Y), month (M), market (Ma) and lamb category (Cat) on prices and number sold. The mean price received over this period was \$1.70 0.33 /kg. Prices were significantly affected by Y ($P < 0.0001$) and was lowest in 1994 (\$1.46 0.01/kg) increased in each year until 1997 (\$1.84 0.01/kg) when prices peaked. Prices fell by \$0.24/kg in 1998 and 1999 before rising to 1997 levels in 2000 ($P < 0.05$). Prices varied significantly with M ($P < 0.001$). The highest prices ($P < 0.05$) were obtained in May (\$1.89 0.02/kg) followed by April and June (\$1.84 0.05/kg), and the lowest prices were received in August-October (\$1.55-1.60/kg). Lambs in Cat 5 (feeder lambs 32-39 kgs) and 6 (feeder lambs < 32 kgs) received the highest prices ($P < 0.05$; \$1.75 0.01/kg) while the lowest prices were received by lambs in Cat 3 (slaughter lambs < 39 kgs) and 4 (slaughter lambs 39-45 kgs) (\$1.50-1.60/kg). Prices were also significantly affected by market

($P < 0.01$), independent of number of lambs available for sale. The number of lamb sold was greatest in 1994 ($P < 0.05$; 15, 887) declined in 1995 but remained constant until 1999, then declined to the lowest levels observed in 2000 (10, 210). A peak in supply of lamb occurred in September ($P < 0.05$; 2161) and was consistently higher in August, October and November than other months ($P < 0.05$). Supply of lamb was lowest in the first 4 months of the year ($P < 0.05$; 218-249). Most lambs were sold as Cat 1 (slaughter lambs 45-59 kgs) ($P < 0.05$) followed by lambs in Cat 2 (slaughter lambs 39-45 kgs) and 4 (feeder lambs 39-45 kgs). The fewest lambs were sold as Cat 3 (slaughter lambs < 39 kgs; $P < 0.05$). The number of lambs sold also varied significantly with market ($P < 0.001$). The results indicate annual and monthly price cycles in the lamb market exist in WV. Higher prices might be obtained by orienting production towards months when prices are highest/supply lowest, by marketing lambs based on weight and category and by selecting among available markets.

Key Words: Lamb, Price, Supply

302 Growth and immune status of orphaned lambs fed milk replacer and supplemented with fish oil or safflower oil. G. S. Lewis*¹ and M. C. Wulster-Radcliffe², ¹USDA, ARS, U.S. Sheep Experiment Station, ²Fort Dodge Animal Health.

Because of recent claims that various oils can enhance immune status, the immunological effects of supplementing orphaned milk-fed lambs with oils rich in long-chain n-3 (i.e., fish oil) and n-6 (i.e., safflower oil) PUFA were investigated. From d 1 to 28 of age, lambs had ad libitum access to a commercial milk replacer, via three-nippled buckets. From d 7 to 28 of age, lambs also received one of three treatments: 1 g twice daily of either soybean oil (control), fish oil, or safflower oil per os in a gelatin capsule ($n = 60$ pens; 20 pens/treatment; one ewe and one ram with similar initial body weights/pen). On d 7, 14, 21, and 28 of age, all lambs were weighed, and jugular blood samples were collected from ram lambs. Lymphocyte proliferation in vitro, differential white blood cell (WBC) counts, and ADG were quantified. Treatment did not affect basal or mitogen-stimulated lymphocyte proliferation or ADG (445 g/pen). However, basal and mitogen-stimulated lymphocyte proliferation increased ($P < 0.05$) over time, indicating that immune competence increased during the experiment. Compared with soybean oil, fish oil and safflower oil decreased ($P < 0.05$; 43 vs 37; SEM = 1.6) the percentage of neutrophils and increased ($P < 0.05$; 47 vs 52; SEM = 1.9) the percentage of lymphocytes per 100 circulating WBC. Lymphocytes per 100 circulating WBC increased ($P < 0.05$) over time. Even though neither fish oil nor safflower oil affected lamb growth (i.e., ADG) or lymphocyte proliferation, both oils altered WBC distributions. That is, both oils increased the proportion of lymphocytes and decreased the proportion of neutrophils in circulation. In our studies with adult sheep, increased proportions of circulating lymphocytes have been associated with an increased ability to prevent infections after intrauterine inoculation with infectious bacteria. Thus, fish oil and safflower oil supplementation may enhance the ability of milk-fed lambs to control infectious bacteria, although that possibility was not tested in this experiment.

Key Words: Lamb, Immune Response, Milk Substitutes

303 Effect of age and some physiological state on seasonal wool growth and fiber diameter of Arabi breed sheep in south west of Iran. Najafgholi Dabiri*, *Shahid Chamran University, Ahwaz/Iran*.

The effects of age and physiological state (pregnancy/lactating) of ewes on seasonal wool growth rate (WGR) and fiber diameter (FD) were studied for 2 years. In 1995, 48 Arabi ewes from the sheep flock of Ramin Agriculture Faculty, Shahid Chamran University in the south west of Iran were allocated in this experiment. Ewes divided into 2 equal groups of young (less than 3 years) and old (more than 3 years), (24/group). Each of these aged groups (balanced for live weight, and time of previous lambing) randomly divided into 2 equal group of dry and wet (pregnant/lactating) ewes (12/subgroup). Wet group of ewes were lambed in the early of Autumn. For a period of 2 years seasonal clean WGR and FD measured from midside patches taken every 3 months (at the end of each season). At the same time ewe live weight (LW) and body condition score (BCS) were measured. Annual fleece weight (AFW) of ewes were also measured for 2 experimental years. Ewe LW were significantly ($P < 0.01$) lower for young ewes than for old ewes (49.60 ± 0.43 VS 53.50 ± 0.46 Kg). The same trend was found for ewe BCS (2.70 ± 0.05 VS

2.9±0.05). Clean WGR was significantly greater in young ewes than in old ewes (0.71±0.02 VS 0.62±0.02 mg/cm²/d, P<0.01). The same trend was also found for AFW (2.65±0.07 VS 2.49±0.07 Kg, P<0.01). Dry ewes had significantly (P<0.01) greater LW (52.7±0.42 VS 50.40±0.47 Kg), BCS (3.3±0.05 VS 2.2±0.05), clean WGR (0.77±0.02 VS 0.60±0.02 mg/cm²/d), FD (34.6±0.18 VS 34.0±0.21um) and AFW (2.8±0.07 VS 2.3±0.07 Kg) than comparative wet ewes. Dry ewes were compared with wet ewes in the four season of year. The measured traits particularly ewe LW and WGR were not affected by season of year in dry ewes, but these traits were lowest (P<0.01) for wet ewes during Autumn season. The lack of effect of season on dry ewes, but highly affected of wet ewes by Autumn indicates that WGR of this breed of sheep is not influenced directly by season, and the differences of WGR between Autumn and other seasons in wet ewes depends the effect of their lactating period not seasonal effect.

Key Words: Seasonal wool growth, Fiber diameter, Ewe age, Dry (non pregnant) ewes, Wet (pregnant/lactating) ewes, Fleece weight

304 Growth and carcass characteristics of Awassi, Awassi x Romanov and Awassi x Charollais ram lambs fed different planes of nutrition. A. Y. Abdullah*¹, M. Mo-mani Shaker², R. T. Kridli¹, and I. Sada², ¹Jordan University of Science and Technology, Irbid/Jordan, ²Czech University of Agriculture, Prague/Czech Republic.

Thirty newly weaned Awassi (A), F1 Awassi x Romanov (AR) and F1 Awassi x Charollais (AC) ram lambs of similar BW (23.9 5.8 kg) were

used to evaluate growth and carcass performance on two planes of nutrition. Animals of all genotypes were randomly assigned to receive ad lib diet (TRT1) or 75% of the feed offered to TRT1 (TRT2) following a 15-d adjustment period. Animals were fed the diets for a period of 119 days. The two diets were isocaloric and isonitrogenous (16% CP and 11 MJ ME). Fifteen animals were slaughtered at the end of the experiment for body and carcass evaluation. No treatment by genotype interactions were detected (P > 0.05) in any of the measured parameters. Total feed consumption was higher (P < 0.001) in TRT1 than TRT2 animals while feed efficiency (kg feed/kg gain) was better (P < 0.05) in TRT2 animals (7.8 and 6.90.3 kg feed/kg gain for TRT1 and TRT2, respectively). Other growth parameters were not influenced by treatment (P > 0.05). Genotype, however, significantly affected final weight (P < 0.01), total gain (P < 0.001), ADG (P < 0.001), and feed efficiency (P < 0.01). Average daily gain was 198 8.3, 152.0 10.9 and 147 8.7 g/d for AR, AC and A ram lambs, respectively. Feed efficiency was 6.4 0.3, 7.8 0.4 and 7.9 0.3 kg feed/ kg gain for AR, AC and A ram lambs, respectively. Dressing percentage was influenced (P < 0.05) by genotype but not by plane of nutrition (P > 0.05). Awassi and AC had higher dressing % compared with AR ram lambs (52.1 0.9, 50.9 1.0 and 47.6 0.9 % for A, AC and AR ram lambs, respectively). Meat: bone ratio was not affected (P > 0.05) by genotype nor by plane of nutrition. In conclusion, plane of nutrition did not influence growth and carcass characteristics except for feed efficiency. Growth performance was better while dressing % was lower in AR than AC and A ram lambs due to the presence of more tail fat in A and AC.

Key Words: Growth, Sheep, Nutrition

Contemporary and Emerging Issues Homeland Security and Animal Agriculture

305 Current thought on bioterrorism: The threat, preparedness and response. D.R. Franz*, *Southern Research Institute.*

In just the last 5 years, the public has learned of the threat of biological terrorism in America. Why biological terrorism? Why now? What is the threat, what are our vulnerabilities and how have they changed since the end of the cold war? How have international political change and biotechnological advances altered the threat? What are the technical issues for the proliferator and for the defense? What assumptions can we make about intent to harm in the post-9/11 world? A biological terrorist attack could have many faces. It might be delivered through inhaled aerosol particles, contaminated food or water, or introduced by an infected insect or animal host. It could affect humans, animals, or both. It could be based on any of hundreds of bacterial, viral or toxin agents. It might occur in any of our cities—or in our agricultural communities—at any time. Although the likelihood of occurrence is probably low, the potential for harm—and for terror—is enormous. These issues and the fundamentals of preparedness and response will be examined to put agro-terrorism in context within the broader view.

Key Words: Bioterrorism, Threat, Preparedness

306 The agroterror threat: An overview of issues and potential impacts. J. Jaax*, *Kansas State University, Manhattan KS.*

The presentation will outline a broad perspective of agroterrorism, ranging from the genesis and nature of the threat, through possible impacts

upon our national interests. Key themes will be discussion of factors contributing to agricultural vulnerabilities, examination of the devastating potential economic implications of agroterrorism, and understanding possible motivations of perpetrators. Additionally, factors that might make an agroterror event possible if not probable will be examined. Finally, some correlations and lessons learned from key past emerging disease events will be briefly discussed.

Key Words: Agroterrorism

307 Security of the food supply. G. Clarke*¹, ¹*Agriculture & Agri-Food Canada/Canadian Food Inspection Agency.*

Security of the food supply is an important issue of homeland security due to the possibility of sabotage and disruption that could occur. Steps that the food industry and government organizations, from the processor through to retail, could or are taking to deter and try to prevent incidents from occurring together with the important elements and principles involved are described. Mechanisms currently in place plus recommendations for future action to minimize disruption should an incident occur, both economic disruption and threats to public health, are also discussed.

Key Words: Security, Food

Dairy Foods Milk Protein Gelation and Their Mixtures with Polysaccharides

308 Protein-polysaccharide interactions in emulsions and gelled emulsions. Eric Dickinson*, *University of Leeds, Leeds, United Kingdom.*

Proteins and polysaccharides are the two main classes of functional macromolecules involved in controlling stability, shelf-life and texture of dairy foods. Both act as structure-making and gelling agents in multiphase colloidal systems, and as stabilizers of oil-in-water emulsions. The action of milk proteins is predominantly through the for-

mation of a macromolecular barrier at the oil/water interface. This protects droplets from sticking together by a combination of steric and electrostatic stabilization mechanisms. The action of polysaccharides (hydrocolloids) typically involves the formation of a polymeric barrier in the aqueous phase between droplets. Polysaccharides like pectin and carrageenan can affect the stability and rheology of milk protein-based emulsions in several ways. The main factors are (i) the nature of the adsorbed milk protein (caseinate, whey protein, micellar casein, etc.), (ii) the nature of the polysaccharide (degree of methoxylation of

pectin, type of carrageenan), (iii) the relative proportions of protein and polysaccharides, (iv) the solution conditions (pH, ionic strength), (v) the processing conditions (heating, high pressure treatment, acidification, etc.), and (vi) the protein#polysaccharide interaction (attractive/repulsive, weak/strong). An attractive protein#polysaccharide interaction may lead to improved stabilization of a protein-based emulsion by formation of a secondary adsorbed layer or by strengthening interparticle interactions in emulsion gel networks. But, at low protein/polysaccharide ratios, the attractive protein#polysaccharide interaction may cause loss of stability through bridging flocculation. A repulsive protein#polysaccharide interaction implies thermodynamic incompatibility between the two biopolymers in mixed solutions at high concentrations, and flocculation and enhanced creaming of the corresponding emulsions due to depletion flocculation.

Key Words: Emulsions, Protein-polysaccharide interactions, Colloid stability

309 Milk protein-polysaccharide interactions. Cornelis G De Kruif^{*1,2}, ¹NIZO food research, P.O. Box 20, 6710 BA Ede, The Netherlands, ²Van 't Hoff Laboratory for Physical and Colloid Chemistry, Debye Institute, University of Utrecht.

The interaction of polysaccharides and proteins is of great relevance to food products, as, for instance in the stabilisation of acidified milk products by pectin. The functionality of carrageenan and other polysaccharides in food products depends on the interaction with the proteins, be it repulsive or be it attractive. Proteins are often present on the surface of emulsion droplets. Also the ropiness and structure of yoghurt products depends on the presence of exo-polysaccharides which are produced by the lactic acid bacteria. In this contribution I will discuss the various types of interaction of proteins and polysaccharides. On mixing polysaccharides and proteins three situations may be distinguished, just as in classical polymer theory as developed by Flory. Firstly, the protein and polysaccharide may mix, which is the less probable situation. Secondly, the protein-polysaccharide mixture may have an attractive interaction. Then the mixtures tend to phase separate into a (bio) polymer rich and a (bio) polymer poor phase. A special case occurs if the protein and the polysaccharide form a so-called (complex) coacervate, due to electrostatic attractions. The coacervation mechanism is used for encapsulation purposes. I will discuss the system with gum Arabic and whey proteins. The third and most common situation occurs if the protein and the polysaccharide tend to demix or phase separate. Adding too much of a thickener to a product may lead to adverse effects of increased instability. As an example I will discuss the interaction of exo-polysaccharides as produced by lactic acid bacteria, guar and carrageenan with casein micelles and whey proteins.

- R. Tuinier, C. Rolin, C.G. de Kruif. Electrosorption of pectin onto casein micelles. *Biomacromolecules* 2002 - M.E. van Marle, D. van den Ende, C.G. de Kruif J. Mellema. Steady-shear viscosity of stirred yoghurts with varying ropiness. *J Rheology* 43, 1999, 1643-1662 - R. Tuinier, J.K.G Dhont C.G. de Kruif Depletion induced phase separation of aggregated whey proteins. *Langmuir* 16, 2000, 1-11 - R. Tuinier, C.G. de Kruif Phase behaviour of casein micelles/exocellular polysaccharide mixtures: experiment and theory. *J. Chem. Phys.*, 110 (1999) 9296

Key Words: Milk protein, polysaccharides, casein micelles

310 Gelation of globular proteins: Current and future perspectives. A. H. Clark^{*1}, W. S. Gosal², and S. B. Ross-Murphy², ¹Unilever Research & Development Colworth, Bedford, U.K., ²King's College, London, U.K.

The gelation of globular protein solutions, particularly by heat, has long been a subject of both practical and academic interest. From a scientific point of view the phenomenon is now fairly well understood, but even today, important details remain unclear such as the exact molecular processes which occur during network building, and the best way to describe these theoretically. There are also issues surrounding the formation of highly heterogeneous gels, i.e. when some form of phase separation is involved; and the whole area of linking failure and water-holding properties to gel microstructure remains highly empirical. The present talk considers what is known about the structural features of heat-set globular protein gels from the molecular level upwards. It will also examine the kinetic description of network building, highlighting the cure curve from mechanical spectroscopy, and its specific features such as gel times and long-time limiting modulus values. Models for

cure curve behaviour will be described, and used to confront real experimental data. The idea of a critical gel concentration will be discussed in relation to its possible origins and significance. Comparison will be made between heat-set gel systems, and their properties, and globular protein gelation by other methods such as alcohol addition. Limitations in current knowledge will be identified, and consideration given to the direction that future research might take in this area.

Key Words: Globular Proteins, Gelation, Structural and Mechanical Properties

311 Mixed gels from whey proteins and polysaccharides. Sylvie L. Turgeon^{*}, Maude Girard, Martin Beaulieu, and Nakhle Haddad, *Dairy Research Centre, Laval University.*

Whey proteins (WP) are well known functional and nutritional ingredients. WP are nowadays incorporated in many foods and the presence of other biopolymers like polysaccharides influence their properties and the resulting mixed solution and gel behavior. Depending on the aqueous environmental conditions (pH, ionic strength, cations, etc.) and the structural characteristics of the biopolymers (charge, molecular weight, conformation, etc.) the overall protein-polysaccharide interaction may be attractive or repulsive. Repulsive interactions are non specific and the system will tend towards phase separation. Attractive interactions will result in associative phase separation by complex formation. Solutions and gels made of beta-lactoglobulin or whey protein isolate mixed with pectin or alginate have been studied using potentiometric frontal analysis continuous capillary electrophoresis, isothermal titration calorimetry, rheological small and large deformation techniques and confocal microscopy. The type of interactions involved in gel structure has been investigated using different temperatures, ionic strengths and dissociating solutions. Depending on the type of interactions and the nature of mixed gels (coupled or phase-separated gels), heating and cooling conditions were critical for gel structure and rheological properties. The relation between behaviors in diluted solutions and gels will be presented.

Key Words: whey proteins, gel properties, polysaccharides

312 Different molecular ways to form filamentous and random aggregate gels. Muriel Subirade^{*1}, Gabriel Remondetto¹, and Thierry Lefevre¹, ¹Centre STELA/INAF/Universite Laval.

Whey proteins are extensively used in food processing because of their high nutritional value and their contribution to food texture (i.e., particularly gel properties). As for many globular proteins, gels of varying physical properties can be formed by modifying environmental conditions, such as temperature, pH, ionic strength, etc. The differences in the physical characteristics are related to the type of gel formed. These structures are divided into two distinct types -i.e., linear and random aggregation. To optimize the use of whey proteins as functional ingredients in food, more insight into the gelling mechanisms is needed. The aim of this presentation is to provide information on the molecular mechanisms and forces involved in the formation of these different gels, in relation to the conditions used.

Key Words: filamentous and random aggregated gels, molecular mechanisms, FTIR spectroscopy

Growth and Development and Ruminant Nutrition

Heifer Growth and Mammary Gland Development

313 Growth and subsequent productivity of dairy replacements. M. E. Van Amburgh*, *Cornell University, Ithaca, NY.*

The growth of heifers for dairy replacement purposes is unique in that the animal's potential for growth is never achieved nor desired due to the well-documented effects on future productivity. To optimize production, growth rates are chosen that minimize fat deposition, and based on extensive research data, are designed to minimize deleterious effects on pre-pubertal mammary development. One of the concerns related to dairy heifer growth is a thorough understanding of the net tissue requirements for a particular rate of gain. The body composition database currently available and in use contains little Holstein and no Jersey breed information and does not represent slaughter data for cattle less than 250 kg body weight. This is a critical deficiency if concerns over absolute growth rates and mammary development during the pre-pubertal period are relevant to discussions of future productivity. Recent studies have illuminated differences among the predicted composition of slaughter animals and the observed values. The growth model published in the Nutrient Requirements for Dairy Cattle, 7th ed., requires the inputting of the mature size of the cattle to generate energy and protein requirements. The use of this input factor across diverse dairy cattle populations increases the precision with which energy and protein requirements are met and might help explain variation in subsequent milk yield based on composition of the gain at a particular stage of development. In addition, few data sets exist that describe both the development of the mammary gland at puberty and the associated milk response. Four data sets will be discussed that allow for a critical examination of this relationship. Further, data generated from calves demonstrated significant changes in body composition based on diet composition, suggesting the potential for long-term carry-over effects on body composition. In addition, data are available that indicate level of nutrient intake and growth rate in early life affects lactation milk yield. The overall objective of this paper will be to integrate body composition, nutrient requirements and supply, and mammary development on milk yield with additional reference to early life effects.

Key Words: Heifer, Body composition, Growth

314 Effect of plasma protein and form of diet in meal fed calves. J.A. Booth*¹, J.D. Quigley², and T.M. Wolfe², ¹Iowa State University, ²American Protein Company.

Calves fed starter rations containing highly fermentable carbohydrates often experience dramatic changes in rumen and blood metabolites. It is not clear if these changes affect the immune competence of these animals. Our objective was to compare the performance and immune response of calves fed two different forms of starter rations (coarse vs. finely ground) supplemented with either spray-dried animal plasma (SDAP) or an isonitrogenous combination of spray-dried red blood cells and whey protein concentrate (RBCW). Holstein bull calves ($n = 28$) were randomly assigned to one of four treatments in a replicated 4×4 Latin square design. Treatments consisted of coarse or finely ground commercial calf starter supplemented with either 5% SDAP or 5% RBCW. The trial consisted of 4 two-week treatment periods and a 21-day pre-experimental period. During days 8-14 of each period, calves were limited to 90% of calculated average intake of the treatment diets from days 1-6. Body weight was measured on the last day of each treatment period. At the same time, jugular blood samples were also taken prior to (0 hour) and post feeding (8 hours) and analyzed for urea N, NEFA, BHBA, WBC, RBC, hemoglobin, and hematocrit. Plasma urea N increased at 0 and 8 hours in the calves fed SDAP ($P < 0.01$ and $P < 0.04$ respectively) and also in the calves fed the finely ground diets ($P < 0.07$ and $P < 0.03$ respectively). Concentrations of BHBA and NEFA were not affected by treatment. Concentrations of RBC were higher at 0 and 8 hours in calves fed SDAP ($P < 0.05$ and $P < 0.16$ respectively). Hemoglobin concentrations ($P < 0.14$) and hematocrit ($P < 0.13$) tended to be higher in calves fed SDAP at 0 hours. Concentrations of WBC were not affected by treatment, yet populations of specific white blood cells differed. This data suggests that the form of diet presented and the addition of spray dried animal plasma does influence blood metabolites associated with rumen function.

Key Words: Dairy Calves, Rumen Function, Spray Dried Animal Protein

315 Performance of Jersey bull calves fed whole milk or milk replacers with varying fat/protein ratios. S. S. Bascom*, R. E. James, M. L. McGilliard, and E. P. Hovingh, *Virginia Polytechnic Institute and State University.*

The objective was to compare growth, feed efficiency, and health of Jersey bull calves fed diets with varying ratios of fat and CP. Week old Jersey bull calves ($n=33$) were assigned to one of four diets. Calves assigned to diet MM received a 21%CP:21% fat milk replacer(MR) fed at 15% of body weight. Calves assigned to diet HH ($n=8$) received a 27% CP:33% fat MR. Calves assigned to diet HL ($n=9$) received a 29% CP:16% fat MR. Calves assigned to diet JM ($n=8$) received whole milk (4.7% fat:3.2% true protein). Calves on diets HH, HL, and JM were fed 180g/day CP to support 650g ADG. Calves were fed three times daily for four weeks. Weight, hip height, wither height, heart girth, body length, were measured weekly. Gains averaged 0.110 ± 0.0335 g/d, 0.357 ± 0.034 g/d, 0.368 ± 0.033 g/d, 0.496 ± 0.034 g/d for diets MM, HH, HL, and JM. Hip height, heart girth, wither height, and body length were not different. Average number of days scouring/calf were 2.1, 6.2, 6.6, and 4.4, for MM, HH, HL, and JM. The average number of daily respiratory scores (1=healthy, 2=nasal discharge, 3= fever) greater than 2 per calf were 1.2, 0.1, 0.6, 0.3, respectively for MM, HH, HL, and JM. Feed efficiencies (g of gain/g of DM) were 0.26 ± 0.039 , 0.5 ± 0.039 , 0.52 ± 0.038 , 0.75 ± 0.040 , for MM, HH, HL, and JM. Calves fed MM had lower feed efficiency and calves fed JM had greater feed efficiency than calves fed other diets. Calves fed HH and HL had similar feed efficiencies. ADG and feed efficiency were greater for calves fed JM than MM, HH, or HL. Calves fed MM had the fewest scour days but also had lower ADG, feed efficiency, and more respiratory problems than the calves fed HH, HL, or JM. Performance of calves fed HH and HL was similar. Feeding 180g of CP in the MR was beneficial to calf performance when compared to diet MM.

Key Words: Calves, Milk, Milk Replacer

316 Contemporary issues in applied dairy replacement heifer research. P.C. Hoffman*¹, ¹University of Wisconsin, Madison.

The principal objective of rearing dairy replacement heifers is to minimize rearing cost while optimizing heifer growth and future lactation performance. One management strategy that reduces heifer rearing cost is to increase the rate of heifer growth thereby reducing days on feed and age at first calving. Complexities and dynamics of accelerating heifer growth have been the focus of replacement heifer research. Studies have investigated prepubertal growth regimes, mammary development, optimum growth, intensified calf feeding and early calving strategies. Accelerating calf and heifer growth and its biological idiosyncrasies can be academically consumptive yet is not the only management strategy available to achieve the principal objective of rearing replacement heifers. In field application, restrictions are made on dairy heifer growth. Despite restrictions, management strategies can still be employed to minimize rearing cost and/or optimize future lactation performance. For example, research data from beef feedlots suggest precision feeding as compared to ad libitum feeding results in modest improvements in feed efficiency (> 10 to 15%). Similarly, new intensified calf feeding strategies have been demonstrated to improve calf feed efficiency (20 to 40%). Feed efficiency of dairy replacement heifers is commonly overlooked in both application and research. Recent research has also defined protein requirements of dairy heifers and can be applied avoiding necessity for luxury protein feeding. Research has identified that dairy replacement heifer diets are over-supplemented with minerals as compared to NRC, 2001 requirements. In addition, plant genetics developed for lactating dairy cows may not be suitable to optimize replacement heifer nutrition. Finally, new NRC, 2001 requirements improve the capability to target feed heifers, and more ably define dietary energy and protein requirements which likewise can improve precision in rearing dairy heifers. This paper will explore current and future research that may aid decreasing dairy heifer rearing cost and improve future lactation performance without inference to altering heifer growth.

Key Words: Heifers, Growth, Feed Efficiency

317 Evaluation of the Hipometer® and Heart Girth tape for estimating body weight in Holstein heifers. K.E. Leslie^{*1}, M. Wallace¹, R.T. Dingwell¹, C. Leslie¹, C.J. McLaren¹, and B. Dow², ¹University of Guelph, Department of Population Medicine, ²University of Guelph, Kemptville College.

Monitoring growth of dairy replacement heifers is useful to ensure that a goal of average age at first calving of approximately 24 months can be met. Standard growth curves have been established. Heart Girth Tapes are available to estimate body weight. The Hipometer® is a new tool for weight estimation using external width between the greater trochanters of the left and right femurs. Holstein heifers at four research herds were used, ranging in age from birth to immediately prior to calving. The objective of this project was to evaluate the Hipometer® and the Tape for estimating body weight of Holstein heifers compared to the actual weight recorded by an electronic scale. At each weighing event, each heifer was weighed by all three methods. The Hipometer® and Tape were each compared to the actual scale weight by calculating the age-adjusted Pearson's Correlation Coefficient (R^2). In addition, the sensitivity and specificity for the ability of each method to determine if the growth rate was normal were calculated using the scale weight and the standard Pennsylvania Growth Curve (± 1 standard deviation) as the gold standard. Data was used from 242 heifer measurements. There was no significant difference in the average weight of animals recorded between the three methods. The R^2 values for the correlation of scale weight and the Hipometer® and Tape were 0.88 and 0.91, respectively. These heifers had a mean age of 10.1 ± 4.5 months of age and weighed an average 277.9 ± 125.9 (55-714) kilograms. The sensitivity and specificity of the Hipometer® and Tape for correctly classifying a heifer as being in the normal range were 89.7% and 75.0%, and 84.6% and 56.7%, respectively. In conclusion, the Hipometer® is an easy, rapid method of estimating the body weight of heifers. The Hipometer® has similar R^2 , sensitivity and specificity to the Heart Girth Tape for estimating the weight of Holstein heifers.

Key Words: Body weight, Hipometer®, Holstein Heifers

318 Increasing energy and protein intake of Holstein heifer calves increases mammary development. E.G. Brown*, M.J. VandeHaar, K.M. Daniels, J.S. Liesman, L.T. Chapin, and M.S. Weber Nielsen, Michigan State University, East Lansing, Michigan.

The objective of this study was to determine if increased energy and protein intake decreases mammary development in Holstein heifers less than 4 mo of age. At 2 wk of age, purchased heifer calves ($n=42$) were assigned randomly to 1 of 4 treatments in a 2 X 2 factorial arrangement with 2 levels of energy intake (low, L; high, H) and with 2 periods of development (2 to 8 wk of age; 8 to 14 wk of age). Treatments were LL, LH, HL, and HH, indicating energy intake during the first and second periods. The L diet was standard milk replacer (20% CP, 20% fat) at 10% of body weight (BW) and an 18% CP grain mix at restricted intake to promote 400 g of BW gain/d. The H diet was a high protein milk replacer (28.5% CP, 15% fat) at 15% of BW and a 22% CP grain mix fed ad libitum. Calves were gradually weaned from milk replacer by 7 wk and slaughtered at 14 wk. In period 1, gains averaged 379 g/d for L calves and 666 g/d for H calves. In period 2, gains averaged 439 g/d for L calves and 1095 g/d for H calves. Final BW for LL, LH, HL and HH were 80, 106, 87 and 121 kg (SEM = 4), respectively. Total mammary gland weights were 253, 391, 266 and 512 g/100 kg BW (SEM = 33); total parenchymal tissue 16, 15, 22 and 23 g/100 kg BW (SEM = 4); and total extra-parenchymal fat 53, 99, 62 and 153 g/100 kg BW (SEM = 15) for LL, LH, HL and HH, respectively. Total parenchymal DNA and RNA for LL, LH, HL and HH were 45, 42, 79 and 86 mg/100 kg BW (SEM = 14) and 140, 132, 194 and 219 mg/100 kg BW (SEM = 32), respectively. Treatment did not alter percent parenchymal protein ($P = 0.65$) or parenchymal fat ($P = 0.29$). Groups HL and HH had 32% more parenchymal mass and 47% more parenchymal DNA than LL and LH. However, no difference was observed in parenchymal mass, DNA and RNA from 8 to 14 wk of age within L and H, nor were there any interactions between feeding level and period. Increasing energy and

protein intake from 2 to 8 wk of age increases mass and total DNA of mammary parenchyma in heifer calves.

Key Words: heifers, mammary, calves

319 Potential role for leptin in mammary development of heifers. M.J. VandeHaar*, L.F.P. Silva, B.E. Etchebarne, and M.S. Weber Nielsen, Michigan State University, East Lansing, MI.

Mammary gland development is impaired when prepubertal heifers are fed high energy diets that promote body growth rates greater than 1 kg/d. Leptin, a protein produced by adipocytes, may help explain this phenomenon. High energy intake increases IGF-I concentrations in serum of prepubertal heifers but, despite IGF-I's potent mammogenic effects in vitro and in vivo, high energy intake decreases mammosgenesis, indicating other factors also regulate mammary development. High energy intake also increases adipose deposition, and heifers that gain the most fat have the least mammary parenchyma. Moreover, proliferation of bovine mammary epithelial cells was reduced when co-incubated with bovine adipose tissue, indicating adipose tissue secretes an anti-mammogenic compound. Adipose tissue produces leptin, and high energy diets increase blood leptin. Leptin reduces IGF-I-stimulated proliferation of MAC-T mammary epithelial cells. At 5 ng/ml, IGF-I increased DNA synthesis to 300% that of cells in basal medium, but ovine leptin at 64 to 160 ng/ml inhibited IGF-I-induced DNA synthesis by 20% ($P<0.05$). Fetal bovine serum at 1% increased DNA synthesis to 1200% that of cells in basal medium, but ovine leptin at 10 to 1000 ng/ml inhibited DNA synthesis by 25% ($P<0.05$). Leptin did not inhibit basal cell proliferation. Based on trypan blue exclusion, leptin was not cytotoxic at the concentrations used. Transcripts for Ob-Rb (the long form of the leptin receptor) exist in epithelial cells of mammary tissue from prepubertal heifers and in MAC-T cells; Ob-Rb is the only Ob-R isoform with a complete intracellular domain and likely is responsible for leptin signaling in cells. In addition, Ob-Rb is closely related to the interleukin-6 (IL-6) receptor, and IL-6 at 50 ng/ml also reduced bovine mammary epithelial cell proliferation by 30%. Some elements (e.g., MAP kinases) of the intracellular signaling pathways for leptin and IGF-I overlap, suggesting possible mechanisms for interactions of the two factors. Studies are ongoing to examine this interaction in vivo and to elucidate the intracellular pathways for such an interaction.

Key Words: Leptin, Mammary gland development, IGF-I

320 Mitogenic effects of parenchymal tissue extracts from different regions within the heifer mammary gland. L. E. Davis*, J. L. Liesman, M. J. VandeHaar, and M. S. Weber Nielsen, Michigan State University, East Lansing.

Our objective was to examine the proliferative response of mammary epithelial cells to extracts of parenchymal tissue from different regions of the mammary gland of dairy heifers. Mammary extracts were prepared from parenchyma collected from proximal and distal regions within the mammary glands of prepubertal heifers ($n = 3$, BW = 213 ± 16 kg). "Proximal" was defined as the 1/3 region closest to the teat and "distal" was defined as the 1/3 region farthest from the teat. MAC-T bovine mammary epithelial cells were cultured in collagen gels in serum-free medium with or without 3% mammary extracts, in three separate assays. After 40 h incubation with treatments, total cellular DNA was measured. Mammary extracts of tissue from proximal regions stimulated cell proliferation more than extracts of tissue from distal regions (proximal = 3.74, distal = 3.38 μ g of DNA/well, SEM = 0.11, $P<0.02$). Addition of mammary extracts stimulated total DNA 108% compared to serum-free medium. Concentrations of IGF-I in extracts did not differ between regions ($P=0.67$). However, higher abundance of IGFBP-2 ($P<0.001$) and a 28-kD BP ($P<0.005$) was noted in extracts of tissue from proximal regions than from distal. A tendency existed for IGFBP-3 to be greater in distal than proximal regions ($P<0.06$). Abundance of IGFBP-1 did not differ by region ($P=0.77$). We conclude that extracts from proximal regions contain more mitogenic activity than those from distal regions of the developing mammary parenchyma in prepubertal dairy heifers.

Key Words: mammary, IGF-I, heifer

Nonruminant Nutrition

Are We Ready for Nutritional Genomics?

321 Microarray and proteomic technology for nutrition research. K. E. Webb, Jr.*¹, E. A. Wong, and H. Jiang, *Virginia Tech, Blacksburg, VA.*

For decades, biochemical and physiological and, more recently, molecular approaches have been employed exhaustively and effectively in the quest to better understand nutrient utilization. A greater understanding of gene regulation and the interactions among their encoded proteins will enable the further extension of knowledge concerning nutritional physiology. The same genes are present in all cells in the body, however, differential expression of a subset of genes determines a cell's function. Multiple genes are responsible for most physiological processes, including nutritional processes such as digestion and absorption. Interactions among gene products are complicated and highly orchestrated. Functional genomics, through microarray hybridization, allows the coordinated assessment of changes in mRNA abundance for thousands of genes simultaneously in a cell or tissue in relation to changing physiological status. Microarrays can be valuable in understanding transcriptional regulation across the genome. mRNA are essential for translation of proteins, however, the presence of the mRNA for a protein does not necessarily mean that the protein is expressed. Further, proteins can persist in cells long after their mRNA are no longer present. Therefore, besides abundance of steady-state mRNA, it is necessary to monitor changes in the expression of proteins. Functional proteomics, the global analysis of gene expression at the protein level, allows the simultaneous evaluation of expression of hundreds or thousands of proteins and possible post-translational modifications of these proteins in cells or tissues using high-resolution, two-dimensional gel electrophoresis. Individually, microarray and proteomic technologies can provide vast amounts of information about gene function in relation to nutritional physiology which can assist in understanding prevailing concepts, enable discover-

ies, and/or facilitate the development of new hypotheses. Combined, they can be immensely powerful. These are new paradigms for examining gene expression in food-producing animals.

Key Words: Microarrays, Proteomics, Nutritional physiology

322 How do these tools help study nutrient function? X. G. Lei*, *Cornell University.*

In a post-genome-sequencing era, gene-chip and proteomic tools are being increasingly applied to study nutrient function and metabolism. Our laboratory has studied in vivo antioxidant functions and signaling of selenium. Using the selenium-dependent glutathione peroxidase (GPX1) knockout mice, we found that minute hepatic GPX1 activity attenuated the pro-oxidant-induced apoptosis, a mixed form of cell death that shares apoptosis and necrosis. To illustrate the underlying signal pathways, we determined the impact of minute GPX1 activity on the time-course of the pro-oxidant-induced expression of 23 apoptosis-related signal molecules in livers of the GPX1 knockout mice and the wild-type mice. Total liver RNA was isolated using the RNeasyTM kit (Ambion, Austin, TX), and detected using the Mouse Apoptosis-1 GEArray kit (Super Array, Inc., Bethesda, MD). A total of 11 out of the 23 genes in the Array gave distinct and reproducible signals. The largest difference in mRNA levels between the two groups of mice was the DNA damage-inducible GADD45, followed by consistent protein responses. Our results unveil a novel signal mechanism for the GPX1 protection against oxidative cell death, and exemplify the usefulness of the genomic tools in studying nutrient function.

Key Words: Selenium, Gene knockout, Microarray

Animal Behavior and Well-Being

Influence of Production Practices on Behavior and Well-Being

323 Reaction of Holstein dairy cattle to a looming person as a temperament assessment tool. J. L. Lanier¹ and T. Grandin*¹, *Colorado State University.*

A population of registered, artificially inseminated Holstein dairy cows (n=263) was used to determine if temperament as measured by reaction to a looming person was associated with average milk production. Individual reaction to a looming person was assessed while the cow was restrained in outdoor head stanchion during the morning feeding. An unfamiliar observer stood 1 m (3 feet) directly in front of each cow's head, keeping the shoulder pointed towards the cow's head, waited 15 s, then calmly leaned sideways towards the cow allowing the inner arm to dangle. Reaction was rated as 1) non-reactive - no reaction, or stretched to sniff observer, 2) mildly reactive - pulled away from observer, did not pull against head stanchion, or 3) highly reactive - pulled against head stanchion or head remained pulled against stanchion throughout test. Milk production values from the current lactation were used. Results were expected a priori for more reactive cows to have lower productivity. One-way analysis of variance with a contrast was used to compare the average production yield of highly reactive cows to the combined average of the mildly and non-reactive cows. Very reactive cows had 47.3 kg less productivity mature equivalent fat compared to the non- and mildly reactive cow average (P = 0.05). No association was found for all other production values. The temperament assessment could have been improved by comparing the cows' reaction to a familiar looming person as well. The use of temperament assessment combined with current production traits could assist dairy producers in their herd management.

Key Words: Dairy cattle, Milk production, Temperament

324 Orientation of beef cattle grazing foothill winter range in Montana. B. Olson*¹, *Montana State University.*

Cattle may graze foothill winter range in northern areas as an alternative to feeding hay, although this exposes them to potential thermal stress. Consequently, cattle may orient to maximize heat gain or to minimize heat loss depending on ambient weather. Our objective was

to determine how mature cattle orient while grazing winter range. During two winters (Winter 1 1996-1997; Winter 2 1997-1998), we recorded orientation of cattle (n = 32) at 30-min intervals from dawn to dusk 3d each wk for approximately 7 wk. Circular statistics, including mean vector (body orientation relative to direction) and vector length (variation around mean vector), were used to characterize orientation. Stepwise multiple regression was used with mean vector and vector length as response variables, and solar radiation, net radiation, temperature, relative humidity, wind velocity, and wind direction as predictor variables. Mean vector was approximately east-west (Winter 1, 80°, Winter 2, 100°; body perpendicular to the sun low in the winter sky), although coefficients of determination were low, especially in the second winter (Winter 1, R² = 0.14; Winter 2, R² = 0.03). Vector lengths increased with increasing solar radiation, especially at cold temperatures (Winter 1, R² = 0.24; Winter 2 R² = 0.17), indicating more cattle were assuming the same orientation under these conditions. Cattle oriented perpendicular to the sun's rays intercept about 80% more direct radiation than cattle facing the sun. On relatively warm, sunny days, radiation absorbed by cattle can range from 4 to 6x (280-420 W m⁻²) basal metabolic heat production (70 W m⁻²). A simple thermal balance model, including net radiation, ambient temperature, cattle surface temperature, latent and sensible heat loss, conduction, storage, and metabolic heat, indicates that net radiation can greatly affect thermal energy gains and losses under different weather conditions.

Key Words: winter, thermal balance, behavior

325 Relationships between daily feed intake and feeding behaviours in feedlot steers. J.A. Basarab*¹, E.K. Okine², and K.L. Lyle¹, *¹Western Forage Beef Group, Lacombe Research Centre, Lacombe, Alberta, Canada, ²University of Alberta, Edmonton, Alberta, Canada.*

This study was conducted to quantify the relationship between daily feed intake and feeding behaviors in feedlot steers. Seventy-five spring born steer calves (330 kg; SD=40 kg), 15 from each of the M1, M2, M3, M4 and TX BeefBooster strains, were adjusted to a high-barley diet (22.0%

barley silage, 78.0% steam rolled barley and supplement) and intensively monitored for individual animal feed intake using the GrowSafe® System. Daily feed intake averaged 10.7 kg d⁻¹ (SD = 2.6). This level of feed intake was accomplished in just over eight feeding events daily (8.2 events d⁻¹, SD = 3.7) and over an average feeding duration of 81.4 min d⁻¹ (SD = 25.3). Head-down time averaged 33.8 min d⁻¹ (SD = 33.8). The relationship between feed intake and feeding duration was curvilinear and accounted for 59.9% ($P < 0.0001$) of the variation in feed intake. Each 10 minute increase in feeding duration resulted in an increase of 1.9 kg d⁻¹ in feed intake between feeding durations of 10 and 90 min d⁻¹. Feed intake reached a plateau after a feeding duration of 110 min d⁻¹, indicating that most feeding activity after 110 min was associated with socialization and rumination. The relationship between feeding head-down time and feed intake was also curvilinear and accounted for 48.5% ($P < 0.0001$) of the variation in feed intake. Feeding frequency was poorly related to feed intake ($r = 0.310$, $P < 0.0001$). These relationships may be useful in converting feeding behaviours to estimates of individual animal feed intake and understanding why low levels of feeding behaviour early in a feeding period are associated with poor growth performance in feedlot cattle.

Key Words: Beef Cattle, Remote sensing, feeding behaviour

326 Effect of timing and uniformity of feed delivery on feeding behavior, ruminal pH and growth performance of feedlot cattle. K.S. SchwartzkopfGenswein^{*1}, T.A. McAllister², D.J. Gibb², K.A. Beauchemin², and M. Streeter³, ¹Alberta Agriculture, Food and Rural Development, Lethbridge, AB, ²Agriculture and Agri-Food Canada, Lethbridge, AB, ³Alpharma Inc., Fort Lee, NJ.

The effects of programmed (P) vs fluctuating (F) feed delivery on ruminal pH were assessed in a crossover experiment (two 28-d periods) involving six mature, ruminally cannulated steers consuming an average of 10.32 kg/d of a barley grain/barley silage-based finishing diet. Steers in group P were fed for ad libitum intake, whereas steers in group F were fed 10% above or below their ad libitum intake on a rotating 3-d schedule. Ruminal pH of each steer was measured continuously via an indwelling electrode placed in the rumen during the last 6 d of each period. Mean pH was 0.10 units lower ($P = 0.15$) for F than P steers (5.63 vs 5.73), and ruminal pH of F steers remained below 6.2 ($P = 0.15$), 5.8 ($P = 0.03$) or 5.5 ($P = 0.14$) for greater proportions of the day than with steers in group P. Inconsistent delivery of feed may lower ruminal pH and increase risk factors associated with acidosis. In Exp. 2, the effects of fluctuation (P vs F) and timing (0800 vs 2100 daily) of feed delivery on feeding behavior and performance during backgrounding and finishing were assessed in a 209-d trial using 240 crossbred beef steers (310 ± 23 kg) in 16 pens, with treatments arranged in a 2 × 2 factorial ($n = 4$). One pen per treatment was equipped with a radio frequency identification (GrowSafe Systems Ltd.) system that monitored bunk attendance by each steer throughout the trial. Feeding regime did not affect ($P > 0.05$) DMI (7.36 kg/d), ADG (1.23 kg/d), feed/gain (6.23), or time spent at the bunk (109 min/d), nor were fluctuation × timing interactions observed ($P > 0.05$). Late feeding increased ($P < 0.05$) daily DMI (7.48 vs 7.26 kg) but this difference was not reflected in ADG, feed conversion or time at the bunk. These studies indicate that the risk of ruminal acidosis was increased with fluctuating delivery of feed, but increased risk of acidosis did not impair animal performance.

Key Words: Feed delivery, Feeding behavior, Cattle performance

327 The effects of ractopamine on behavior and physiology of finishing pigs. J.N. Marchant-Forde^{*2}, D.C. Lay Jr.², B.T. Richert¹, and E.A. Pajor¹, ¹Dept of Animal Sciences, Purdue University, 1151 Lilly Hall, West Lafayette, IN 47907, ²USDA-ARS, Livestock Behavior Research Unit, Purdue University, West Lafayette, IN 47907.

This study aimed to examine the effects of ractopamine (RAC) on behavior and physiology of pigs during handling and transport. Twenty-four groups of 3 finishing pigs were randomly assigned to one of two treatments, four weeks prior to slaughter; 1) finishing feed plus RAC (10ppm), 2) finishing feed alone. Pigs were housed in adjacent pens with fully-slatted floors and access to feed and water ad lib. Behavioral time budgets were determined in half the pens over a single 24-hour period during each week. Behavioral responses to routine handling and weighing were determined at the start of the trial and weekly. Heart-rate (HR) responses to unfamiliar human presence were measured in all

pigs and blood samples were taken from a single pig in each pen on different days during week 4. At the end of week 4, pigs were transported for 20 min to slaughter. HR was recorded from at least one pig per pen during transport and a further post-slaughter blood sample was taken from pigs previously sampled. During weeks 1 and 2, RAC pigs spent less time inactive (week 1, 75±2% vs 81±1%, $p \leq 0.05$; week 2, 76±1% vs 81±1%, $p \leq 0.01$) and less time lying laterally (week 1, 55±2% vs 65±2%, $p \leq 0.01$; week 2, 58±3% vs 68±1%, $p \leq 0.05$). There were no differences in time budgets during weeks 3 and 4. Initially, there were no differences in responses to handling. However, over each of the next 4 weeks, fewer RAC pigs exited the home pen voluntarily, they took longer to be removed from the home pen, longer to handle into the weighing scale and needed more interactions from the handler to enter the scales. At the end of week 4, RAC pigs had higher HR in the presence of an unfamiliar human (144.6±3.2 bpm vs 136.4±2.7 bpm, $p \leq 0.05$) and during transport (151.6±4.1 bpm vs 140.7±3.3 bpm, $p \leq 0.05$), but not during loading and unloading, and had higher circulating epinephrine (253.0±55.0 pg/ml vs 101.5±15.0 pg/ml, $p \leq 0.05$) and norepinephrine (991±150 pg/ml vs 480±58 pg/ml, $p \leq 0.01$) than control pigs. Circulating cortisol concentrations and cortisol responses to transport did not differ between treatments. The results show that ractopamine does affect the behavior and physiology of finishing pigs and may make them more difficult to handle and more susceptible to handling and transport stress.

Key Words: Swine, Behavior, Well-being

328 Modulation of health and production by oral beta-glucan and ascorbic acid after transport. S. D. Eicher^{*1} and T. R. Johnson², ¹USDA-ARS, ²Purdue.

Objective of this study was to determine production and health differences in Holstein calves, following transport, given an oral yeast cell-wall derivative, purified β -glucan from yeast cell-walls, or a positive control. Calves ($n=39$) were blocked by sex and assigned to treatments; (IG) 113 g of a yeast cell wall derivative (Energy-plus, Natural Chem Industries, LTD) and 250 mg of an ascorbic acid product (Stay-C, Roche Vitamins), (BG) 150 mg of a β -glucan fraction from yeast cell-walls that is equivalent to that contained in Energy-plus (Biopolymer Engineering) plus 250 mg Stay-C, or (Con) a positive control with no supplements, but subcutaneous electrolytes. Calves were fed an all milk, milk replacer at 4.45 kg/d in 2 equal feedings with supplements in the milk replacer. A grain based dry feed was offered beginning on d 3. Calves, 3 to 10 d-of-age, were transported for 4 h, after being weighed and sampled by jugular venipuncture, then calves began treatments in outdoor hutches. Weights were taken weekly for 4 wk and feed weighed back every other day. Fecal and clinical scores, and nasal and ocular discharge occurrences were recorded 3 times per wk. Blood samples were collected 0 h then d 3, 7, 10, 14, 21, and 28 post-transport. Data were analyzed as a repeated measures design using GLM procedures of SAS. Although weights were not different among calves, intake at week 4 was less for IG than for Con ($P < .05$). Feed efficiency was improved for IG ($P < .05$) and tended to improve for BG ($P < .10$) at wk 4. Plasma IgG, fecal and clinical scores, serotonin, and tryptophan were not different ($P > .10$). Ocular and nasal discharge scores were greater for BG than for IG during wk 2 ($P < .05$). This coincided with peripheral blood mononuclear cell counts that were least for BG compared to IG and Con (d 10) but IG was greater than Con (d 3), and than BG (d 21 and 28) ($P < .05$). Plasma fibrinogen tended ($P < .10$) to be greater for IG than Con (d 7) and than BG (d21). Both β -glucan products were beneficial for feed efficiency by wk 4. However, it appears the mechanisms may be different because many of the health and immune measures were different between IG and BG at d 10 to 28.

Key Words: Dietary Immunomodulators, Dairy Calves, Transport

329 The effect of holding pen time on milk production and blood components in Holstein dairy cows. A. G. Fahey^{*1}, M. M. Schutz¹, E. A. Pajor¹, S. D. Eicher², S. J. Larkin¹, and K. A. Scott², ¹Purdue University, West Lafayette, IN, ²USDA-ARS, West Lafayette, IN.

During dairy farm expansion, cows frequently spend more time standing in the holding pen before milking and are away longer from food, water and stalls. Thus, the objective of this study was to investigate the effect of time spent in the holding pen on milk production and blood parameters in Holsteins. Thirty-five cows were randomly assigned to

two groups. During period 1 (wk 1 and 2), cows in group A (n=17) were kept in a holding pen for 40 min before milking and cows in group B (n=18) were kept in the same holding pen for 120 min before milking. Both groups of cows were off the study for 12 d between period 1 and 2 in order to reduce any carryover effects. During period 2 (wk 3 and 4), cows in group A were kept in the holding pen for 120 min and cows in group B were kept in the holding pen for 40 min. During this time, milk weights were measured daily and milk composition and post-milking blood samples were taken from each cow 4 times during each period. Milk composition data included protein, fat, lactose, and somatic cell scores (SCS). Blood components measured included fibrinogen, white blood cells, peripheral blood mononuclear cells, granulocytes (GRAN%), and hematocrit (HCT%), which were examined as indicators of stress or dehydration. Weekly means of weights, SCS, and blood components were obtained, as were differences between means for the two weeks in each period. Statistical models used to analyze production and blood records included the effects of treatment, period and cow. Cow had a highly significant ($P<.01$) effect on all traits except for GRAN and HCT%, but not on differences from wk 1 to 2 within time period. The effect of period was highly significant ($P<.01$) for differences in milk component weights from wk 1 to 2 in each period and significant for milk ($P<.01$), fat ($P<.10$), lactose ($P<.05$), HCT% ($P<.05$), and difference in GRAN% from wk 1 to 2 ($P<.05$). Length of time in the holding pen affected only protein yield ($P<.10$), with cows held longer producing 0.03 kg more protein per day. Results indicate that exposure of cows for short times to increased stays in a holding pen does not significantly affect production or stress indicators in the short term.

Key Words: Holding pen, Milk production, Blood components

330 Weaning age impairs spatial learning in pigs at increased but not basal levels of stress. K. Laughlin* and A.J. Zanella, *Animal Behavior and Welfare Group, Department of Animal Science, Michigan State University.*

The cognitive abilities of domestic animals and how these are affected by environmental factors and the animal's own internal state, have been the focus of a number of recent applied ethology studies. Previous research has shown that domestic pigs have accurate spatial memory abilities, which can be impaired when animals are presented with relatively mild disturbance treatments. It is hypothesized that the practice of early weaning in pigs subjects the animals to increased levels of stress hormones which may have a detrimental effect on their subsequent cognitive development, perhaps through modulation of glucocorticoid receptor activity within the regions of the brain responsible for learning and memory. We adapted the Morris water maze to examine cognitive abilities in young female pigs, comparing the performances of early-weaned pigs (EW=12 d of age) with conventionally weaned (CW=21 d of age) littermates at basal and increased levels of stress. A circular pool was filled with opaque water containing a hidden platform. Spatial learning was measured by a decrease in latency to reach the platform across 7 exposures separated by 10-min intervals. Performances of EW (n=12) was compared to those of CW (n=12) pigs when tested at d14 and d23. We found no significant differences between the groups during normal undisturbed trials (ANOVA; $F_{1,22}=1.58$, NS). We then socially isolated EW (n=6) and CW (n=6) pigs for 15-min prior to testing, which resulted in a significant increase in salivary cortisol in these animals (paired t-test; $N=12$, $t=7.82$, $p<0.001$) and compared their performances in the maze to those of non-isolated control groups. We found no significant effect of isolation on the performances of CW pigs (ANOVA, $F_{1,10}=1.28$, NS). However, isolated EW pigs did not appear to learn the task, showing no decrease in latency to reach the platform across successive visits to the pool, and their performance was significantly poorer than the EW control group (ANOVA; $F_{1,10}=9.59$, $p=0.01$). Cognitive impairment under stressful situations may compromise the adaptive response of pigs leading to potential management and welfare problems.

Key Words: Pig cognition, Water- maze, Early-weaning

331 Sexual behaviour of male New Zealand white rabbits in an intensive production unit. V. Fuentes*, C. Villagran, and J. Navarro, *¹Centro Universitario de los Altos Universidad de Guadalajara, México.*

Sexual behaviour in the male New Zealand White Rabbit in intensive production units is not fully documented. Therefore the objective of this work is to provide further information about the sexual behaviour

of this species under intensive production. Fourteen, 6- to 12-mo old male rabbits were studied, housed individually under natural photoperiod (19 Latitude North). Mating was carried out twice a week. When mated a non-pregnant female was introduced to their cages for a time period of 6 min. During this time the number of mounts, latency between mounts, number and latency of ejaculations, enuresis (urination), grasping and kicking were observed and recorded. In total, 222 mounts were observed and recorded. Males mated one to five times. There was a relation between sexual behaviour and aggressiveness. Enuresis (urination) was observed only in one occasion. Grasping was noted in 142 mounts and kicking observed in 133 matings. For the first five matings, male rabbits mounted and ejaculated within 4.20 minutes. In addition, the minimum time taken from the moment of ejaculation and the beginning of next mounting was 17 s; the longest time noted was 5 minutes, 33 seconds. During the statistical analysis of the results it was observed that there was a significant difference between rabbits using a one factor ANOVA ($F=11.51333$; 13,208 df ; $P<0.05$). The sexual behaviour of white New Zealand male rabbits is regularly maintained through time, and environmental temperature and photoperiod did not influence their sexual behaviour.

Key Words: sexual behaviour, Rabbits, Mating

332 Effect of dehydration on some behavioral aspects of camels. H Abdel Rahman*,¹ M.A. El Sherif², M.A. El Sayed¹, S.S. Omar¹, and N.M. Ibrahim², *¹Minufiya University, ²Desert Research Center.*

Four she camels (*Camelus dromedaries*), aged 12 yrs and weighing 558.6 kg on average, were kept in 15 x 11 m open yard and fed ad libitum on fresh acacia and clover hay. They were exposed during summer and winter to 5 dehydration cycles (7 d each), proceeded by 2 wk control period (CP). Fresh drinking water was available ad lib during CP. Behavioral patterns were recorded 3 times/ season (on last 2 d of CP, d 6 and 7 of 5th dehydration (DH) cycle and first (RH1) and second (RH2) rehydration days. Dehydrated animals lost 105.5 and 76.8 kg in summer and winter ($P<0.01$), but they restored 85 and 60% on RH1 mounted to 128 and 105 % of body weight (BW) loss on RH2, respectively. Summer and winter water intake (WI) increased ($P<0.01$) on RH1 to be 236 and 197% of control WI, equal to 20.3 and 14.4 % of DH live BW, respectively. On RH2, the corresponding values were 78, 81, 6.7 and 5.9% ($P<0.01$), respectively. Time spent feeding, ruminating and idling was 29.6, 30.4 and 39.7 % of daily activities in summer CP vs. 6.8, 20.2 and 73.0% in DH period, being 34.3, 38.9 and 26.6% vs. 21.6, 32.0 and 46.4 % in winter, respectively. Both dehydration and season effects on such traits were highly significant ($P<0.01$). RH camels still spent greater time idling (45.5 and 50.1% of daily activities on DH1 and DH2 in summer vs. 41.3 and 39.3% on DH1 and DH2 in winter, respectively, ($P<0.01$). Combination effect of DH and hot climate on feeding behavior delayed recovery more than 2 d RH, while WI was recovered from long thirst period (7 days) within 1 day only. To face dehydration, camels alter their daily behavioral activities through reducing time spent feeding and ruminating and increased that idling.

Key Words: Dehydration, Behavior, Camel

333 Sexual performance of Awassi and Awassi x Romanov yearling rams. R. T. Kridli*,¹ M. Momani Shaker², A. Y. Abdullah¹, and I. Sada², *¹Jordan University of Science and Technology, Irbid/Jordan, ²Czech University of Agriculture, Prague/Czech Republic.*

This study was designed to compare libido and biological parameters of Awassi (A) with F1 Awassi x Romanov (AR) yearling rams. Romanov rams were imported to Jordan to improve fertility of Awassi sheep. In September, eight sexually nave, 10-mo old rams (four from each genotype) were evaluated for BW, body condition score (BCS) and scrotal circumference (SC) every 2 wk for 2 mo. Sexual performance was recorded on four occasions, each 2 d apart. During each occasion, rams were individually exposed to two estrous Awassi ewes for 20 min during which sexual behavior was monitored. Body weight and BCS were similar ($P>0.05$) for both genotypes, however, AR had greater ($P<0.001$) SC than A rams (30.6 ± 0.2 cm and 27.4 ± 0.2 cm for AR and A rams, respectively). Body weight for both A and AR rams increased with each test day. No correlations were detected ($P>0.05$) among BW, BCS and SC. Bouts of leg kicking, anogenital sniffing and mount attempts were similar ($P>0.05$) for both A and AR rams. There was a tendency

($P = 0.10$) for AR rams to have greater mounting frequency compared with A rams (20.9 \pm 2.8 mounts/20 min and 14.5 \pm 2.8 mounts/20 min for AR and A rams, respectively). The frequency of raising the fat tail of females, however, was greater ($P = 0.06$) in A than AR rams. Neither A nor AR rams managed to service the ewes. Significant correlation existed ($P < 0.05$) between bouts of leg kicking and mounting frequency

($r = 0.42$) and between mounting frequency and tail-raising ($r = 0.62$). Results indicate that A and AR rams have similar sexual performance. Awassi rams managed to raise the fat tail of females more frequently thus predicting a greater advantage in natural mating over AR rams.

Key Words: Sheep, Libido, Behavior

Animal Health Mastitis and Management

334 Infrared thermography to evaluate milking induced alterations in teat tissue fluid circulation. C. O. Paulrud^{*1}, S. Clausen², P. E. Andersen², M. Bjerring³, and M.D. Rasmussen³, ¹Danish Dairy Board, ²Risoe National Laboratory, ³Danish Institute of Agricultural Sciences.

Machine milking may influence the defense mechanisms of the teat by altering teat tissue fluid-dynamics. The skin temperature reflects the underlying circulation and tissue metabolism. Use of thermography can focus, collect and transform the infrared range of the electromagnetic spectrum that is emitted from any body in a heat dependant fashion. Thermography images a pictorial summary of the heat gradients generated and can thereby visualize the thermal patterns of the skin resulting in useful mapping of the underlying circulation. Two healthy cows and one heifer with moderate teat oedema where milked with a conventional liner and a very soft experimental liner in a split udder design mode. Thermographic pictures where taken before teat preparation with a wet cloth, immediately after preparation, and successively after milking for 10 min. Skin temperatures were measured approximately 5 mm from the teat apex, at the mid, and at the base of the teat. The thermographic patterns where visually different between teats milked with different liners. During preparation, teat apex-, mid teat- and teat base-temperature fell 3.61.4, 3.41.6 and 1.70.9 C respectively. The decrease at mid teat and teat base temperature where however less distinct among teats with moderate oedema. Immediately after milking, all teats milked with the soft liner where colder at the teat apex (mean 2.10.4C) and slightly warmer at the middle (1.10.6C). During milking, temperature at the teat base decreased of teats without oedema and milked with the conventional liner but did however rise among teats milked with the soft liner and among teats with moderate oedema. Present findings may be explained by the soft liner having a relatively low ability to massage the teat apex combined with a relatively good capacity to massage the teat sinus and maintain fluid circulation at the teat base. We conclude that thermography is useful for study and evaluating the effects of different milking techniques on teat fluid dynamics.

Key Words: Milking, Teat, Thermography

335 Bedding amendments for environmental mastitis control in dairy cattle. E. K. Kupprion, J. D. Toth^{*}, Z. Dou, H. W. Aceto, and J. D. Ferguson, *University of Pennsylvania, Kennett Square, PA/USA.*

Coliform bacteria are environmental mastitis pathogens that thrive in manure and bedding and are often responsible for transient peracute and acute mastitis. The purpose of this experiment was to investigate if acid and alkaline amendments added to dairy cow bedding are effective in controlling mastitis-causing bacteria populations. Alum, fluidized bed combustion coal flyash (FBC), flue gas desulfurization flyash (FGD), or hydrated lime were added to kiln-dried sawdust bedding material (1:10 amendment:bedding, DM basis) overlying mattresses in dairy tie-stalls with no-amendment control included for comparison. Each treatment was replicated three times. Bacteria counts were made by plating samples of bedding, mattress swab, and teat end swab, collected on day 1, 2, 3; colonies were identified as total Gram-negative bacteria, *E. coli*, and *Klebsiella* spp. pH was also determined on bedding samples. All amendments but FGD exhibited antibacterial effect. Flyash FBC appeared to be most effective on day 1; the hydrated lime treatment suppressed bacteria growth on day 1 and 2 with the antibacterial effect diminished on day 3. Alum was able to suppress bacteria populations throughout the 3-day sampling period. The antibacterial effect of the amendments was apparently related to pH alteration of the bedding material. Hydrated lime raised pH by about 5 units during day 1 and 2, FBC by nearly 5

units on day 1, whereas alum reduced pH by about 3 units throughout the 3-day period. Bedding pH was not changed by the FGD treatment.

Key Words: Environmental Mastitis, Mastitis Control, Bedding Amendments

336 Impact of two coliform mastitis vaccination schedules on milk yield, dry matter feed intake and intramammary infections of dairy cattle. C.S. Petersson^{*1}, K.E. Leslie¹, D.F. Kelton¹, and B.A. Mallard², ¹Department of Population Medicine, ²Department of Pathobiology, University of Guelph, Ontario, Canada.

Late lactation cows and springing heifers from two research herds were enrolled two weeks prior to drying off and randomly assigned to one of two vaccination protocols. Group A involved vaccination at dry-off, three weeks before expected calving, and 2 to 9 days in milk (DIM). Group B cows were vaccinated two weeks before dry-off, at dry-off, and at three weeks before expected calving. Daily milk weights were recorded from enrolment until the day of drying off, as well as for the first 30 days of the next lactation. Quarter milk samples were aseptically collected once from day 2 to 9 DIM for bacteriological culture. After calving, dry matter intakes (DMI) were recorded for all cows during the period from the day before to the two days after the Group A vaccination date. Descriptive data from the first 141 cows that have completed the trial are summarized. The mean decline in milk production over the two-week period prior to drying off was -11.8 kg and -13.6 kg for Group A and Group B cows, respectively. This difference was not statistically significant. Milk production on the day prior to dry-off in Groups A and B was 12.0 kg and 12.2 kg, respectively. After calving, the average milk production at 30 DIM was 37.5 kg and 37.8 kg cows in Groups A and B, respectively. On the day of vaccination for Group A after calving, DMI values were 11.8 kg and 13.0 kg for group A and B, respectively ($P=0.07$). Daily milk production on this date was found to be 26.5 kg and 27.5 kg for Groups A and B, respectively. Results of milk bacteriology from 656 quarter samples have isolated major pathogens from 29 and 14 quarters in groups A and B respectively. *E. coli*, *Klebsiella* and environmental *Streptococci* were found in 12, 3, and 10 versus 3, 1 and 5 of the quarters from animals in Groups A versus B, respectively. Preliminary results favor coliform mastitis vaccination at two weeks before, at dry-off and at transition.

Key Words: Vaccination, Mastitis, Coliform

337 Multiple boosters of J5 vaccine elicit strong lactational antibody responses in dairy cows. R.A. Darch^{*1}, L. Nielsen¹, P. Saama¹, R.J. Erskine², A.P. Belschner³, and J.L. Burton¹, ¹Animal Science, Michigan State University, ²Large Animal Clinical Sciences, Michigan State University, ³Pharmacia Animal Health.

J5 E. coli vaccines have done well to protect cows from coliform mastitis in early lactation. However, data from our group show that peak rates of coliform mastitis occur between 3 and 5 months of lactation, even in J5 vaccinated herds, suggesting that protective antibody responses wear off quickly after the final dose of vaccine is administered. The objective of this study was to determine if multiple boosters of J5 vaccine maintain strong anti-coliform antibody responses throughout lactation. Commercial J5 bacterin was used to immunize two groups of cows ($n = 4$ multiparous, 2 primiparous per group); control cows received the recommended 3 doses of J5 vaccine (at dry off, 30 days dry, and 14 days postpartum) while treated cows received 12 doses (the recommended 3 doses plus 9 additional doses at 30-day intervals). Weekly blood samples were collected from all cows throughout the trial for ELISA assay of serum anti-J5 *E. coli* IgM, IgG1, and IgG2 antibody responses. ELISA test data were normalized against negative control values and resulting

data analyzed by repeated measures (SAS). Results showed that all cows mounted clear IgM, IgG1, and IgG2 antibody responses when administered 3 doses of vaccine. However, treatment influenced ($P < 0.0001$) the shape of each antibody response profile. Control cow responses declined once vaccinations were terminated while treated cow responses increased steadily throughout lactation. Differences between treatment groups were particularly striking for the IgG1 and IgG2 response profiles. Results show that multiple boosters of J5 bacterin sustains strong serum antibody responses in lactating cows.

Key Words: Coliform Mastitis, Vaccines, Antibody Response

338 An evaluation of the ColiMast test for detection of coliform mastitis in dairy cattle. S.K. Gawrylash^{*1}, K.E. Leslie¹, M. Archambault², and A. Bashiri¹, ¹University of Guelph, Department of Population Medicine, ²University of Guelph, Animal Health Laboratory.

A rapid and accurate method to determine the type of pathogen causing clinical mastitis would be useful. The ColiMast test is an enriched growth media in a vial. After incubation, a color change indicates the presence of coliforms. This project has evaluated the test characteristics of the ColiMast test for detecting coliforms in clinical mastitis milk samples. Samples were obtained from submissions to the University of Guelph laboratory. A ColiMast vial was inoculated with 2 ml of milk and incubated at 37°C. Color change was evaluated at 12 and 24 hours. The original milk samples underwent standard culture. In addition, four farms inoculated a ColiMast test with milk from each case of clinical mastitis. The producer checked the ColiMast test at the next two milkings to observe and record any color change. The original milk sample was frozen and sent to the University of Guelph. A second ColiMast test was done on the same sample after thawing, and sent for bacteriological culture. Sensitivity and specificity of ColiMast were calculated. In addition, reasons for false positive and false negatives were identified. A Kappa Value for the agreement between the ColiMast tests done on-farm and in the lab was calculated. Complete results were obtained from 505 samples. A total of 172 samples were positive for coliforms. After 24 hours of incubation, 128 of these lab-positive samples were also positive on ColiMast (sensitivity = 0.74). Of the 333 samples that were negative for coliforms on culture, 261 were ColiMast negative (specificity = 0.78). This means that there were 72 ColiMast tests that gave a false positive result. It is noteworthy that the ColiMast test uses 2 ml of milk in an enriched liquid growth medium as compared to a 0.01 loop inoculum in milk culture. Of the 72 false positive tests, 26 had no significant growth on culture. The larger volume of milk may allow for relatively small numbers of coliforms to grow and cause a color change. The Kappa Value was 0.85 when the test was read at 12 hours suggesting excellent agreement between ColiMast tests done on the farm and in the lab. The agreement was substantially less at 24 hours ($K=0.48$). In conclusion, the ColiMast test offers great promise for use in a treatment decision-making protocol.

Key Words: Mastitis, Clinical, Diagnosis

339 Characteristics of milk samples submitted for culture in Wisconsin from 1994 - 2001. J. A. Makovec^{*} and P. L. Ruegg, University of Wisconsin, Madison.

Bovine mastitis is an extremely costly disease of dairy cattle because of its frequent occurrence and impact on milk production. Microbiologic examination of milk samples from mastitic cows is useful in determining the cause of the infection and deciding on appropriate preventative and therapeutic strategies. The objective of this study was to examine the characteristics of milk samples submitted for culture in Wisconsin from 1994 to 2001. Clinical case records from milk samples submitted to the Wisconsin Veterinary Diagnostic Laboratory from January 1994 until June 2001 were retrieved, and the test results were copied from original paper records into a computer spreadsheet for analysis. Test results ($n=83,650$) were recorded as no growth, contaminated or identified as specific bacterial pathogens. Multiple bacteria were isolated from some milk samples. The proportion of samples identified as contaminated by the laboratory varied by year ($P<0.0001$) and ranged from a high of 20.6% in 1997 to a low of 9.5% in 2001. The proportion of samples coded as no growth increased from 22.6% in 1994 to 49.7% in 2001. The proportion of *Staph aureus* and *Strep ag.* isolated from milk samples was associated with year ($P<0.0001$). Isolation of *Staph aureus* decreased from 17.7% in 1994 to 9.7% in 2001 while isolation of

Strep ag. decreased from 8.1% in 1994 to 3.0% in 2001. Coagulase negative *Staphylococcus* were isolated from 12.7% to 17.5% of all samples and environmental *Streptococcus* were isolated from 11.6% to 20.1% of all samples. *E.coli* were isolated from 3.1% to 6.7% of all submissions. Number of tests requested was associated with year ($P<0.0001$) ranging from 16,505 in 1999 to 6,301 in 1995. Number of tests requested was associated with month ($P<0.0001$) ranging from 8,932 in April to 3,948 in December. Antimicrobial susceptibility tests were run on 10.65% of all samples. Microbial examination shows a decrease in the proportion of contagious bacteria in comparison to the proportion of environmental pathogens.

Key Words: Mastitis, Milk samples, Milk quality

340 Evaluation of *Mycoplasma species* shedding patterns in milk of lactating dairy cows with intramammary infections. M. Biddle^{*} and L. Fox, Washington State University, Pullman.

This study was conducted to evaluate the shedding patterns of ten lactating dairy cows with mycoplasma intramammary infections. Milk samples were collected daily for 28 days using aseptic techniques. Mycoplasma isolation in milk samples was initiated by directly plating a fresh milk sample onto a mycoplasma agar plate. Isolation was also attempted by inoculating mycoplasma enrichment broth, to increase the likelihood of isolation for 4 days and then transferring broth to an agar plate. Agar plates from direct culture and enrichment broth were incubated at 37°C, 10% CO₂, for 10 days before examination. Agar plates were examined for growth of mycoplasma colonies and the numbers of colony forming units (CFU) were recorded. Mycoplasma was isolated from milk samples of 8 cows by direct plate inoculation, with and without enrichment. In samples from 2 cows mycoplasma was only detected from agar plating of broth culture. Contrasting isolation frequencies of direct plate versus broth culturing resulted in isolation of mycoplasma species 68% of the time from both direct plate and broth culturing methods. Mycoplasma species were isolated in 23% of the broth cultures alone and 9% of the time through direct plate only. A bimodal frequency distribution of mycoplasma shed in mammary composite and quarter milk samples was observed. In composite milk samples, mycoplasma was never recovered in 35% of the samples, while 54% of the samples had more than 6 million colonies recovered. In 43% of the quarter milk samples mycoplasma was never recovered while in 39% of the samples there were greater than 6 million colonies. The use of enrichment broth has the potential to improve detection of cows with mycoplasma intramammary infections. Data indicated that periods of latency might exist when cows with mycoplasma mastitis may not be shedding this pathogen in milk. These latent periods can affect diagnosis of this disease

341 Impact of intramammary treatment of CMT positive early postpartum dairy cows. J.A. Wallace^{*1}, K. Stipetic², K.E. Leslie¹, R.T. Dingwell¹, Y.H. Schukken², and P. Baillargeon³, ¹University of Guelph, Department of Population Medicine, ²Cornell University, ³Clinique de St-Louis/Embryoc.

1781 quarters of 489 cows from dairy herds in Quebec ($n=14$), Ontario ($n=2$), and New York ($n=7$) were enrolled. All quarters from each cow were tested by the dairy producer using the California Mastitis Test (CMT) between calving and day 3 in milk, and sampled aseptically for milk bacteriology. A CMT score >0 was considered positive. Cows with a positive CMT were randomly assigned to receive either the label dose of intramammary cephapirin sodium (Cefa-Lak) or no treatment. All CMT positive cows were sampled for bacteriological culture on two more occasions (10-16 DIM, and 17-23 DIM) to determine cure of infections. Outcomes evaluated included the effect of treatment on cure for major pathogens, and the effects of treatment on linear score (LS) and milk production for the first three DHI tests post calving. The sensitivity (56%) and specificity (86%) of CMT for detecting cows infected with major pathogen infections was relatively good, although the test characteristics varied among farms; particularly in relation to the rate of IMI in fresh cows. There was a significant difference in cure rates for major pathogens ($p<0.01$), especially for the environmental streptococci ($p<0.0001$) between the 135 treated quarters and the 186 controls. The impact of CMT score, treatment group, and cure were assessed by measuring changes in LS and milk production using a mixed model procedure, controlling for herd, breed, and lactation. Overall, cows with a CMT 3 had a higher LS ($p<0.05$). Treated cows were 3.6 times more likely to cure a major pathogen infection ($p<0.02$). Cows that cured a

major pathogen had a lower LS on test date 3 ($p=0.08$). As LS increased milk production decreased. There was a trend in the data that indicated that untreated cows with high CMT score at calving (score 2 and 3) had a lower milk production on the first test days, whereas this effect was not present in treated cows with a high CMT score. In conclusion, early antibiotic treatment of CMT positive quarters had a significantly greater cure rates than controls, particularly with the environmental pathogens.

Key Words: Mastitis, Postpartum, Therapy

342 Reported antimicrobial usage on organic and conventional dairy farms in the Midwest and Northeast. A.M. Geiger^{*1}, P.L. Ruegg¹, L.D. Warnick², J.B. Kaneene³, S.J. Wells⁴, C. Fossler⁴, and L. Halbert³, ¹University of Wisconsin, Madison, WI, ²Cornell University, Ithaca, NY, ³Michigan State University, East Lansing, MI, ⁴University of Minnesota, St. Paul, MN.

A longitudinal study is evaluating risk factors for antimicrobial resistance on dairy farms. The objective of this part of the project was to compare antimicrobial usage on conventional (CON) versus organic (ORG) dairy farms. A questionnaire ($n=131$) was administered at an initial visit by trained personnel. Data were entered into a central database and analyzed using SAS. Conventional dairies used significantly more ionophores and coccidiostats in weaned calves ($p<.0038$.) More milk from cows treated with antibiotics ($p=1.401 \times 10^{-5}$.) and more milk replacers containing antibiotics ($p=.004$) were used to feed calves on CON farms. Significantly more CON dairies used antibiotics ($p=.0003$) to treat respiratory disease in cows. There was no significant difference in the use of antibiotics to treat respiratory diseases or scours in calves. The use of Tetracycline ($p=.002$.) and Trimethoprim-Sulfa ($p=.0049$) to treat calf scours was higher in CON dairies. No ORG dairies but 40.4% of CON dairies reported the use antibiotics to treat mastitis ($p=1.307 \times 10^{-6}$.) The most common antibiotics used to treat mastitis on CON dairies were: Penicillin (42.42%), Ampicillin (26.26%), Amoxicillin (15.15%), and Oxytet (18.18%). Comprehensive dry cow therapy was used by 97.98% of CON versus 3.13% of ORG. Significantly more conventional dairies used antibiotics to treat metritis or retained placenta ($p<.0001$.) Significantly more conventional dairies used antibiotics to treat foot problems in adult cows ($p<.0001$.) Although there was no significant difference in the use of antibiotics in footbaths, significantly more CON dairies used tetracycline in the footbath ($p=.0214$.) No ORG herds but 17.17% of CON used antibiotics in the water or feed of weaned calves and heifers ($p=.0122$.) Of the organic dairies, 50% reported the use of antibiotics in their dairy cattle. After antibiotics had been used, 10% of ORG herds reported using animals for organic milk production after a withdrawal has passed. No ORG herds used animals for organic meat production after administering antibiotics. As expected, this study found that the use of antimicrobials is significantly higher on CON farms as compared to ORG farms.

Key Words: Antimicrobial, Organic, Drugs

343 Influence of environmental stressors and prophylactic antibiotic on serum antioxidant concentrations and incidence of bovine respiratory disease of feeder steers. N. K. Chirase^{*1,3}, C. W. Purdy², R. W. Loan³, R. Briggs², G. Duff⁴, J. Avampato¹, and D. Murray⁵, ¹Texas Agricultural Experiment Station, Amarillo and West Texas A&M University, Canyon, ²USDA/ARS, Bushland, TX and Ames, IA, ³Texas A&M University, College Station, ⁴Arizona State University, Tucson, Arizona, ⁵OXIS International, Portland, OR.

Feeder cattle often encounter many environmental stressors and pathogens associated with the marketing process and translocation to the feedyard. Exposure to stressors could compromise the antioxidant and immune defense systems, resulting in morbidity and mortality of these calves. An experiment was conducted to determine the effects of prophylactic antibiotic treatment and posttransit commingling of feeder calves obtained from two sources (New Mexico and Tennessee), to measure red blood cell (RBC) lysate concentrations of cellular glutathione peroxidase (cGPx), reduced glutathione (GSH) and superoxide dismutase (SOD) and assess the incidence of bovine respiratory disease (BRD). One hundred twenty one (121) crossbred steers (average BW 190 kg) were purchased in TN and eighty four (84) crossbred steers of similar size and age were obtained in NM, vaccinated, weighed, and blood obtained for RBC. Steers were randomly allotted into 3 commingling treatment groups (3 replicates per group): 1) New Mexico (NM), 2) Tennessee

(TN) and 3) Commingled (Mixed). One-half of the steers in each treatment group received pretransit prophylactic Nuflor (1 mL/15 kg of BW, s.c.). Upon arrival at the feedyard in Clayton, NM, all steers were managed using commercial feedyard management protocols. Steers were also scored daily for BRD and blood was obtained upon arrival (d 0) and on morbid steers on various days. All the oxidative stress biomarkers were standardized using HB content of the cell. The data were subjected to the analysis of variance using the General Linear Models procedure of SAS. Pretransit HB (mg/dL), cGPx (mU) and GSSG (nmol) were lower ($P<0.05$) in TN steers than NM steers. On the contrary, the GSH concentrations of the NM steers were lower than the TN steers. Pretransit cGPx values for TN calves correlated ($r=0.27$; $P<0.01$) with episodes of BRD at the feedyard. As incidence of BRD increased from 0 to 4, cGPx concentrations decreased from 95.3 to 20.3 mU, respectively. Superoxide dismutase and GSH responses were inconsistent among all treatments. These results suggest that oxidative stress biomarkers could be used as biomarkers of BRD susceptibility. Furthermore, antioxidant supplementation may be required to restore the antioxidant defense system

Key Words: Feeder Steers, Oxidative Stress, Bovine Respiratory Disease

344 Effect of environmental stressors and prophylactic antibiotic on serum antioxidant concentrations and incidence of bovine respiratory disease of feeder steers. N. K. Chirase^{*1,3}, C. W. Purdy², R. W. Loan³, R. Briggs⁴, G. Duff⁵, and J. M. Avampato¹, ¹Texas Agricultural Experiment Station, Amarillo and West Texas A&M University, Canyon, ²USDA/ARS, Bushland, TX, ³Texas A&M University, College Station, TX, ⁴USDA/ARS, Ames, IA, ⁵Arizona State University, Tucson, Az.

Feeder cattle often encounter many environmental stressors and pathogens associated with the marketing process and translocation to the feedyard. Exposure to stressors could compromise the antioxidant and immune defense systems, resulting in morbidity and mortality of these calves. An experiment was conducted to determine the effects of prophylactic antibiotic treatment and posttransit commingling of feeder calves obtained from two sources (New Mexico and Tennessee), to measure serum antioxidants (retinol, α - and γ -tocopherol) concentrations and assess the rate of bovine respiratory disease (BRD). One hundred twenty one (121) crossbred feeder steers (average BW 190 kg) were purchased in TN and eighty four (84) crossbred steers of similar size and age were purchased in NM and calves were vaccinated, weighed, and blood obtained via jugular venipuncture. The calves were randomly allotted into 3 commingling treatment groups (3 replicates per group): 1) New Mexico (NM), 2) Tennessee (TN) and 3) Commingled (Mixed). One-half of the steers in each treatment group received pretransit prophylactic Nuflor (1 mL/15 kg of BW, s.c.). Upon arrival at the research feedyard in NM, all steers were managed similar to commercial feedyard management protocols. Steers were also scored daily for BRD and blood was obtained via jugular venipuncture upon arrival (d 0), 7, and 28 d posttransit. The data were subjected to the analysis of variance using the General Linear Models procedure of SAS. There was no antibiotic treatment by commingling interaction ($P>0.05$) for serum free retinol, α - and γ -tocopherol concentrations and incidence of BRD. Regardless of commingled group, transit stress decreased ($P<0.01$) serum free retinol and α -tocopherol concentrations of feeder steers on d 7 and 28 posttransit. By d-28, serum α -tocopherol concentrations decreased from 6.3 ug/mL to 1.65 ug/mL, far below the critical levels for cattle. Prophylactic antibiotic treatment did sustain ($P>0.05$) serum antioxidant concentrations of steers. Although, γ -tocopherol also decreased regardless of commingled or antibiotic treatment, they increased three-fold by d-28. These results suggest that transit stress reduced serum antioxidant concentrations to critical levels at the feedyard and supplementation may be required to restore them.

Key Words: Feeder Steers, Oxidative Stress, Bovine Respiratory Disease

345 Development and validation of a pruritic index to assess the impact of chorioptic mange infestation in dairy cows. K. Day^{*1}, K. Leslie¹, T. Duffield¹, D. Kelton¹, J. Jansen², and W. Sears¹, ¹University of Guelph, Guelph, ON, ²Ontario Ministry of Agriculture, Food, and Rural Affairs, Fergus, ON.

Recent studies have reported a significant association between presence of mange lesions and reduced production in early lactation. In addition, there was a significant positive production response to moxidectin therapy in the transition period. However, the biological reasons for these

effects were not described. It is suspected that mange infestation results in intense pruritus and decreased DMI. The objective of this study was to develop and validate a semi-quantitative scoring system to categorize the degree of pruritus in mange infested cattle. In addition, the association between Pruritic Index Score, Mange Lesion Score, presence of Chorioptes mites, measures of productivity, and response to endectocide treatment in Ontario dairy cattle were evaluated. Subjective measures of mange lesion and pruritus were developed and evaluated. Study herds were solicited from veterinarians based on observed mange lesions. All lactating cows were scored for pruritic index and mange lesions at enrollment and six weeks post treatment. In a subset of 135 cows in three herds, each cow was scored by six different individuals to develop an inter-reader assessment of these subjective scoring systems using a statistical permutation test. Mange positive cows were matched with mange negative herd mates for parity and stage of lactation. All cows were randomly assigned to receive moxidectin pour-on endectocide or a placebo pour-on solution. The study population consisted of 1179 cows in 21 herds. The overall prevalence of mange lesions was 47.8% and of pruritus was 56.5%. Herd level prevalence of mange lesions ranged from 19 to 72%. Inter-reader comparison of pruritic index and mange lesions showed a small but significant variation among readers. Pairwise comparison showed overall differences between mean scores for lesion and itch between readers, as well as significant differences between some readers for both lesion and itch scores. More differences were observed for inter-reader lesion scores than for itch scores. Pruritic index and mange lesion scores were significantly associated. When DIM, parity, and random herd effects were controlled, positive pruritic index score was significantly associated with higher milk production on the DHI test closest to enrollment.

Key Words: Mange, Pruritus

346 Cow characteristics and management factors on locomotion in Holsteins. T. E. van Dorp^{*1}, L. R. Schaeffer¹, P. Boettcher², D. Kelton¹, and M.M. Shoukri³, ¹University of Guelph, Guelph, ON, Canada, ²IDVGA-LITA, Segrate (MI), Italy, ³University of Western Ontario, ON, Canada.

Risk factors related to locomotion of Holstein dairy cows were separated into the characteristics of the cow (locomotion score, parity, days in milk, body condition score, and 150-day kg milk production) and management factors (flooring, hoof trimming, footbath, and feeding around parturition). The objective was to relate the risk factors to the change in locomotion scores from first to second visit (49 to 59 days apart). Milking cows of 26 free stall herds were scored for locomotion (from 1 Excellent to 5 Lame) and body condition (BCS)(from 1 Skinny to 5 Obese). Data consisted of 5774 observations on 3298 cows (2478 cows had 2 observations). Locomotion score was analyzed with a linear mixed model. Herd was included as a random effect. Results indicated that herd explained almost 3 percent of the variability, whereas the unexplained variability, the residual, accounted for 97 percent. Cows with more parities and more days in milk were associated with reduced locomotion. Cows with more body condition and higher 150-day milk production were associated with improved locomotion. Management practices indicated that not using a footbath, using a footbath twice per month, not using formaldehyde, not trimming the hoofs, and changing the diet twice after calving were associated with improved locomotion. These results should be interpreted with caution, because the number of herds was relatively small, and significant management factors were usually found when the number of herds in a category was small. The large residual variance suggested that other more possibly important factors (disease) were not recorded during this study.

Key Words: Locomotion, Dairy cows

347 Effect of environmental stressors and prophylactic antibiotic on performance, fever status and incidence of bovine respiratory disease of feeder steers. N. K. Chirase^{*1,3}, C. W. Purdy², R. W. Loan³, R. Briggs⁴, G. Duff⁵, and J. M. Avampato¹, ¹Texas Agricultural Experiment Station, Amarillo and West Texas A&M University, Canyon, ²USDA/ARS, Bushland, TX, ³Texas A&M University, College Station, TX, ⁴USDA/ARS, Ames, IA, ⁵Arizona State University, Tucson, Az.

Feeder cattle often encounter many environmental stressors and pathogens associated with the marketing process and translocation to

the feedyard. Exposure to stressors could compromise the antioxidant and immune defense systems, resulting in morbidity and mortality in these calves. An experiment was conducted to determine the effects of prophylactic antibiotic treatment and posttransit commingling of feeder calves obtained from two sources (New Mexico and Tennessee), to determine performance and rate of bovine respiratory disease (BRD). One hundred twenty one (121) crossbred feeder steers (average BW 190 kg) were purchased in TN and eighty four (84) crossbred steers of similar size were obtained in NM and calves were vaccinated, weighed, rectal temperature (RT) measured, and randomly allotted into 3 commingling treatment groups (3 replicates per group): 1) New Mexico (NM), 2) Tennessee (TN) and 3) Commingled (Mixed). One-half of the steers in each treatment group received pretransit prophylactic Nulflor (1 mL/15 kg of BW, s.c.). Upon arrival at the Clayton Livestock Research Center, Clayton, NM, all steers were housed by groups and managed similar to commercial feedyard management protocols. Steers were also scored daily for BRD, weighed and rectal temperatures measured upon arrival (d 0), 7, 14, 21 and 28 d posttransit. The data were subjected to the analysis of variance using the General Linear Models procedure of SAS. There was no antibiotic treatment by commingling interaction ($P > 0.05$) for ADG, RT or BRD rates. Bovine respiratory disease rate was higher in the TN and Mixed groups than the NM group (2.22 and 1.72 vs 0.92, respectively). However, on d 7, 14, 21 and 28 of the study, the NM calves gained less ($P < 0.01$) and also had higher RT on d 28 than the TN and Mixed calves. Prophylactic antibiotic had no effect ($P > 0.05$) on RT or ADG of calves of all treatment groups but lowered ($P < 0.05$) BRD rates (1.33 vs 1.91). As the BRD rates or episodes of sickness increased, the ADG of calves decreased. These results suggest that more studies are required to understand the role of environmental stressors on feeder cattle performance and health.

Key Words: Feeder Steers, Performance, Bovine Respiratory Disease

348 A comparison of the effect of *Neospora caninum* on milk production in two populations of Ontario dairy herds. Jamie Hobson^{*1}, Todd Duffield¹, Dave Kelton¹, Bev McEwen², Sharon Hietala³, Kerry Lissemore¹, Ken Leslie¹, Gerard Cramer¹, and Andrew Peregrine¹, ¹Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada, ²Animal Health Laboratory, University of Guelph, Guelph, Ontario, Canada, ³California Animal Health and Food Safety Laboratory System, Davis, University of California, U.S.A.

Studies on *Neospora caninum* infection in dairy cattle and its effect on milk production have yielded conflicting results, possibly due to differences in study methodology or to an as yet undetermined biological effect. The objective of this work was to compare these effects and propose a theory explaining the association between *N. caninum* serostatus and milk production. Group A consisted of cows from 28 case herds of a large study into *N. caninum* in Ontario dairy herds conducted in 1999. These herds had experienced at least one *N. caninum* abortion based on fetal histopathology in 1998/99; subsequent whole herd serology was completed in 1999. Group B comprised 57 herds that were sampled in the 1998 Ontario Sentinel Herd Project and were considered representative of Ontario herds. Cow-level completed 305-day milk production records were obtained for all cattle from the Ontario Dairy Herd Improvement program from the parity corresponding to the time of serum collection. Cow-level serostatus was determined with a kinetic-ELISA, using a sample-to-positive control ratio cutoff of ≥ 0.45 . Data were analysed using a linear regression model with the GENMOD procedure in SAS ver.8 controlling for parity, days in milk at test date, and the random effect of herd clustering. Seropositive cows in Group A produced 276 kg less 305-day milk than seronegative cows ($n=1196$, $p < 0.05$). In contrast, Group B seropositive cows produced 151 kg more 305-day milk ($n=3162$, $p=0.10$) than seronegative cows. Therefore, if *N. caninum* caused abortion problems in a herd, milk production was negatively affected in seropositive cows, but when *N. caninum* did not cause an abortion problem, milk production was enhanced in seropositive cows. The authors theorize that the effect of *N. caninum* infection on cow-level milk production is dependent on the immunological ability of cattle to control *N. caninum* infection.

Key Words: *Neospora caninum*, Milk production, Abortion

Breeding and Genetics

Factors Affecting Fertility and Longevity

349 Assessment of trends in involuntary culling in expanding herds using survival analysis methodology. K. A. Weigel*, R. W. Palmer, and D. Z. Caraviello, *University of Wisconsin - Madison*.

Trends in voluntary and involuntary culling were examined in 141 Wisconsin dairy herds that expanded significantly between 1994 and 1998. Data included 59,280 Holstein cows that calved from January 1987 through December 1999. Mean failure time (from first calving until culling) for uncensored observations was 767 days. Data were analyzed using a Weibull proportional hazards model that included a random, time-independent effect of herd, as well as fixed, time-dependent effects of year-season, parity by stage of lactation, and milk yield by expansion time. Cows were grouped into deciles according to within herd-year ranking for milk yield (after adjustment for age and parity), and the effect of milk yield on culling was considered before, during (same year and following year), and after the most recent major expansion. Prior to expansion, the lowest producing cows in each herd were 6.82 times as likely to be culled, as compared with average cows, but this risk ratio decreased to 4.29 during the expansion period and 1.51 after the expansion. Meanwhile, the highest producing cows were 0.61 times as likely to be culled as average cows prior to expansion, and this risk ratio increased to 0.71 during the expansion period and 0.84 after the expansion. This indicates a trend over time toward less voluntary culling of unprofitable cows and more involuntary culling of sick, injured, or infertile cows, at least in expanding herds. This trend could reflect greater stress of production, reduced individual cow care, poorer health among (inferior quality) purchased animals, or problems with biosecurity. This trend is undesirable, in terms of genetic progress, because it reflects a reduction in the intensity of selection of dams of replacement heifers. In addition, this trend likely contributes to the shortage of replacement heifers on many modern dairy farms.

Key Words: Expansion, Survival, Holsteins

350 Analysis of the relationship between linear type traits, inbreeding, and survival in US Jersey cows using a Weibull model. D. Z. Caraviello*, K. A. Weigel, and D. Gianola, *University of Wisconsin Madison WI USA*.

The ability of a dairy cow to resist involuntary culling is of high economic importance to the dairy farmer. Genetic improvement of survival can lead to lower replacement costs, decreased veterinary costs, more opportunities for voluntary culling, and a higher proportion of cows producing at a mature level. The objective of this study was to evaluate the relationship between linear type traits, inbreeding and survival in Jersey cattle using a Weibull model. Data were obtained from USDA Animal Improvement Programs Laboratory, and these included 284,943 Jersey cows with first calving between January 1, 1981 and August 17, 2000 from 2,913 herds. Average failure time was 880 days after first calving. Our model included the effects of herd-year-season of calving, inbreeding, age at first calving, parity-stage of lactation and within-herd quartiles for mature equivalent milk. Linear type traits were analyzed one at a time. All udder traits jointly, all locomotion traits jointly and final score were evaluated in three additional models. Each one of the type traits was divided in ten classes and class number five was chosen as reference. The 5 traits with the highest impact on survival were Udder Depth, Suspensory Ligament, Fore Udder, Front Teat Placement, and Rear Udder Height. Animals in class number one for these traits had between 1.50 and 1.87 times higher risk of being culled than animals in class number five.

Key Words: survival, type traits, inbreeding

351 Correlations among measures of dairy cattle fertility and longevity. P. M. VanRaden*, H. D. Norman, and R. H. Miller, *USDA Animal Improvement Programs Lab, Beltsville, MD USA*.

Genetic correlations among fertility, longevity, and other traits were estimated by multitrait REML from three data sets. Five reproductive traits were compared using individual breeding data from 2,195,643 lactations of Holstein cows from 3447 sires and 3440 mating bulls. Lactations were initiated in 1998 through 2000. Heritabilities for cow fertility

were 6.6% for days to first breeding, 4.0% for days to last breeding, 1.8% for number of inseminations, 1.0% for 70-d nonreturn rate, and 10% for gestation length. Days to last breeding were more correlated with days to first breeding (0.85) than with number of inseminations (0.61) or nonreturn rate (-0.21). Mating bull fertility contributed 0.5% of phenotypic variance for nonreturn rate. Very similar estimates were obtained using 145,976 lactations of Jersey cows except that days to first breeding had a lower heritability (4.0%). Two longevity traits were compared using data from 1,062,791 Holstein cows born during 1992 through 1994 from 3080 sires. Productive life, which is limited to 10 mo of credit per lactation, was compared with lifespan, which included credit for all months between lactations. Heritabilities were 7.6% for productive life and 6.7% for lifespan; genetic correlation of the two traits was 0.986. Calving interval from first to second lactation was the measure of cow fertility. Cows culled after first lactation were assigned a mean calving interval of 415 d except those culled for reproductive failure, which were assigned the trait limit of 530 d. High protein and fat yields were correlated genetically (0.32) with long calving intervals. Many of the genes that affect fertility also affect longevity. Fertility was more correlated with productive life (-0.59) than with lifespan (-0.46); somatic cell score also was more correlated with productive life (-0.31) than with lifespan (-0.28). Thus, productive life was preferred to lifespan as a measure of longevity. Selection for productive life has reduced the decline in cow fertility, but direct selection on fertility evaluations could be more profitable.

Key Words: Fertility, Longevity, Genetic correlation

352 Modeling length of productive life in beef cows. N. Vukasinovic*, M. Berweger Baschnagel², and N. Kuenzi³, ¹*Utah State University*, ²*SVAMH, Switzerland*, ³*Swiss Federal Institute of Technology*.

This study investigated factors influencing the length of productive life (LPL) in the population of registered Angus beef cows in Switzerland using survival analysis techniques. The data included 7,090 records on cows calving between 1975 and 1998. LPL was defined as the number of days from the first calving to the weaning of the last calf. Cows that were still alive at the end of the data collection period, as well as those cows with no further records up to 250 days after the weaning of the last calf, were defined as censored. Cows with missing first calving date were defined as left truncated. The data included 45% censored and 16% left truncated records. The mean LPL was 1,683 days for uncensored records and 1,815 days for censored records, reflecting the fact that more records on cows with longer LPL were from the recent years. LPL was modeled using a mixed Weibull survival model. The following fixed effects were included in the model: age at first calving, proportion of Angus genes, housing system, and a cow's scores for type, feet and legs, and udder. Time dependent covariates included in the model were stage of lactation, calving year and season, and birth and weaning weight of the calf. A random effect of herd-year-season, assumed to follow a loggamma distribution with the parameter $\gamma = 5.00$, was also included in the model, but it was integrated out in the analysis. The estimated shape and scale parameters of the baseline (Weibull) hazard function were 2.36 and 0.02, respectively. The model explained about 83% of the variability in LPL. All effects in the model except the housing effect were significant (p -value < 0.05). The relative culling risk was estimated for each level of each effect. The greatest increase in relative culling risk was observed in first calving cows immediately after the weaning of the calf. These cows had up to five times higher risk of being culled than an average cow, suggesting that most selection decisions were made after a cow completed her first production cycle. Also, cows with very low or very high weaning weights of the calf were at a higher than average culling risk, indicating that low production and fertility problems appear to be major reasons for culling of beef cows.

Key Words: Beef cattle, Length of productive life, Survival analysis

353 Genetic relationships among fertility traits of Holsteins and Jerseys. H. D. Norman^{*1}, R. H. Miller¹, P. M. VanRaden¹, J. R. Wright¹, and J. S. Clay², ¹*Animal Improvement Programs Laboratory, Agricultural Research Service, Beltsville, MD*, ²*North Carolina State University, Raleigh*.

Dairy Herd Improvement data with service dates from 2,195,643 Holstein and 171,981 Jersey sire-identified lactations from 1995 through 2000 were used to assess genetic variation in and relationships among fertility traits: days to first service (**D1**), days to last reported service (**DL**), nonreturn rate to first service before 70 d (**NR**), and number of services (**NS**). Mean NR was calculated by herd-year, and herd-years with NR of <10% or >90% were excluded; NR was not examined for cows that left the herd before 70 d after first insemination or if first service was after September 15, 2000. Phenotypic means for D1, DL, NR, and NS, respectively, were 90 d, 141 d, 55%, and 2.10 services for Holsteins and 83 d, 125 d, 57%, and 1.99 services for Jerseys. Data were adjusted for fixed effects of parity for all fertility traits and also for lactation stage at first service for NR and NS. Adjustment was also made for partial regression of fertility trait on mean of two highest test-day yields of milk, fat, and protein and for deviation of calving age from mean for corresponding parity. In the table below, heritabilities (diagonals) and genetic correlations (above diagonals) were estimated by multitrait REML with an adjustment for herd-year-season of first service; phenotypic correlations are below diagonals. Standard errors for heritability estimates for Holsteins and Jerseys, respectively, were 0.003 and 0.009 for D1, 0.002 and 0.008 for DL, 0.001 and 0.006 for NR, and 0.001 and 0.006 for NS. Genetic variation for NR is low, but progeny groups can be large. Because DL has a higher heritability than NR and a moderate to high genetic correlation with D1 and NS, it may be the best single criterion of cow fertility of the four traits.

Trait	Holstein				Jersey			
	D1	DL	NR	NS	D1	DL	NR	NS
D1	0.066	0.85	0.24	0.15	0.040	0.73	0.09	0.05
DL	0.41	0.040	-0.21	0.61	0.41	0.029	-0.55	0.70
NR	0.00	-0.32	0.010	-0.88	0.00	-0.36	0.011	-0.97
NS	0.00	0.76	-0.57	0.018	0.00	0.76	-0.62	0.022

Key Words: Fertility, Nonreturn rate, Reproduction

354 Results of 25 years of selection for functional traits. A. Karlsen^{*}, T. Steine, E. Sehested, M. Svendsen, and I.M.A. Ranberg, *GENO Breeding and A.I. Association*.

Norwegian Dairy Cattle (NRF) have been selected for functional traits and yield for more than 25 years. Major emphasis has been put on fertility and mastitis in the breeding goal as well as on production traits, calving ease, and stillbirths. Information on production, calvings, fertility, and health status is stored in the Norwegian Dairy Herd Recording (NDHR). In total 92% of the farms, representing approximately 290,000 cows, are members of the NDHR, where recording is compulsory. Only veterinarians can perform medical treatments, and veterinary treatments are included in the NDHR. Progeny testing for functional traits is based on 250-350 daughters to obtain breeding values with high accuracy. Sires with a high total merit index based on production and functional traits are used in the breeding scheme. Genetic trends are estimated for all traits. The genetic trend for fertility shows a significant increase in 60 days non-return rate for heifers for the last 25 years. The phenotypic average 56 days non-return rate of heifers is currently more than 77%, with a calving interval of approximately 1 year. Increased resistance to mastitis has a weight of 22% in the breeding goal. The genetic trend shows a very significant increase for resistance to mastitis; in 2000 the phenotypic average shows that approximately 11% of the heifers were treated for mastitis. Only veterinarians can prescribe antibiotics, and routine use of antibiotics to prevent mastitis is not allowed. Calving ease as well as stillbirths have been included in the breeding goal since 1978, and are now not considered a problem in the NRF-population. More than 93% of the calvings are reported as having no problems at calving. Only 2% of the calvings are reported as having major problems. The percentage of abortions is less than 1, and less than 3% of the calves are stillborn.

Key Words: Functional Traits, Cattle, Genetic Trends

355 Correlations between Estimated Breeding Values (EBVs) of juvenile growth traits and cows' stayability in an Angus herd. D.P. Rasal^{*1}, G.H. Crow¹, J.N.B. Shrestha², and A. Brule-Babel³, ¹*Dept. of Animal Science, University of Manitoba, Winnipeg, MB R3T 2N2*, ²*Agriculture and Agri-Food Canada, Lennoxville, QC J1M 1Z3*, ³*Dept. of Plant Science, University of Manitoba, Winnipeg, MB R3T 2N2*.

Records of 3,284 animals for juvenile growth traits and 581 cows for stayability to 3 years of age (Stay3) from an Angus herd in Manitoba were analysed to estimate the correlations between their EBVs. Univariate animal models (ASREML) were used to analyse body weights at birth (BW), at 205-d weaning (WW) and at one year of age (YW), pre-weaning daily gain (WG) and post-weaning gain to one year of age (PWG). The models included fixed effects due to birth year, birth type, calf's sex and age of dam (a covariate), and random direct and maternal genetic effects. The study also utilized an ASREML univariate logit animal model that included fixed effects due to cow's birth herd and year, and a random direct genetic effect for Stay3 as a binary scored trait. Survival analysis revealed that the risk of a cow being culled from the herd rose sharply after 3 years of age given the maximum calving opportunity up to 10 years. The direct h^2 estimates for BW, WW, YW, WG and PWG were .54, .22, .24, .18 and .21, respectively. Corresponding maternal h^2 estimates were .14, .18, .10, .19 and .01, respectively. The direct h^2 estimate for Stay3 was .17. All estimates were within the range of those published previously. Product-moment and rank correlations of direct and maternal EBVs for growth traits with direct EBV for Stay3 were all significant, except that there was no relationship of direct EBVs for WG and PWG with that for Stay3. The correlations of direct EBV for BW and maternal EBVs for BW, WW and WG with EBV for Stay3 ranged from .11 to .23, while the product-moment and rank correlations between maternal EBV for PWG with direct EBV for Stay3 were -.14 and -.12, respectively. The results suggest that the genetic merit of cows' stayability to 3 year of age has a favorable relationship with the maternal genetic merits of pre-weaning growth traits, but there appears to be an antagonism with that of post-weaning gain.

Key Words: Beef cattle, Growth and stayability, Correlations of EBVs

356 A genetic study of longevity in swine. F. Fortin^{*} and R. I. Cue, *Department of Animal Science, McGill University (Macdonald Campus), Montreal, Quebec, Canada*.

Data from the Quebec swine breeding program (1996 to 2001) were used to estimate genetic parameters for longevity and to evaluate the contribution of non-genetic factors. After data verifications there were 10039 Yorkshire sows and 8856 Landrace with records of herd life. The program 'The Survival Kit V3.12' (Ducrocq and Silkner, 2001) was used to estimate heritability separately within each breed, using a Cox proportional hazard model. Time-independent fixed effects of year of birth, estimated breeding values (EBV) backfat, EBV age to 100 kilos, EBV litter size and their interactions with herd, and age at first service were included. The effect of litter size within parity and the effect of event (farrowing, weaning or heat) were treated as fixed time-dependent variables. The random effect of sire using sire relationships back 2 generations was considered as the source of genetic variation. Length of productive life (longevity) was defined as the number of days from first service until culling. In the survival analyses of the Yorkshire sows, all explanatory factors had a significant effect ($P < 0.05$) on longevity of sows while only age at first service was not significant ($P < 0.05$) for the Landrace breed. The effects of litter size within parity and event had the largest influence among the factors included. There is an increasing culling risk for the period after weaning compared to the period after farrowing or heat. Also, the risk of being culled is higher at lower parity and with lower litter size. The significant interaction factors of herd and EBV's show that EBV's can have divergent effects on the culling risk for different herds. For the Yorkshire sows, the effect of age at first service shows a tendency of higher culling risk for a higher age. The sire variances were 0.042 and 0.032 for the Yorkshire and Landrace, respectively, which correspond to heritabilities of 0.16 and 0.13. It can be concluded that there is genetic variation that can be used for increasing longevity by selection.

Key Words: Longevity, Swine, Heritability

357 Comparison of effect of vacuum condensed and ultrafiltered milk on pasteurized Process cheese. M. R. Acharya* and V. V. Mistry, *MN-SD Dairy Foods Research Center, South Dakota State University.*

Milk was concentrated by ultrafiltration (UF) or vacuum condensing (CM) and milks with two levels of protein: 4.5% (UF1 and CM1) and 6.0% (UF2 and CM2) for concentrates and a Control (C) with 3.2% protein were used for manufacturing five replicates of Cheddar cheese as discussed earlier (Acharya et al. 2001. J. Dairy Sci. 84 (Suppl.1):306). For manufacturing pasteurized Process cheese a 1:1 blend of shredded 18-week and 30-week Cheddar cheese, butter oil and disodium phosphate (3%) was heated and pasteurized at 74°C with direct steam injection. The moisture content of the resulting Process cheeses was 39.4 (C), 39.3 (UF1), 39.4 (UF2), 39.4 (CM1) and 40.2% (CM2). Fat and protein contents were influenced by both level and method of concentration of cheese milk. Fat content was the highest in C (35.0%) and the lowest in UF2 (31.6%), whereas, protein content was the lowest in C (19.6%) and the highest in UF2 (22.46%). Ash content increased with increase in level of concentration of cheese milk with no effect of method of concentration. Meltability of Process cheeses decreased with increase in level of concentration and was higher in C than the concentrates. Hardness was highest in UF cheeses (8.45 kg-UF1 and 9.90 kg-UF2) followed by CM cheeses (6.27 kg-CM1 and 9.13 kg-CM2) and C (3.94 kg). Viscosity of molten cheese at 80°C was higher in 6.0% protein treatments (1043 cp-UF2 and 1208 cp-CM2) than in by 4.5% protein treatments (855 cp-UF1 and 867 cp-CM1) and in C (557 cp). Free oil in Process cheeses was influenced by both level and method of concentration with C (14.3%) being the lowest and CM2 (18.9%) the highest. Overall flavor, body and texture, and acceptability were significantly higher for Process cheese made with the concentrates compared to control. This study demonstrates that the application of concentrated milks for Cheddar cheese making has an impact on Process cheese characteristics. The type of concentration technique (UF or CM) also is a factor.

Key Words: process cheese, ultrafiltration, condensing

358 Comparison of three methods to quantify water soluble calcium in Mozzarella cheese. 2. Effect of short-term aging. M.A.S. Cortez¹, M.M. Furtado¹, and P.S. Kindstedt*², ¹Federal University of Vicosa/CAPEs, MG/Brazil, ²University of Vermont, Burlington, VT/USA.

Previous studies have shown that the concentration of water soluble (WS) Ca in the expressible serum (ES) from Mozzarella cheese may increase during the first 2 wk after manufacture. This study compared WS Ca measurements obtained by two different dilute WS extract methods (M1, Metzger et al. (2001) J. Dairy Sci. 84:1357; M2, Kuchroo and Fox (1982) Milchwissenschaft 37:331), and one ES method (M3, Guo and Kindstedt (1995) J. Dairy Sci. 78:2099) during short-term aging of Mozzarella cheese. A cultured low-moisture part skim Mozzarella cheese was obtained from a commercial manufacturer on the day after manufacture and stored at 4°C. Six WS extracts (M1, M2) and six ES samples (M3) were prepared from replicate cheese samples at 3, 6, 9, and 12 d after manufacture, and then analyzed for total solids and crude protein, pH, Ca, P, and Na, concentrations. The data were analyzed according to a split-plot CRD to evaluate the effects of method and storage time on the measurements. WS Ca was affected significantly by method, storage time, and their interaction. Mean WS Ca values, expressed as percentage of total Ca, for the three methods were # d 3: M1 = 38%, M2 = 30%, M3 = 21%; d 6: M1 = 36%, M2 = 28%, M3 = 23%; d 9: M1 = 38%, M2 = 31%, M3 = 26%; d 12: M1 = 36%, M2 = 29%, M3 = 28%. WS Ca increased significantly during storage when measured by M3 but did not change significantly by M1 or M2. WS P increased significantly during storage when measured by M3 but decreased significantly by M1 and M2. The pH of the WS extracts (M1, M2) and ES (M3) was affected significantly by method, storage time, and their interaction. The pH of the M1 WS extract was higher than the cheese pH due to a dilution effect, whereas the pH of M2 extract was lower, due to fermentation during the preparation of the extract. The pH of WS extracts (M1, M2) increased more during aging than the pH of ES (M3). The differing pH

profiles during extraction may have affected WS Ca measurements and contributed to inconsistent results among methods.

Key Words: Mozzarella cheese, Soluble calcium, aging

359 Reduction of losses of salt (NaCl) during the manufacture of cheddar cheese. S. S. Nair* and V. V. Mistry, *MN-SD Dairy Foods Research Center, South Dakota State University.*

One part of pasteurized, separated milk (0.58% fat) was ultrafiltered (55°C, 16.0% protein), another vacuum condensed (12.5% protein) and a third was not concentrated. Cheddar cheese was manufactured using six treatments by standardizing unconcentrated milk to a casein/fat ratio of 0.74 with unhomogenized 35% fat cream (C); homogenized (6.9 MPa/3.5 MPa) 35% fat cream (CH); unhomogenized cream and ultrafiltered milk (UF); homogenized cream and ultrafiltered milk (UFH); unhomogenized cream and condensed milk (CM); and homogenized cream and condensed milk (CMH). C and CH had 3.7% fat and 3.5% protein and the respective values in the remaining treatments were 4.9 and 4.6. Starter (DVS, 7g/kg protein) and rennet (20 ml/100 L for C, CH or 14 ml/100 L for UF,UFH,CM,CMH) were added. Cooking temperature (°C) was 37 for C and CM, 39 for CH, 36 for UF, and 38 for UFH and CMH. Salting (2.7% by weight of milled curd) was done in three equal portions each with three minutes mixing. Fat in whey ranged from 0.16 to 0.35%, and protein from 0.91 to 1.27%. Fat in salt whey ranged from 0.39 to 1.34%, protein from 1.22 to 1.45%, and salt from 6.27 to 8.99%. Moisture content was lowest in the UF and CM cheeses (36.0 and 35.7%) but increased to 36.9 and 37.1% by homogenization. Salt content in the control and ultrafiltered milk cheeses was dependent on homogenization (1.33%, C; 1.83%, CH; 1.33%, UF; 1.70%, UFH). Salt retention was higher in condensed milk cheeses than in those from ultrafiltered milk or control and was not affected by homogenization (1.62%, CM; 1.64%, CMH). Salt recovery in cheese increased from 41.9 in C to 59.9% in CH, and from 41.8 in UF to 54.7% in UFH. The increase was smaller for condensed milk cheeses (50.8 in CM to 52.3% in CMH). For control and ultrafiltered milk cheeses the percentage salt in salt whey was lower with homogenization as was the total amount of salt whey generated. The higher retention of salt due to homogenization may be due to higher resistance to the movement of sodium chloride in the protein-fat matrix.

Key Words: Cheddar cheese, Homogenization, Salt recovery

360 The role of physicochemical properties in governing cheese texture. J.A. Brown*, E.A. Foegeding, M. Drake, and C. Daubert, ¹North Carolina State University.

Cheese is a popular food due to its diversity in application, nutritional value, convenience, and good taste. Producing high quality cheeses that meet consumer expectations is crucial in order for cheesemakers to remain competitive. These expectations include end-use functionality (shred, melt, stretch, etc.) and proper texture. Currently, there is not a clear understanding of what characteristics govern these aspects. This study seeks to define physical properties of young cheeses in order to understand their role in perceived cheese texture. Mozzarella and Pizza cheeses were tested at 4, 10, 17, and 38 days of age; processed cheese was also included. Rheological methods were employed to determine the viscoelastic, non-linear, and fracture properties of the cheeses. A trained sensory panel developed appropriate descriptive language and product-specific reference scales to evaluate cheese texture. Both sensorial and rheological methods differentiated the cheese varieties, and patterns were observed as the cheese aged. Rheological analysis showed the cheeses were viscoelastic gels with greater storage (G' , elastic) than loss (G'' , viscous) moduli. The overall magnitude of G' decreased as the cheeses aged; creep recovery analysis confirmed the loss of overall firmness with time. Five sensory terms differentiated the ages of the cheeses within varieties. Correlations between the sensory and rheological methods were observed, and the predictive nature of such measurements on cheese texture was evaluated. Principle component analysis revealed that sensory evaluation alone was better able to order the cheeses according to age than the when only combinations of rheological methods were used; combinations of both methods chronologically placed the cheeses. These results have significant implications in the cheese industry; by understanding how texture changes during the early stages of

aging, cheesemakers can custom make cheeses with specified textures more accurately. Future testing should focus on how such parameters affect end-use functionality in order develop similar models which will help cheesemakers to meet consumer demands.

Key Words: Cheese Texture, Rheology, Sensory

361 Effect of adding yeast extract on proteolysis and flavor development of reduced fat Cheddar cheese. Shakeel Rehman^{*1}, Nana Farkye¹, Eba Vedomuthu², and MaryAnne Drake³, ¹*Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo, CA 93407*, ²*994 NW Hayes, Corvallis, OR, 97330*, ³*South East Dairy Research Center, North Carolina State University, Raleigh, NC 27695*.

Yeast extract is used as a nutrient for growing lactobacilli. The growth of non-starter lactic acid bacteria (NSLAB) in Cheddar cheese is suppressed by pasteurization of milk and hostile environment of Cheddar cheese. This study was undertaken to determine the effect of adding yeast extract to reduced fat Cheddar cheese curd to promote growth of NSLAB for enhancing flavor. Cheese was manufactured from 100 kg standardized milk on two occasions. After milling, the curd was divided into two portions, C and E. To control portion, C, salt was added at normal levels. A mixture of salt and yeast extract was added to the experimental, E. The cheeses were ripened for 7 months at 8C. One week-old cheeses were analyzed for gross composition. NSLAB were enumerated during ripening. Proteolysis was assessed by urea-polyacrylamide gel electrophoresis (PAGE) of the cheeses and by determination of water soluble N (WSN) and concentration of total free amino acids. A 6-member trained descriptive sensory analysis panel evaluated flavor attributes. Mean % moisture, fat, protein, salt-in-moisture and pH were 40.8, 20.5, 31.1, 4.2 and 5.22 respectively, in E cheeses, and 39.5, 20.5, 30.9, 3.3 and 5.22, respectively, in C cheese. NSLAB counts in E cheeses were 10^1 , 10^3 , 10^5 , cfu / g compared to 0, 10^1 , 10^4 cfu / g in C respectively, after 1, 7 and 30 days of ripening. After 60 days, cell densities of NSLAB were similar (10^6 cfu/g) in C and E cheese. Addition of yeast extract to curd did not influence primary proteolysis. The total free amino acids were significantly higher in E cheese than C cheese throughout ripening, suggesting faster secondary proteolysis in the former cheeses. The sensory panel perceived that the E cheeses had higher intensities of whey, fruity, sulfur, nutty, sweet and sour flavors, but had lower intensities of brothy flavors as compared to C cheeses. Also, the E cheeses were perceived to be more mature than corresponding C cheese. Results show that the use of yeast extract in the manufacture of Cheddar cheese increases the secondary proteolysis and improves flavor.

Key Words: yeast extract, reduced fat Cheddar, NSLAB

362 Effect of pH on chemical and functional properties of cheese. A.J. Pastorino¹, C.L. Hansen¹, and D.J. McMahon^{*1}, ¹*Western Dairy Center, Utah State University*.

Our objective was to determine the effect of pH on chemical and functional properties of cheese. Commercial Cheddar cheese (34% moisture, 30% fat, 1.7% salt, 0.8% calcium) was obtained on 1 d and cut into 0.4 to 0.5-kg blocks that were vacuum packaged and stored for 14 d at 4C. Cheese blocks were then high-pressure injected 1, 3, or 5 times, with a 20% (wt/wt) glucono-delta-lactone solution. Successive injections were performed 24 h apart. After 40 d of storage at 4C, cheese blocks were analyzed for chemical and functional attributes. Injection of glucono-delta-lactone solution decreased cheese pH. After 5 injections, cheese pH was 4.7 compared to 5.3 in the control, uninjected cheese. Decreased pH increased the content of soluble calcium and decreased the total calcium content of cheese. At the highest level, injection of acid promoted syneresis, and residual moisture was observed inside cheese packages. Thus, after 5 injections the moisture content of cheese decreased from 34% to 31%. This resulted in decreased cheese weight, 2.5% after 5 injections. Injecting acid decreased cheese hardness, and at the highest levels of injection, decreased pH and moisture content caused the cheese to become brittle. Thus, the cheese lost structural cohesion, fracturing during testing. When heated, the initial rate of cheese flow increased when pH was lowered from 5.3 to 5.0. However, lowering cheese pH to 4.7 caused decreased flowing rate. Also, the final extent of cheese flow was unaffected by lowering pH to 5.0, but it decreased when cheese pH was lowered to 4.7. We concluded that adding an acid solution to cheese alters protein interactions. At low levels, acid injection decreases interactions between proteins as calcium is solubilized. In contrast, at

high levels, acid injection promotes protein-to-protein interactions as the proteins approach their isoelectric point. Hence, the acid precipitation of proteins overcomes the opposing effect caused by increased calcium solubilization. Therefore, calcium content would direct cheese functionality when the pH of cheese is above 5.0.

Key Words: Syneresis, Calcium, Acid precipitation

363 Impact of high solids cheesemilks that are standardized with cold ultrafiltration retentates on the functionality of non-pasta filata mozzarella cheese. S. Govindasamy-Lucey^{*1}, M. G. Zimbric¹, J. J. Jaeggi¹, M. E. Johnson¹, and J. A. Lucey², ¹*Center for Dairy Research, University of Wisconsin, Madison, Wisconsin, USA*, ²*Department of Food Science, University of Wisconsin, Madison, Wisconsin, USA*.

Non pasta-filata mozzarella (pizza) cheese, a washed, stirred curd style cheese made with mesophilic starter, was manufactured from a blend of cold (whole milk) UF retentate (28% TS) and partially skimmed milk to obtain a milk with 13.6% solids and a casein:fat ratio of 1.0. Control cheese was also made with partially skimmed milk (casein:fat ratio of 1.0, and 11.25% solids). Coagulation was monitored by dynamic low-amplitude oscillatory rheology (DLAOR) in a Physica UDS200 rheometer at 34°C. Cheese functionality was assessed using the UW-Meltmeter, DLAOR and by visual observation when baked on pizza. Gels made from the UF fortified cheesemilks coagulated faster (17 vs 25 min). Rate of firming was also considerably faster in UF fortified milks. The shear stress of the gels, force required to break gels, was considerable higher (50 vs 26 Pa) in the UF fortified cheesemilks compared to control samples. UF fortified cheeses had lower moisture contents (44.6-46.6%) than control cheeses (46.8-49.5%). Melting was assessed by the rate of decrease in cheese height measured by UW-Meltmeter and the rate of increase in the loss tangent parameter (at temperatures > 40°C) as determined from DLAOR tests. The storage modulus (G') of the cheese decreased with increasing temperature as the cheese was heated in the rheometer. The loss tangent curves were shifted higher as the cheeses aged. Melting properties at 1 wk were similar. At 2 wk, UF fortified cheeses melted faster than control. In cheeses ripened between 1 to 3 mo, differences in melting between cheeses were reduced. There were no significant differences in the functional performances between cheeses when they were baked on pizzas. Proteolysis levels, as indicated by TCA-soluble nitrogen, were similar in both cheeses. In conclusion, fortification of pizza cheesemilks with UF retentates at least up to 13.5% total solids had a relatively minor influence on cheese functionality but there was increased fat and nitrogen recoveries as well as reduced moisture contents.

Key Words: Ultrafiltration, Non pasta-filata mozzarella, Cheese rheology

364 Does presalting and brine concentration influence salt uptake by Ragusano cheese? C. Melilli^{*1}, D. M. Barbano², G. Licitra³, G. Tumino¹, G. Farina¹, and S. Carpino¹, ¹*Consorzio Ricerca Filiere Lattiero Casearia, Ragusa, Italy*, ²*Northeast Dairy Food Research Center, Cornell University, Ithaca, NY*, ³*D.A.C.P.A., Catania University, 95100 Catania, Italy*.

Raw milk (864 L), was made into Ragusano cheese. Prior to stretching, the curd (pH=5.23 and 16C) was cut into slices and divided into 22 (11 presalted and 11 not presalted) portions of 3.9 kg. The 11 presalted cheeses were made by dry salting (2% w/w) the slices of curd prior to stretching. At the end of stretching each 3.9 kg mass of cheese was shaped (15x15x15 cm) and held for 22 h at 18C. One of the 11 presalted and one of the 11 non presalted cheeses were analyzed prior to brining. Five of the 10 presalted blocks and five of the 10 non presalted blocks were submerged in a saturated brine for 24 d. The 5 remaining blocks of presalted and the 5 of the non presalted cheeses were totally submerged in a brine containing 18% salt, for 8 d and then they were moved to the saturated brine until 24 d. Cheeses were removed from the brine at 1, 4, 8, 16 and 24 d, weighed and analyzed. The uptake of salt and the loss of moisture were measured by dividing the entire block of cheese in four portions representing the surface to the center. The cheeses kept in saturated brine for 24 d lost (P<0.01) more weight than cheeses that were in 18% brine for the first 8 d. The total salt content (g) was increased (P<0.01) by both presalting and use of 18% salt brine. Moisture loss was higher with presalting (P<0.05) and saturated brine (P=0.07). Salt (%) decreased and moisture (%) increased from the surface to the center of each block. Presalting had no detectable impact on moisture content

in any location within the block. The moisture (%) at the surface of the block in 18% brine was higher ($P < 0.01$) than for saturated brine. This produced a more open, soft structure at the surface of the blocks in 18% brine and allowed more uptake of salt. Subtracting the effect of the presalting treatment from the salt content shows clearly that the lower brine concentration had the strongest impact on increasing both the total salt (%) and rate of salt uptake.

Key Words: Brine, Presalting, Ragusano cheese

365 Temperature induced moisture migration in reduced fat Cheddar cheese. A.A. Olabi*¹ and D.M. Barbano¹, ¹*Cornell University, Northeast Dairy Foods Research Center, Ithaca, NY.*

Moisture migration during cooling of 290 kg Cheddar cheese blocks is a problem. The problem is of greater magnitude in reduced and low fat varieties. The objective of this study was to design and evaluate the performance of a laboratory scale apparatus for simulation of temperature induced moisture migration in 290 kg blocks of Cheddar cheese. Two apparatus were designed to produce a systematic temperature gradient in small cheese slabs over a 36 h period to simulate the temperature gradient that develops during cooling of a 290 kg block. One of the apparatus was designed to induce a moisture migration downwards with gravity and the other against gravity. The apparatus produced moisture migration ranges of 9.7% and 6.4%, for the apparatus to induce moisture migration downwards and upwards, respectively. The moisture moved from areas of warm cheese to areas of cold cheese during cooling, as occurs in 290 kg blocks. These ranges were comparable to the ones obtained with 290 kg reduced-fat Cheddar blocks. In addition, small but significant differences in pH were created within slabs. The direct effect of the temperature gradient on moisture migration within cheese slabs appeared to be more important than the possible impact of the small pH gradient produced within the cheese by the temperature gradient.

Key Words: Reduced Fat Cheddar, Moisture Migration, Temperature

366 Studies on using milk protein concentrate in pizza cheese manufactured by culture or direct acidification. Shakeel Rehman*¹ and Nana Farkye¹, ¹*Dairy Products Technology Center, California Polytechnic State University, San Luis obispo, CA 93407.*

Milk protein concentrate (MPC) has high casein, low lactose and high calcium content. Enrichment of cheese milk with MPC should, therefore, enhance yields and improve quality. The objectives of this study were: (1) to compare pizza cheese made by culture acidification using standardized whole milk (WM) plus skim milk (SM) vs WM plus MPC; and (2) Compare cheese made using WM + MPC by culture acidification to that made by direct acidification. The experimental design is as follows; vat1 (V1) = WM + SM + culture (commercial thermophilic lactic acid bacteria), vat 2 (V2) = WM + MPC + culture, and vat 3 (V3) = WM + MPC + direct acid (2% citric acid). Each cheese milk was standardized to a casein to fat ratio of 1.1. The experiment was repeated thrice. Yield and composition of cheeses were determined by standard methods while the proteolysis was assessed by urea polyacrylamide gel electrophoresis (PAGE) and water soluble N contents. Meltability of the cheeses was determined during one month of storage, in addition to pizza making. The addition of MPC improved the yields from 10.34% 0.566 in V1 cheese to 14.5% 0.844 and 16.65 2.23, respectively in V2 and V3 cheeses but the moisture (at 50%) adjusted yields were 10.74, 18.28 and 11.12 % for V1, V2 and V3 cheeses respectively. The % fat recoveries were 78.19 7.0, 86.29 13.02 and 77.07 6.40 in V1, V2 and V3 cheeses respectively. The % total solid recoveries were 45.72 4.97, 57.90 1 and 55.53 6.40 in V1, V2 and V3 cheeses, respectively. The % protein recoveries were 64.13 6.74, 61.52 % 11.84 and 58.44 14.04 in V1, V2 and V3 cheeses respectively. The % moisture, fat, protein and salt were 49.60 2.78, 20.16 1.60, 22.47 2.258 and 1.16 0.58; 46.22 2.24, 21.66 2.30, 23.08 0.49 and 2.22 0.36; 55.14 0.80, 16.0 1.73, 21.51 2.00 and 2.04 0.34, respectively in V1, V2 and V3 cheeses. The V1 cheese had better meltability than V2 cheese initially but the difference became minimum during storage. V3 cheese had best meltability. The lowest and highest levels of proteolysis were found in V2 and V3 cheeses. The study demonstrates use of MPC in pizza cheese manufacture with improved yield both by culture acidification as well as direct acidification.

Key Words: Pizza cheese, milk protein concentrate, yield

367 Effect of modifying lactose concentration in cheese curd on proteolysis and quality of Cheddar cheese. Shakeel Rehman¹ and Patric Fox², ¹*Dairy Products Technology Center, Calpoly State University, San Luis Obispo, CA 93407*, ²*Department of Food Science, Food Technology and Nutrition, University College, Cork, Ireland.*

The objectives of this study were to determine the role of lactose in Cheddar cheese. Cheese was manufactured from three 100 kg batches of milk: (1) control (C), (2) lactose-reduced cheese (L), in which a volume of whey equal to 40% of the original volume of milk was removed and replaced with 25% volume of water (40C) at the start of cooking, and (3) lactose enriched-cheese (H) was made from milk supplemented with lactose powder to give 8.4% lactose in cheese milk. Samples were taken during ripening for enumeration of starter bacteria, non-starter lactic acid bacteria (NSLAB), residual lactose (RL), pH and proteolysis. Proteolysis in the cheeses during ripening was assessed by determining water-soluble N (WSN) as % of total N, urea polyacrylamide gel electrophoresis (PAGE) of the water-soluble (WSF) and -insoluble fractions, reverse phase-HPLC of 70 % ethanol-soluble (ES) and insoluble (EIS) fractions of WSF, concentration of individual and total free amino acids (TFAA). During ripening the cheeses were graded by two commercial graders and by a 14-member sensory panel. The L-cheeses were depleted of lactose within 90 days of ripening while the H cheese contained 1.4 % RL up to 180 days of ripening. The pH remained constant in C and L cheeses, while it dropped continuously in the H cheeses during ripening. The modification of lactose caused no marked effect on gross composition, primary proteolysis or on numbers of starter bacteria and NSLAB in the cheeses. RP-HPLC showed that L cheese had the lowest concentration of ES peptides and highest concentration of EIS hydrophobic peptides. The lowest and the highest concentration of TFAA were in H and L cheese, respectively. Commercial graders perceived L cheese too young for grading up to 4 months of ripening but 180 day-old L cheese was awarded flavor scores similar to C cheese. The 180 day-old H cheese was awarded poorest flavour scores. Sensory evaluators reported that L cheese had a significantly lower flavor intensity and a less sour acid flavor, a lower firmness and was more crumbly but had better mouth-coating properties than the control or H cheese. The H cheese was more rubbery than the C or L cheese.

Key Words: Cheddar cheese, lactose, proteolysis

368 Regional differences in the chemical and microbial quality of Cheddar cheese manufactured in the United States. N.A. Khilla*¹, T. Considine¹, and N.Y. Farkye¹, ¹*Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo, CA.*

The quality of Cheddar cheese is derived from the initial quality of milk and from added starter and nonstarter microflora that colonize cheese during manufacture and ripening. Variations in nonstarter lactic acid bacteria (NSLAB) may be plant specific, leading to suggestions that regional differences exist in Cheddar cheese quality. This study's objective was to determine if regional differences exist in the chemical and microbial quality of Cheddar cheese during ripening. Commercial Cheddar cheese manufactured in thirteen different factories across the U.S. were analyzed at Cal Poly, San Luis Obispo. Cheeses were aged for approximately 2 months in the respective factories of origin before receipt at Cal Poly, where they were ripened at 8C. Cheeses were sampled on the day of arrival (day 0) and at intervals of 1, 3, 6 and 9 mo (corresponding to actual cheese age of 3, 5, 7 and 11 mo) for analysis. Chemical (i.e., proteolysis) and microbial (i.e., counts for total bacteria, starter and NSLAB) analyses were performed. The levels of water soluble N (WSN) in day 0 samples ranged from 6.6 to 19.2%, and from 24.3 to 50.7% after 9 mo ripening. The rate of increase in WSN was apparent between cheeses from different factories. Concentrations of free amino acids (measured by the cadmium ninhydrin method) ranged from 0.19 to 2.85mg Leu/g at day 0 and from 2.92 to 8.87mg Leu/g after 9 mo. On day 0, starter counts ranged from 10^6 to 10^9 CFU/g while NSLAB counts ranged from 10^5 to 10^9 CFU/g. At 9 months starter counts were $< 10^5$ CFU/g while most of the NSLAB counts were 10^4 to 10^5 CFU/g. Over 124 random isolates grown on casein agar plates showed that approximately 44% hydrolyzed casein. Results suggest differences in ripening profile of Cheddar cheeses made in different factories.

Key Words: Cheddar, Proteolysis, Microbial

369 Determination of organic acids in the water soluble fraction of Cheddar cheese. Therese Considine*¹ and Nana Farkye¹, ¹ *Dairy Products Technology Center, Calpoly State University, San Luis Obispo, CA 93407.*

The objective of this study was to compare the current method of analyzing organic acids in cheese with a modified method using the water soluble fraction (WSF) of cheese. Organic acids play an integral role in cheese quality as they are believed to contribute to the flavor. Depending on their concentrations, organic acids together with sulfur compounds, lactones, methyl ketones, alcohols and phenolic substances can have a negative or positive contribution to cheese flavor. Organic acids appear because of the hydrolysis of fatty acids, bacterial growth, normal bovine metabolic processes or direct addition of acidulants. Quantitative determination of organic acids in dairy products is important to monitor starter culture activity, bacterial growth and to trace quality changes

during ripening. Current methods of analyzing organic acids in cheese require lengthy extraction, whereby five grams of cheese is stirred for one hour in 25 ml dilute (0.009N) H₂SO₄, followed by centrifugation, filtration and Aminex HPX-87H[®] column with detection between 210-214 nm. In many cases of cheese research, especially when monitoring proteolysis, the WSF is already prepared for further research (e.g., for determination of free amino acids, water soluble nitrogen levels). Thus, by adjusting the WSF (50g cheese/100 ml water) with H₂SO₄ to give a final concentration of 0.009 N H₂SO₄, it is possible to monitor organic acids in the WSF. Six cheeses analyzed by both the current and modified WSF yielded almost identical HPLC profiles. The organic acids detected were: orotic, oxalic, pyruvic, propionic, lactic and uric acid. The simplicity of the method allows rapid monitoring of organic acids during ripening of cheese.

Key Words: Water soluble nitrogen, Cheese, Organic acids

Forages and Pastures Silages and Forage Composition

370 Effect of alfalfa hay and silage on the performance of dairy cows in early lactation. A. A. Naserian*¹, ¹ *Ferdowsi university of Mashhad.*

alfalfa hay is popular crop in dairy cattle feeding but it is not suitable for silage because of, low in soluble carbohydrates and high buffering capacities. Hay, untreated, and treated with 0.5% urea alfalfa silage were studied with nine multiparous Holstein cows. Weighting mean was 594 ± 42Kg in this trail. The average milk production of the cows was 29.9 ± 1.7 Kg/d prior to the experiment. Cows were randomly assigned to 3*3 latin square designed experiment. Diets were A)30% alfalfa hay +12%corn silage +5% cottonseed +53% concentrate B)30%untreated alfalfa silage with similar ingeridents in diet A C)30% treated alfalfa with 0.5% urea with similar ingerdents in diet A. The diets were balanced to supply requirments according to(NRC 1989) and were offered ad libitum in two equal portions. Each experimental period was 21 days. the cows were adapted to their diets for 14 days which was followed by a 7 days collection period for determination of digestibility and milk production. milk and blood samples were taken in the last two days of every collection period. The results indicated that intakes of dry matter were similar in different diets. No significant differences were detected for DM, OM, CP, NAF and ADF digestibilities. Milk production was slightly higher in treatment 3(31.28) versus 1(30.92).Blood metabolites were not affected by treatments expect blood urea nitrogen which was higher in treatment 3 (15.58) versus 1(12.07). Therefore it seems that alfalfa silage can be used up to 30% of rations DM without any adverse effects on the milk production and compositions

Key Words: Dairy cattle, Alfalfa silage, Milk production

371 Edible covering reduces spoilage in bunker silos. L.L. Berger*, N.A. Pyatt, and J.R. Sewell, *University of Illinois-Urbana.*

The goal of this research was to develop an edible covering for bunker silos that would simultaneously reduce spoilage and serve as a nutrient source when fed. The criteria used in developing the covering was that it must provide effective protection, be edible, provide essential nutrients, be palatable, cost effective, and easy to apply. Whole plant corn (40.0% DM) was chopped and packed to equal densities (215 kg DM/m³) into six side-by-side 3.66-m long x 1.83-m wide x 1.83-m deep bunker silos. Equal volumes (1570.5 kg DM) of pre-ensiled whole-plant corn were weighed into each bunker, leveled and packed with a small tractor and lawn roller. The three treatments were, uncovered, covered with polyethylene plastic, or covered with a starch-salt matrix. The starch-salt matrix was applied to achieve a surface thickness of 1.5 cm. After curing 3 days, paraffin wax was melted and a thin layer applied to the starch-salt matrix with a paint roller. The forage was ensiled for 92-days. Spoiled silage was separated prior to feeding. A wooden frame 148.6 x 30.5-cm was utilized to measure the spoilage under a fixed area. This measurement was made at 3 locations on each silo. Surface spoilage under the frame was 14.3, 16.4 and 1.2 kg DM (P < 0.05) for the uncovered, plastic and starch-salt coverings, respectively. Forty-eight Angus heifers were allotted by weight to 12 pens. Two pens of heifers were randomly assigned to each silo. Silage DM fed was 704, 887, and 1220 kg (P < 0.05) for the uncovered, plastic and starch-salt covered silos, respectively. Animal days per bunker were 140, 152, and 212 (P < 0.05)

for the three treatments, respectively. For the last 6-days, heifers fed silage protected with the starch-salt covering were fed 0.91 kg (as-fed) of the covering daily. Heifers consumed 91% of the covering. The ash content of the pre-ensiled forage and spoilage from uncovered, plastic, and starch-salt treatments averaged, 5.8, 11.4, 8.7, and 18.3%, (P < 0.05) respectively. These data suggests that a portion of the salt leached into the silage immediately under the covering.

Key Words: Bunker Silo, Edible Covering, Spoilage

372 Effects of substituting sunflower silage for corn silage in diets for lactating cows. L. A. Leite¹, B. O. Silva¹, R. B. Reis*¹, L. M. Fonseca¹, and D. K. Combs², ¹ *Escola de Veterinária UFMG, Brasil,* ² *University of Wisconsin, Madison.*

Objectives of this study were to compare dry matter intake, apparent dry matter digestibility, milk yield and milk composition of Holstein cows fed diets in which sunflower silage (SS) replaced corn silage (CS) as the forage component. Five ruminally- cannulated cows, 60 to 82 DIM, were arranged in a 5X5 Latin Square design. Periods were 21 days and treatments were dietary forage from: 100% corn silage (100CS); 34% sunflower silage plus 66% corn silage (34SS); 66% sunflower silage plus 34% corn silage (66SS); 100% sunflower silage (100SS); or 100% corn silage plus whole cotton seed (CS-WCS). The diets were formulated according NRC 2001, to be iso-nitrogenous and iso-energetic. Dry matter intake, milk yield and milk protein yield were lower for 100SS compared to 100CS (P<0.05). However, partial replacement of CS with SS did not affect milk and protein yield. Cows on diets with 34 or 66% of the forage as SS produced more milk per unit of dry matter intake compared to those on CS-WCS diet. Partial replacement of corn silage with sunflower silage could be a viable option for lactating cows in this range of milk production.

	100CS	34CS	66CS	100SS	CS-WCS	SEM	P value
DMI, kg/d	21.3 ^a	19.7 ^{ab}	19.1 ^{ab}	17.6 ^b	20.3 ^a	1.39	0.02
DM Dig, %	69.2	64.6	63.9	57.8	68.1	6.34	0.10
Milk Yield, kg/d	27.4 ^a	27.5 ^a	27.3 ^a	24.0 ^b	25.5 ^{ab}	1.57	0.02
FCM, kg/d	26.2	25.0	25.2	22.6	25.5	1.93	0.10
Fat, %	3.7 ^{ab}	3.4 ^a	3.5 ^{ab}	3.6 ^{ab}	4.0 ^a	0.26	0.03
Protein, %	3.1 ^a	2.8 ^{ab}	2.7 ^b	2.9 ^{ab}	3.0 ^a	0.14	0.02
Fat Yield, kg/d	1.02	0.94	0.96	0.87	1.02	0.10	0.14
Protein Yield, kg/d	0.84 ^a	0.78 ^{ab}	0.74 ^{ab}	0.70 ^b	0.77 ^{ab}	0.06	0.04
MUN, %	0.229	0.233	0.240	0.237	0.226	0.02	0.87
Milk Yield, kg/kg DMI	1.29 ^{bc}	1.40 ^{ab}	1.46 ^a	1.39 ^{ab}	1.26 ^b	0.09	0.04

^{a,b,c} Means within the same row with different superscript differ according to the P value in the table.

Key Words: corn silage, sunflower silage, dairy

373 Effect of variety on chemical composition and ruminal nutrient degradability of pea silage. A. F. Mustafa*¹, P. Seguin¹, I. Adeleye¹, and D. Ouellet², ¹McGill University, Ste-Anne-De-Bellevue, QC, Canada, ²Agriculture and Agri-Food Canada, Lennoxville, QC, Canada.

A study was conducted to determine the effects of pea (*Pisum sativum* L.) variety on chemical composition and ruminal nutrient degradabilities of pea silage. The varieties were Lenca (L), Carneval (C), and Delta (D). The pea varieties were sown in field plots in May 2001 and were harvested in July 2001. Harvested forage was then ensiled in mini-silos for 70 d. Chemical analysis showed that variety L contained higher ($P < 0.05$) NDF (42.7 vs 32.5% DM) and ADF (31.8 vs 25.3% DM) and lower ($P < 0.05$) starch (6.8 vs 9.8% DM) levels than C and D. Crude protein was highest ($P < 0.05$) for C (20.5% DM), intermediate ($P < 0.05$) for D (19.0% DM) and lowest ($P < 0.05$) for L (17.9% DM). Distribution of protein fractions showed that L contains lower ($P < 0.05$) soluble protein and higher ($P < 0.05$) neutral detergent insoluble protein levels than the other two pea varieties. However, no difference ($P > 0.05$) in acid detergent insoluble protein level was observed between the three silage treatments. Estimated net energy of lactation was highest ($P < 0.05$) for C (1.64 Mcal/kg), intermediate ($P < 0.05$) for D (1.55 Mcal/kg) and lowest ($P < 0.05$) for L (1.46 Mcal/kg). Results of the in situ experiment indicated that L had lower ($P < 0.05$) ruminal DM (69.2 vs 74%) and CP (84.1 vs 90.6%) degradabilities than C or D. However, ruminal degradability of NDF was similar among the three varieties (average 32.9%). It was concluded that chemical composition and ruminal nutrient degradabilities of pea silage are significantly influenced by variety.

Key Words: Pea silage, Chemical composition, Ruminal nutrient degradability

374 Effect of corn silage maturity and crop processing on performance of dairy cows. G. Ferreira*¹, D.R. Mertens², P. Berzaghi^{2,3}, and R.D. Shaver¹, ¹University of Wisconsin, Madison, WI, ²ARS-US Dairy Forage Research Center, Madison, WI, ³University of Padova, Italy.

The objective of this experiment was to evaluate the effects of maturity and processing of corn silage on the performance of cows differing in production level. Forty-eight lactating dairy cows were blocked by stage of lactation (mid or late) and parity (1, 2 or ≥ 3) and assigned to replicated 4 \times 4 Latin squares (28-d periods) with a 2 \times 2 factorial arrangement of treatments: early or late maturity (E or L) and processed or unprocessed (P or U). Crop DM contents at harvest time were 30.7% for E and 41.5% for L. Diets were composed by 70% of corn silage and 30% of concentrate and averaged 17% CP and 28% aNDF (DM basis). Daily DMI was higher for L compared to E (22.5 vs. 21.0 kg/d) and for P compared to U (22.2 vs. 21.2 kg/d). Fiber intake was higher for P than for U (6.34 vs. 5.51 kg/d), but no difference was observed between E and L (5.95 vs. 5.90). Interactions between maturity and processing were observed for both DM and aNDF intake. No differences were observed on DM and aNDF intake between cows of mid and late stages of lactation. A higher milk yield was found for P compared to U (24.4 vs. 23.3 kg/d), but no difference was obtained between E and L (24.0 vs. 23.8 kg/d). Milk fat content was higher for E than for L (3.93 vs. 3.70%), but did not differ between U and P (3.88 vs. 3.76%). No differences were obtained among treatments for milk protein content. Cows in late lactation had higher milk fat (4.13 vs. 3.51%) and milk protein (3.81 vs. 3.10%) contents compared to cows in mid lactation. Body weight gain was higher for P than for U (0.69 vs. 0.45 kg/d), but no difference was found E and L (0.57 vs. 0.57 kg/d). Cows in late lactation gained more weight than cows in mid lactation (0.74 vs. 0.40 kg/d). In this experiment, processing resulted in greater DM and aNDF intakes, MY and BWG. The interactions for DM and aNDF intakes suggest that processing had a greater effect on intake when corn silage was in an early stage of maturity.

Key Words: Corn Silage, Maturity, Processing

375 Variability in relationships among forage intake, digestibility, NDF and ADF. S. W. Coleman*¹ and J. E. Moore², ¹USDA, ARS Subtropical Agricultural Research Station, Brooksville, FL, ²University of Florida, Gainesville, FL.

Confusion exists about forage quality and in methods to measure or predict forage quality. The conventional wisdom is that there are close

relationships between voluntary forage dry matter intake (DMI) and digestible dry matter (DDM) concentration, DMI and NDF, and DDM and ADF. Correlation coefficients were obtained from several publications on grasses and legumes, and from a test database of 75 grass hays fed to cattle for voluntary intake measurement and to cattle or sheep for digestibility. Published correlations (r) between DMI and DDM range from -0.32 to 0.86. In the test database, the correlation between DMI and DDM was 0.75. The conventional wisdom is that intake of NDF is a constant 1.2% of BW, a concept based on work with mixed diets balanced for high producing dairy cows. Several publications, however, have not confirmed this concept, particularly for forages fed alone. In the test database, NDF intake ranged from 0.4 to 2.4% of BW. When DMI was estimated from the equation: $DMI (\% BW) = 120/NDF$, DMI was underestimated in most cases except for protein-deficient native grasses where DMI was overestimated. Many forage testing programs use simple regression equations to predict DMI from NDF and DDM from ADF. In the early research that serves as the basis for some of these programs, Van Soest (J. Anim. Sci. 24: 834, 1965) reported $r = -0.65$ between DMI and NDF, and $r = -0.74$ between DDM and ADF ($n=83$, grasses and legumes), similar to that found in the test database (-0.55 and -0.71, respectively). Published r values have ranged from 0.03 to -0.90 between DMI and NDF, and from -0.39 to -0.93 between DDM and ADF. We conclude 1) that voluntary intake and digestibility are related but often independent components of forage quality; 2) that when grasses and legumes are fed alone for measurement of forage quality, NDF intake will not be constant across all forages; and 3) that conventional wisdom about the relationships between DMI and NDF, and DDM and ADF cannot be justified. Routine forage testing programs using only NDF and ADF may often provide unacceptable estimates of DMI and DDM, for both grasses and legumes.

Key Words: Forage intake, Digestibility, Prediction

376 Divergent phenotypic selection for concentrations and ratios of fiber components in timothy. A. Claessens*¹, D. Mather², G. Belanger¹, G. F. Tremblay¹, and R. Michaud¹, ¹Agriculture and Agri-Food Canada, Ste-Foy, QC, Canada, ²McGill University, Macdonald Campus, Sainte-Anne-de-Bellevue, QC, Canada.

Animal performance has been shown to improve when using forages bred for increased digestibility, which can be achieved by selecting for reduced fiber concentration. Our objective was to evaluate the effects of divergent phenotypic selection for concentrations and ratios of fiber components on the improvement of *in vitro* true digestibility (IVTD) of timothy (*Phleum pratense* L.). Divergent phenotypic selection was conducted in a population of 495 high yielding timothy plants for neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), hemicellulose (HEM), cellulose (CEL), ADL/HEM, ADL/CEL, ADL/HEM+CEL, and HEM/CEL. For each selection criterion, the eight highest and eight lowest plants were selected and intercrossed separately. The populations derived from selection were evaluated on the spring growth of a two-year field experiment. Direct divergent selection responses were significant ($P < 0.01$) in both years for NDF, CEL, ADL/HEM, ADL/CEL, ADL/HEM+CEL, and HEM/CEL. The ADL/CEL selection criterion produced the most divergent populations for IVTD. In 1999 and 2000, the low ADL/CEL population showed a decrease of 4.6 and 5.0 g kg⁻¹ in lignin and an increase of 22 and 32 g kg⁻¹ in IVTD compared to the high ADL/CEL population. In both years, the low and high ADL/CEL populations had similar hemicellulose and cellulose concentrations, as well as similar DM yield. Selection for low ADL/CEL on high yielding genotypes seems to be a promising approach to increase timothy digestibility without adversely affecting DM yield.

Key Words: *in vitro* true digestibility, fibers, timothy

377 Seasonal fluctuations in kikuyu grass (*Pennisetum clandestinum*) yield and nutrient composition, and impact on growth rate of nursing calves. J.R. Carpenter*¹, B.W. Mathews², R.Y. Niino-DuPonte¹, and M. Kaheki¹, ¹CTAHR, Univ. of Hawaii at Manoa, ²CAFNR, Univ. of Hawaii at Hilo.

Forage-livestock systems on improved tropical grass pastures are an integral part of agriculture and the economy in the tropics. Key limitations include the available pastures' ability to support growth, reproduction, and lactation due to their high moisture and fiber, and low protein and

energy content. The objectives of this study were to retrospectively determine the seasonal fluctuations in improved kikuyu grass (*Pennisetum clandestinum*) pasture yield and nutrient composition, and impact on growth rate of nursing calves. Data from fourteen grazing cycles over a 7-year period, seven in the spring and seven in the fall, was combined into a single data base. For each grazing cycle groups of cow/calf pairs from mixed breed beef cattle (assigned to groups by age and body weight) were grazed on three 1.2-ha paddocks per group, each having a 4 to 6-wk rest and 2 to 3-wk grazing cycle. Pasture swards were clipped during each cycle to determine yield, nutrient (NIRs) and mineral (ICPE) composition. Stocking rates (hd/ha) were highest ($P < .01$) for Spring/Summer grazing cycles. Total live weight gain (kg/ha) and average daily gain (kg/d) for calves were lower ($P < .05$) during the fall (287.7 and .69, respectively) than the spring (517.8 and .91, respectively). Forage DM production during the fall was only 65% that of the spring. Data shows that the production potential of both forage and animals is significantly impacted by the climate during the growing period. The mean % ash, CP, NDF, ADF and IVDMD for the 289 samples (DM basis) was 8.1, 17.4, 52.2, 34.4, and 76.6, respectively. Climate, forage yield, pasture nutrient composition, grazing options and fluctuations in calf prices must all be considered in comparing the economics of a fall versus spring calving cycle in the tropics.

Key Words: Grazing cow/calves, Tropical kikuyu grass, Yield and nutrient composition

378 Fatty acid and nutrient composition of annual rye and ryegrass forage. S. J. Freeman*, J. A. Bertrand, T. C. Jenkins, and B. W. Pinkerton, *Clemson University, Clemson, SC / USA.*

The objective of this study was to document the changes in fatty acid and nutrient content of two forages over time. Weekly samples of rye (*Secale cereale*) and ryegrass (*Lolium multiflorum*) pastures were collected during their growth phase. One aliquot was analyzed for DM. The remaining sample was immersed in liquid nitrogen at the time of cutting to cease cellular metabolism. These samples were then freeze-dried and ground through a 2-mm screen. Samples were analyzed for CP, NDF, ADF, lignin, fat, ash, sugar, starch and fatty acids. The percent CP, NDF, fat and ash significantly changed across time ($P < 0.05$) for rye. The percent CP, NDF and ADF significantly changed across time ($P < 0.05$) for ryegrass. The average DM, CP, NDF, ADF, lignin, fat, ash, sugar, starch and total fatty acids percents for rye and ryegrass were 33.87, 29.45, 26.56, 17.05, 29.84, 44.60, 15.23, 24.19, 0.29, 0.27, 10.86, 7.69, 4.81, 2.68, 19.40, 14.21, 5.37, 7.14, 5.67 and 3.75, respectively. For both forages, C18:3 was the fatty acid of highest quantity for all sampling times and averaged 50.86% and 43.86% of all fatty acids present for rye and ryegrass, respectively. Other fatty acids of high quantity were C18:2 and C16:0 which were 8.89% and 11.98% for rye and 8.53% and 11.27% for ryegrass. For rye, the total fatty acid content peaked at 6.79% at week 2 of sampling and was lowest at 4.65% at week 17 of sampling. For ryegrass, the total fatty acid content peaked at 4.87% at week 5 of sampling and was lowest at 1.75% at week 9 of sampling. The content of C16:0, C16:1, C18:3 and C24:0 fatty acids and total fatty acids significantly changed ($P < 0.05$) over time for rye. The content of C16:0, C16:1, C18:0, C18:1, C18:2, C18:3, C20:0, C22:0 and C24:0 fatty acids and total fatty acids significantly changed over time ($P < 0.05$) for ryegrass. In conclusion, the fatty acid content of rye and ryegrass ranged from 4.65% to 6.79%, and from 1.75% to 4.87% of total DM, respectively.

Key Words: Pasture, Fatty Acids

379 How relevant are meals in the short-term regulation of diet choice? M.P. Yeates*, B.J. Tolcamp, and I. Kyriazakis, *Scottish Agricultural College, Edinburgh, UK.*

When cows are offered a choice of foods, which are nutritionally complementary, they are able to select a consistent combination of these foods over long periods of time. Analysis of how such consistent diet choice is achieved, in terms of short-term feeding behavior, may further our knowledge of how cows regulate nutrient intake. Previous work, on meal pattern analysis and on nutrient synchronisation, led us to hypothesise that animals may select a consistent diet within a meal. In three experiments cows were offered a choice between high (H) and low (L) protein foods and short-term feeding behavior data were collected using computerised feeders. Feeding behavior was first analysed in terms of

visit characteristics. The greater intake of H, relative to L in the experiments, was more closely related to the ratio of H visits to L visits, than to differences in the intake per visit to H and L. Individual meal criteria were estimated and visits were clustered into meals. Cows typically had six meals per day. The observed frequency distribution of meal composition, in terms of the proportion of visits to H feeders, was determined. Subsequently, the observed visits were randomly re-clustered into bouts, consisting of the same number of visits as were observed in meals, and the frequency distribution of random bout composition was calculated. Comparison of the frequency distributions of meals and random bouts provided no evidence that cows attempted to achieve their long-term average diet composition within a meal. We also investigated if cows attempted to regulate diet choice within a meal by adjusting their intake per visit depending on the food type visited, such that they achieved a consistent diet choice within a meal. There was no evidence that this occurred. In conclusion, our analyses have shown that cows did not attempt to select a consistent diet within a meal. Indeed, the data suggest that the timeframe of diet choice regulation must be considerably greater than a meal. Therefore, within a meal, a diet that was synchronous for energy and protein was not selected.

Key Words: Diet choice, Cow, Feeding behavior

380 Effect of barley or soybean supplementation on growth, and carcass and meat characteristics of steers finished on pasture. J.L. Duynisveld*, E. Charmley¹, P. Mir², and Z. Mir², ¹AAFC Crops and Livestock Research Centre, Canada, ²AAFC Lethbridge Research Centre, Canada.

The effect of supplementing pasture-finished cattle on their performance, carcass characteristics, meat quality, and fatty acid composition of beef was studied. Thirty-two British cross steers (initial BW 360 kg) were assigned by weight to one of 4 treatments; TMR (finished indoors on a totally mixed ration comprising 60 % silage and 40 % barley (DM basis); P (grazed on permanent grass/legume pasture); PB (grazed on pasture supplemented with 5 kg barley hd⁻¹ d⁻¹; PS (grazed on pasture supplemented with 2 kg hd⁻¹ d⁻¹ whole roasted soybeans. Cattle were slaughtered in September after 105 d on test at between 500 and 600 kg BW. At slaughter, carcass data and tissue samples were collected for analysis of carcass and meat characteristics and fatty acid composition. Gains of BW were higher ($P < 0.01$) for TMR-fed cattle (1.43 kg d⁻¹) than for cattle on other treatments which averaged 1.02 kg d⁻¹. Steers grazing pasture alone had the lowest backfat ($P < 0.05$), highest drip ($P < 0.05$) and volatile losses cooking losses ($P < 0.05$). The beef from P was more tender ($P < 0.05$) than from other treatments when measured using both Instron Kramer techniques and trained sensory panel analysis. When expressed as % total fatty acids, beef from all pasture-based treatments had 66% higher levels of CLA (c9 t11) ($P < 0.001$) than TMR-fed cattle, however there was no difference among the three pasture-based treatments. The t10 c12 CLA concentration was higher for P and PS than for other treatments ($P < 0.0001$). CLA levels in wet meat were higher in PS than in the TMR treatment. Levels of polyunsaturated fatty acids (PUFA) were highest in P and PS ($P < 0.05$) and lowest in TMR. The proportion of CLA in PUFA (9%) did not change among treatments. Pasture increased PUFA and CLA in beef compared to a TMR-based diet. However feeding soybeans, a source of linoleic acid, did not further increase CLA levels.

Key Words: Pasture, Beef, CLA

381 An evaluation of the use of alkanes for estimating intake and digestibility of forages from fecal grab samples. E. Charmley*, H.V. Petit², D.R. Ouellet², D.M. Veira³, and R. Michaud⁴, ¹AAFC, Crops and Livestock Research centre, ²AAFC, Dairy and Swine Research and Development Centre, ³AAFC, Kamloops Range Research Unit, ⁴AAFC, Soils and Crops Research and Development Centre.

Ratios of endogenous (odd chain length) and exogenous (even chain length) n-alkanes can be used to determine intake and digestibility of pasture by cattle. However, the accuracy and precision of this method has to be validated. In a trial with 12 growing beef steers, grass/legume silage was either fed ad libitum or at 70% of ad libitum (Restricted) for 29 d. After 7 d on feed, a controlled release capsule (CRC) (Captec, New Zealand), containing C₃₂ and C₃₆, was inserted into the rumen of each steer. Fecal grab samples were taken daily thereafter and total collection of feces was conducted from 12 to 18 d after CRC insertion. Observed

and predicted dry matter (DM) digestibility was not influenced by level of feeding, with observed digestibility averaging 66.9 % (SEM=1.84). Predicted digestibility values, estimated without correction for alkane recovery were 86, 96, 93 and 100 % of observed, using C₂₇, C₂₉, C₃₁, and C₃₃ alkanes, respectively, with C₂₇ and C₃₁ being different (P<0.05) to the observed value. When adjustments were made for alkane recovery, corresponding values were 118, 104, 108, and 100 %, with only the C₂₇ value being different (P<0.05) from the observed value. Predicted DM intake using the C₃₁:C₃₂ ratio was underestimated at the restricted (P<0.05) and ad libitum (P<0.10) levels of feeding, when calculated using the manufacturers release rate (190 mg d⁻¹). However, when actual

release rates of 239 (restricted) and 211 (ad libitum) mg d⁻¹ were used, estimates agreed with observed values. Although the accuracy of prediction for DM intake was high, the precision was low, with significant (P<0.05) discrepancies for both treatments and all methods of measurement. Discrepancies of up to 2.9 kg d⁻¹, when average DM intake was only 7 kg d⁻¹ was a concern. Endogenous alkanes can be used to accurately predict digestibility. However daily fecal grab samples did not give precise measurements of intake, based on the ratio of endogenous to exogenous alkane markers.

Key Words: Alkane, Marker, Forage

Nonruminant Nutrition
Ractopamine and Somatotropin on Nutrient Metabolism and Pork Quality

382 Effect of ractopamine on optimum dietary phosphorus regimen for growth in pigs. T.R. Lutz* and T.S. Stahly, *Iowa State University, Ames, IA.*

Ten replications of individually-penned gilts from a high-lean strain were utilized to determine the effect of ractopamine (RAC) on the optimum dietary available phosphorus (AP) regimen. At 70 kg BW, pigs were randomly allotted to a corn-soybean meal basal diet (.08% AP) adequate in all nutrients except AP. The basal diet was supplemented with mono-dicalcium phosphate to create six AP concentrations (.08, .13, .18, .23, .28, .33%) and ractopamine HCL to create two RAC concentrations (0 vs. 20 ppm). A constant Ca/AP ratio of 2.5:1 was maintained in each diet. BW gain and feed intake were recorded weekly until each pig individually reached 114 kg BW. Pigs were then slaughtered keeping the ham and loin for subsequent dissection and bone removal. Dietary AP additions resulted in improved (P<.01) daily BW gain, but did not alter carcass or ham-loin muscle content. Dietary AP additions also linearly improved (P<.01) bone integrity as observed by ham-loin bone content and femur weight and mineral content. RAC improved (P<.01) BW gain (+125 g), gain/feed ratio (+64 g/kg), and carcass and ham-loin muscle (+3.4%, +5.6%) content. RAC reduced (P<.01) the ham-loin bone content and femur weight and mineral content, but the amount of additional bone or bone mineral accrued per unit of added dietary AP was linear and independent of RAC. Based on breakpoint analysis, BW gain and femur mineral content in non-RAC pigs were optimized at dietary AP concentrations of .20% and .31%, respectively. Because of their greater muscle accretion capacity, thus P demand, pigs fed RAC from 70 to 114 kg BW needed an additional .02 to .03% AP to maintain the same ham-loin bone and femur mineral contents as the non-RAC pig.

Key Words: Ractopamine, Phosphorus, Pig

383 Effects of vitamin and mineral concentrations and ractopamine hydrochloride in diets for growing-finishing pigs. C. Starkey*, J. Hancock, D. Kropf, C. Jones, K. Hachmeister, T. Lawrence, D. King, and J. Dunn, *Kansas State University, Manhattan.*

A total of 160 pigs (two pigs/pen and 10 pens/treatment) were used to determine the effects of added vitamins and minerals (VM) and ractopamine hydrochloride (RAC) on growth and carcass characteristics. Treatments for 32 to 96 kg were corn-soy diets formulated to 70 and 130% of NRC recommendations for vitamins (A, D, E, K, niacin, pantothenic acid, riboflavin, thiamin, B₆, and B₁₂) and minerals (I, Fe, Se, and Zn). For 96 kg to 123 kg, treatments of with or without VM additions and without or with RAC (20 mg/kg) were imposed. No differences in ADG or gain/feed were observed from 32 to 96 kg among pigs fed diets with the 70 and 130% treatments (P > 0.2). For 96 to 123 kg, there were no differences in ADG or gain/feed among pigs fed the diets with or without VM (P > 0.7), but RAC increased ADG and gain/feed (P < 0.001). These effects were consistent regardless of prior vitamin and mineral fortification, i.e., no interactions (P > 0.15) with the 70 and 130% treatments from 32 to 96 kg BW. Carcass measurements were not affected by the 70 vs 130% or the with vs without VM treatments (P > 0.06). Pigs fed RAC had heavier (P < 0.01) carcasses, less (P < 0.05) last-rib backfat thickness, and greater (P < 0.01) dressing percentage, longissimus area, and percentage carcass lean. In conclusion, low inclusions of VM from 32 to 96 kg BW and withdrawal of VM from 96 kg to

market had no effects on growth or carcass characteristics. Also, RAC did not increase the need for VM supplementation.

	ADG, kg	Gain/feed kg	HCW, backfat, mm	Item ^a 10th rib simus area, cm ²	Longis- lean, %	Carcass
70% +VM						
-RAC	1.01	0.377	88.8	20	35	51.6
+VM +RAC	1.01	0.380	92.9	17	38	53.5
-VM -RAC	1.03	0.377	89.9	19	34	52.1
-VM +RAC	1.05	0.383	92.7	17	38	53.5
130% +VM						
-RAC	0.98	0.369	88.3	18	36	52.8
+VC +RAC	1.05	0.393	93.8	17	38	53.4
-VM -RAC	1.03	0.382	89.9	19	36	52.4
-VM +RAC	1.07	0.385	93.1	16	39	54.1
SE	0.02	0.007	2.0	1	1	.05

^aOverall data (32 to 123 kg).

Key Words: Pig, Vitamins and minerals, Ractopamine

384 Effects of vitamin and mineral concentrations and ractopamine hydrochloride on pork quality. C. Starkey*, J. Hancock, D. Kropf, C. Jones, K. Hachmeister, T. Lawrence, D. King, and J. Dunn, *Kansas State University, Manhattan.*

A total of 160 pigs (two pigs/pen and 10 pens/treatment) were used to determine the effects of added vitamins and minerals (VM) and ractopamine hydrochloride (RAC) on pork quality. Treatments for 32 to 96 kg BW were corn-soy diets formulated to 70 and 130% of NRC recommendations for vitamins (A, D, E, K, niacin, pantothenic acid, riboflavin, thiamin, B₆, and B₁₂) and minerals (I, Fe, Se, and Zn). For 96 kg to 123 kg, treatments of with or without VM additions and without or with RAC (20 mg/kg) were imposed. No differences (P > 0.05) among pigs fed the VM and RAC treatments were observed for initial color score, expressible moisture, water-soluble protein, and pH of the longissimus 24 h after slaughter. However, RAC increased shear force (P < 0.001) and deletion of VM from 96 to 123 kg increased thiobarbituric acid values (TBA) slightly at d 6 (P < 0.01). An interaction among the VM and RAC treatments indicated that marbling increased when RAC was added to diets with VM and decreased when RAC was added to diets without VM (P < 0.04). Also, thaw loss and cooking loss decreased when RAC was added to diets with VM and increased when RAC was added to diets without VM (P < 0.05). In conclusion, the VM treatments had few affects on measurements of pork quality, but RAC did increase shear force. Also, there were VM by RAC interactions that suggested slight decreases in pork quality when RAC is used in diets without VM from 96 kg to slaughter.

	Ultimate pH	Item Expressible moisture, mg/g	Color score ^a	Marbling score	TBA at d 6 ^b , mg/1000g
70% +VM					
-RAC	5.83	122	4.1	3.1	0.11
+VM					
+RAC	5.82	120	3.8	3.5	0.09
-VM					
-RAC	5.88	123	4.0	3.2	0.11
-VM					
+RAC	5.80	132	4.0	3.2	0.15
130% +VM					
-RAC	5.76	133	4.1	3.2	0.11
+VC					
+RAC	5.94	100	4.1	3.5	0.08
-VM					
-RAC	5.72	172	3.9	3.2	0.13
-VM					
+RAC	5.78	151	3.7	2.8	0.12
SE	0.06	23	0.1	0.2	0.02

^a NPPC color (scale of 0 to 6) and marbling (scale of 0 to 10).

^b TBA at d 6.

Key Words: Pork quality, Vitamins and minerals, Ractopamine

385 Effect of space allocation and ractopamine (Paylean®) on barrow growth performance and carcass characteristics. M C Brumm^{*1}, R C Thaler², and P S Miller¹,
¹University of Nebraska, ²South Dakota State University.

Danbred USA barrows (n=264, 29.7 kg BW) were used to evaluate the effects of space allocation and ractopamine (Paylean®) (P) addition to finishing diets. Space allocations of .55 m² (CR) and .74 m² (UC) from arrival to slaughter were achieved by housing 19 or 14 pigs per fully slatted pen. Four weeks prior to slaughter, P treatments of 0 or 10 ppm in corn-soybean meal based diets formulated to contain 0.92% lysine and 16.1% CP were initiated within space allocation treatments. There were four pens per treatment combination. Diets contained 1.10% lysine from arrival to 36 kg BW, 0.97% from 36 to 69 kg and 0.77% from 69 kg to 4 weeks prior to slaughter. All UC pigs were slaughtered on d 86 (107.1 kg BW), with CR pigs slaughtered on d 93 (108.6 kg BW). There was no effect of 10 ppm P on ADG, but ADF decreased (2.70 vs 2.89 kg/d; P<0.01) and gain:feed improved (0.351 vs 0.322; P<0.01) vs the 0 ppm treatment during the 4 wk of P treatments. Overall, ADG (0.86 vs 0.91 kg; P<0.01) and ADF (2.32 vs 2.41 kg; P<0.1) were reduced for the CR vs UC treatments. While there was no effect of P on overall ADG or ADF, there was improvement in gain:feed (0.379 vs 0.368; P<0.10) for the 10 vs 0 ppm treatment. On d 86, all pigs were individually scored for severity of tail biting on a 1 to 4 scale with 1 being no evidence of tail biting and 4 severe tail biting. Space allocation (1.4 vs 1.3 mean

score, CR vs UC respectively) and P treatment (1.5 vs 1.3, 10 vs 0 ppm respectively) had no effect (P>0.10) on tail biting. Although there was no effect of P on slaughter weight (107.8 kg BW), carcass yield increased slightly (75.3% vs 74.6%; P<0.10) for the 10 vs 0 ppm treatment. Carcass backfat measured by IPB, Inc personnel decreased for the CR vs UC treatments (15.0 vs 15.7 mm; P<.10). There was no effect of space allocation on loin muscle depth, estimated carcass % lean or IBP carcass merit. Barrows fed 10 ppm P had greater muscle depth (68.8 vs 67.0 mm; P<0.01), carcass lean (56.0 vs 55.5%; P<0.01) and carcass merit (\$0.132 vs \$0.122/kg; P<0.05) than the 0 ppm fed pigs. These results suggest that the response to P is independent of the response to altered space allocation.

Key Words: Pigs, Ractopamine, Space

386 Excessive amino acids limit the response to exogenous porcine Somatotropin (pST). D. Brana-Varela and J. A. Cuaron*, *CNI-Fisiología y Mejoramiento Animal, INIFAP, Mexico.*

Two experiments were conducted to revise the effect of graded levels of pST (daily i.m. injections/28-d) and of dietary Lys. Relative to Lys, Thr, Met and Trp were constant and CP was ~15.4×Lys. Exp. 1, a factorial arrangement of 3 pST doses (0, 3 and 6 mg/pig/d) and 3 Lys (g/kg, true ileal digestible) to energy (ME, Mcal/kg) ratios (LTE): 1.87 (6/3.2), 2.31 (7.5/3.25) and 2.76 (9.1/3.3), had 18 pens of 16 pigs (1:1 gilts and barrows) in a commercial farm affected by respiratory diseases. Pigs were weighed initially (99.9±2.3 kg) and every two weeks; Feed intake was recorded once every week; Fat and muscle depths at P2 were measured on the 10th and last ribs in the same interval by real time ultrasound scanning. Exp. 2 was the factorial arrangement of 3 pST levels (0, 2.5 and 5 mg/pig/d) and 3 dietary Lys densities (.7, .81 and .92%) at a fixed dietary energy level (ME, 3.2 Mcal/kg); Sex (barrows and gilts) was included as a factor. Pigs (72) were individually housed to 4 replications in the 3×3×2 interaction. Initial wt was 83.3±6 kg; Feed intake was measured daily; Body wt change was recorded weekly and lean eye area, fat and muscle depths were registered initially and on d-14 and 28. In Exp. 1, pST resulted in a linear (P<.004) reduction of feed intake (2.9, 2.6 and 2.4 kg/d), as identically did the LTE ratios. In the interaction, avg. daily feed intake (ADI) is depicted by the equation ADI=3.497-(.088×pST dose, mg/d)-(.11×LTE²); P<.001, r=.91. While pST improved quadratically (P<.05) avg. of daily gain (ADG: 728, 805 and 793 g/d), LTE resulted in similar ADG (786, 771 and 770 g/d). Daily pST reduced linearly (P<.001) backfat change (4.2, 1.4 and -1.2 mm) but, in muscle depth change, pST and LTE interacted (P<.001). The response to Lys and pST in Exp. 2, was a linear decrease (P<.01) in ADI, but ADG resulted in a Lys×pST interaction (P<.06): at 0 (742, 716 and 765 g/pig) or 2.5 mg/pig/d (1003, 811 and 797 g/d), Lys resulted in none or a negative change, while the slope was positive (855, 960 915) with the 5 mg/d dose. Body composition was affected by pST, a linear reduction (P<.001) in backfat, or increments (P<.03) in muscle depth. If Lys concentration in the diet exceeds the requirement, the effects on ADI and ADG will be negative.

Key Words: Amino acids requirements, Somatotropin, Finishing pigs

Physiology Estrus Synchronization I

387 Paired use of milk progesterone testing and a PreSynch OvSynch timed insemination protocol in lactating dairy cows. J.D. Ferguson¹, D.T. Galligan¹, J.W. Brooks^{*2}, G. Azzaro², S. Ventura², and G. Licitra³, ¹University of Pennsylvania, ²Consorzio Ricerca Filiera Lattiero-Casearia, Ragusa, Italy, ³University of Catania, Italy.

The objective was to improve herd reproductive efficiency by using milk serum progesterone (P4) testing with a modified PreSynch OvSynch program. Nine test herds ranged in size from 30 to 140 lactating dairy cows. Milk samples were collected at 14 day intervals beginning at 3 weeks post partum. A threshold P4 concentration was calculated to classify samples as "high" or "low". Sampling continued for each cow until at least one "high" value was obtained, indicating cyclicity. Percentages of cows which began cycling at 5, 7, 9, and more than 9 wks were 72.9%, 15.7%, 8.3%, and 3.1% respectively of 420 cows. Thus, 27.1% of cows bred before 7 wks post calving are acyclic, meriting use of a milk P4 test to

identify acyclic cows. At each of the first two samplings cows received 25 mg PGF2α (Dinolytic®, Pharmacia & Upjohn) for PreSynch. Cyclic animals continued with OvSynch beginning 14 days after the most recent sampling. Cows were administered 50 mg GnRH (Cystoreline®, VETEM) (d -10), followed by 25 mg PGF2α (d -3), then 50 µg GnRH (d -1) with AI to follow 8-18 hrs later (d 0). For possible reinsemination, all cows not returning to estrus were administered 50 mg GnRH 32 days after insemination (d 32), with rectal palpation for pregnancy to follow in 7 days (d 39). Thus, all normally cycling cows were inseminated at 59-65 d post calving and at 101-107 d post calving if non-pregnant at palpation. Reproductive data were also collected from 9 control herds (n=463) matched for cow number with test herds (n=482). First service CR for all animals was greater (P<0.05) in test herds than control herds (34% vs. 23%). Days to first breeding was lower for test cows than for control cows (66 vs. 73; SE=0.681 and SE=1.92). Upon completion of data collection, reproductive efficiency will be analyzed by survival anal-

ysis. The paired use of milk serum P4 testing and a modified PreSynch OvSynch protocol improved reproductive performance in these herds.

Key Words: P4, Synchronization, Cyclicity

388 The length of pregnancy modifies the association between the length of the dry period and subsequent milk yield. C Enevoldsen¹, ¹Royal Veterinary and Agricultural University, Copenhagen, Denmark.

Data were collected from 66 herds without and 61 herds (2464 lactations) with specific focus on dry cow management. The relation between length of the dry period and milk yield in subsequent lactation was analyzed with a random coefficient regression model. The dry period was divided into the planned dry period defined as the number of days from drying off to expected calving (under management control) and the deviation of pregnancy length from the expected 279 days (random component). In herds without specific focus on dry cow management there was an interaction between planned dry period, pregnancy length and peak milk yield in previous lactation. The combination of a three week planned dry period and a pregnancy length 10 days shorter than expected was associated with approximately 12 kg less milk per day at 60 days post partum in subsequent lactation compared to the combination of 10 week planned dry period and a pregnancy 10 days longer than expected. The effect of planned dry period was only 1-2 kg at a pregnancy 10 days longer than expected. Peak yield in previous lactation modified the response surface slightly. In herds with specific focus on dry cow management, dry periods cows with lower body condition score at drying off were usually dried off earlier and the variation in planned dry periods was substantially reduced. The combination of shorter planned dry periods and shorter pregnancy lengths was still associated with significantly less milk in subsequent lactation but the effect was much less pronounced compared with herds without focus on dry cow management. These findings indicate that both length of pregnancy and herd management policy with respect to dry cows must be taken into account in models of milk production.

Key Words: Dry period, Length of pregnancy, Milk yield

389 ECP induced changes in ovarian function of lactating dairy cattle. S. M. Pancarci*, J. A. Bartolome, T Dickerson, and W. W. Thatcher, University of Florida, Gainesville, FL, USA.

The ability of estradiol cypionate (ECP) to alter ovarian follicular and CL development was examined as a potential strategy to induce follicle turnover in a timed artificial insemination protocol (TAI). Cows were synchronized for estrus with GnRH (Cystorelin®; Merial Ltd., 100 µg, i.m.) and PGF_{2α} (Lutalyse®, 25 mg; i.m.) given 7 d apart. Cows detected in estrus were assigned to treatments (T) of a 2 x 3 factorial experiment. Cows were injected with either ECP (ECP®, Pharmacia Corp., 2 mg; i.m.) or cottonseed oil (CSO, 1ml, i.m.; control) on d2 (control, T1, n=6; ECP, T2, n=6), d5 (control, T3, n=6; ECP, T4, n=6), and d13 (control, T5, n=5; ECP, T6, n=6) of the estrous cycle. The day of initial ECP and CSO injection was designated experimental day (ED) 0. PGF_{2α} (25 mg, i.m.) was injected on ED10 followed by ECP (1 mg, i.m.) or CSO 24 h later. Ovaries were monitored by ultrasound and blood samples were collected daily from ED0 to subsequent CL formation. In the d13 groups, blood samples were collected hourly for 12 h after the initial injections of ECP and CSO to monitor the metabolite of PGF_{2α} (PGFM). ECP treatment induced an earlier deviation (T x d2-5 vs 13; P<0.02) of the newly recruited follicle on d2 (8.8 < 10.7 d) and d5 (7.3 < 10.3 d) but not on d13 (10.8 ~ 9.8 d). Homogeneity of regression curves for size of the new recruited dominant follicles were not parallel (P< 0.01) between treatments and reflected an earlier growth in response to ECP on d2 and 5 but not on d13. ECP treatments suppressed growth of the existing dominant follicles on d2, 5 and 13 based upon homogeneity of regression (T x ED; P< 0.01). ECP attenuated mean concentrations of plasma progesterone (5.8 ± 0.5 < 8.3 ± 0.6 ng/ml; P< 0.01) indicative of an antiluteotropic effect of ECP. ECP failed to induce release of PGFM on d13 of the estrous cycle. Examination of follicular dynamics in response to ECP indicates that ECP may be used during the metestrus to mid-diestrus periods at the beginning of a TAI protocol to induce follicle turnover.

Key Words: ECP, follicle dynamics, corpus luteum

390 Estrus, ovarian, and hormonal responses after resynchronization with progesterone (P4) and estrogen in lactating dairy cows of unknown pregnancy status. S.Z. El-Zarkouny*, B.A. Hensley, and J.S. Stevenson, Kansas State University.

Our objective was to determine if the first eligible estrus after AI could be resynchronized in cows of unknown pregnancy status. On d 13 after timed AI (TAI=d 0; Ovsynch protocol), a used CIDR was inserted for 7 d. Cows received no further treatment (controls) or were treated with estradiol benzoate (EB; 1 mg) or estradiol cypionate (ECP; 0.5 or 1 mg) on d 13 and 21. Blood samples were collected from d 13 to 24 for later determination of P4 and estradiol-17β (E2). Ovarian structures were mapped in 63 cows from d 13 to 24 and in 121 more cows from d 20 to 24. Pregnancy status was verified on d 28 and 56 by ultrasonography of uterine contents. Both doses of ECP and EB affected neither feed intake nor milk yield during 11 d after d 13. Injections of estrogen had no detrimental effect on established pregnancies (d 28): 41% (n=51), 41% (n=48), 37% (n=44), and 39% (n=47) for control, EB, ECP-0.5, and ECP-1. Subsequent embryo survival to d 56 was less (P<0.05) after EB (62%) than controls (86%), ECP-0.5 (69%), and ECP-1 (89%). In open cows, concentrations of P4 on d 13 to 24 were less (P<0.05) after EB (1.8 0.4 ng/mL), ECP-0.5 (2.4 0.4 ng/mL), and ECP-1 (1.6 0.4 ng/mL) than in controls (2.8 0.4 ng/mL), whereas no decrease occurred in pregnant cows. Peak concentrations of E2 were greater (P<0.05) in estrogen-treated cows on d 14 and 22 than in controls, but E2 remained elevated longer to d 16 and 24 after EB and ECP-1. Appearance of a new dominant follicle after estrogen on d 13 occurred earlier (P<0.05; 2.6 0.5 d) than controls (4.3 0.7 d). More (P<0.05) open cows treated with estrogen ovulated after d 21 (70%; n=64) than controls (42%; n=24), whereas in pregnant cows the percentages were similar (5%; n=45 vs. 5%; n=20), respectively. Of 122 open cows, 61% were detected in estrus between d 21 and 26 and their conception rates did not differ (control=31%, n=16; EB=30%, n=20; ECP-0.5=38%, n=24; ECP-1=31%, n=16). Number of standing events (P=0.11), duration of standing time (P<0.05), and interval to estrus (P=0.10) after d 21 were greater for EB than ECP cows. We conclude that estrogen+CIDR protocol had no detrimental effects on established pregnancies, ovarian responses, and subsequent conception.

Key Words: Estrogen, Estrus Resynchronization, Progesterone

391 Effect of milking frequency (MF), estradiol cypionate, and bST on milk yield and reproductive outcomes in dairy cows. C.A. Blevins*, J.J. Aberle, J.E. Shirley, B.A. Hensley, S.M. Tiffany, and J.S. Stevenson, Kansas State University.

Our objectives were to determine the outcome of lactation and reproductive performance, based on MF, estradiol cypionate (ECP), and bST. Lactating cows were blocked by parity (1 vs. 2+) and assigned randomly to a 2 x 2 x 2 factorial experiment: 1) MF consisted of 4x daily (4X) milking for the first 30 DIM vs. 2x daily (2X) milking, with all cows milked 2x after 30 DIM; 2) 10 mg of ECP given as postpartum therapy (ECPT) before 10 DIM vs. controls that received ECP diluent (cottonseed oil; CSO); and 3) biweekly bST starting after 60 DIM vs. no bST. Milk yields were measured daily and then averaged for 0-30, 31-60, and 61-90 DIM. Ovulation before AI was synchronized using 100 µg of GnRH 7 d before 25 mg of PGF_{2α}, followed in 24 h by 1 mg of ECP beginning between 59 and 72 DIM. Cows were inseminated after detected estrus or at 48 h after ECP. Pregnancy rates were assessed by transrectal ultrasonography 28-30 d after AI. The 4X cows (n=73) had greater (P<0.01) milk yields (33.1 0.8 kg) through 30 DIM than 2X cows (29.9 0.8 kg, n=70). An interaction (P<0.05) of MF with ECPT was detected for milk yields (kg) through 60 DIM (2X+CSO = 33.2 1.1, n=34; 2X+ECPT = 35.3 1.1, n=36; 4X+CSO = 36.5 1.1, n=36; 4X+ECPT = 34.3 1.1, n=37). An interaction (P=0.10) of treatments was detected for milk yields from 61-90 DIM: 2X+CSO+no bST = 37.9 1.5, n=16; 2X+CSO+bST = 39.1 1.4, n=18; 2X+ECPT+no bST = 38.9 1.4, n=17; 2X+ECPT+bST = 39.9 1.3, n=19; 4X+CSO+no bST = 39.2 1.5, n=16; 4X+CSO+bST = 39.8 1.3, n=20; 4X+ECPT+no bST = 33.1 1.4, n=17; 4X+ECPT+bST = 40.0 1.3, n=20). Percentage of cows in estrus was greater (P<0.01) for 2X+CSO (66.7%; n=33) than for 2X+ECPT (47.2%; n=36), 4X+CSO (41.7%; n=36), and 4X+ECPT (44.4%; n=36). Pregnancy rates were greater (P<0.05) in ECPT (48.6%; n=72) than in CSO (33.3%; n=69) cows. Increased fertility also was found for bST cows (44.4%; n=36) vs. controls (40.0%,

n=105). In conclusion, early postpartum ECP therapy increased pregnancy rates, however it had detrimental effects on milk yields when cows were milked 4x daily unless treated with bST.

Key Words: Estradiol Cypionate, bST, Milking Frequency

392 Synchronization of estrus in dairy cows using prostaglandin F_{2α} (PGF_{2α}), gonadotropin-releasing hormone (GnRH), and estradiol cypionate (ECP). J. M. Borman^{*1}, R. P. Radcliff², B. L. McCormack², F. N. Kojima², D. J. Patterson², K. L. Macmillan¹, and M. C. Lucy², ¹University of Melbourne, Werribee, Australia, ²University of Missouri, Columbia, MO.

An estrous synchronization protocol was developed for use in lactating dairy cows using PGF_{2α}, GnRH, and estradiol cypionate (ECP). In Experiment 1, cows received two injections of PGF_{2α} (on d 0 and 11) (PP; n = 10) or two injections of PGF_{2α} (d 0 and 11) and 100 µg of GnRH on d 3 (PGP; n = 10). In Experiment 2, cows were treated with PGP (n = 7), or PGP and 1 mg of ECP at the same time (PGPE₀; n = 7) or 1 d after the second PGF_{2α} injection (PGPE₁; n = 7). In Experiment 3, 101 lactating dairy cows in a commercial herd were assigned to one of three treatments; PP, PGP, or PGPE₁. Follicular growth was measured by ultrasound in Experiment 1 and 2. All cows were blood sampled for progesterone and estradiol analyses and inseminated at estrus. In Experiment 1, a higher percentage of GnRH-treated cows ovulated after the first PGF_{2α} injection (90 vs. 50%; P < 0.05) and GnRH-treated cows tended to have larger dominant follicles at the time of the second PGF_{2α} injection (16.5 ± 0.5 vs. 15.0 ± 0.7 mm; P < 0.10). The percentage of cows that ovulated after the second PGF_{2α} injection was similar (60%). In Experiment 2, ECP-treated cows had higher preovulatory plasma estradiol concentrations (3.6 ± 0.6, 6.9 ± 0.6, and 7.0 ± 0.6 pg/ml; P < 0.01; PGP, PGPE₀, and PGPE₁ respectively) following the second PGF_{2α} injection and a higher percentage ovulated (43, 86, and 86%; P < 0.05; PGP, PGPE₀, and PGPE₁ respectively). In Experiment 3, a higher percentage of PGPE₁ cows were observed in standing estrus (26, 34, and 63%; P < 0.01) and ovulated (56, 63, and 78%; P < 0.05) (PP, PGP and PGPE₁ respectively) after the second PGF_{2α} injection. In conclusion, the PGP protocol increased the number of cows that ovulated after the first PGF_{2α} injection and produced a more mature dominant follicle at the time of the second PGF_{2α} injection. Adding ECP to PGP (PGPE₁) enhanced the expression of estrus and improved ovulation percentage.

Key Words: Estrus Synchronization, Estradiol, Dairy Cows

393 The use of ovsynch and heatsynch for re-synchronization of cows open at pregnancy diagnosis by ultrasonography. JA Bartolome^{*}, FT Silvestre, ACM Artech, S Kamimura, LF Archbald, and WW Thatcher, University of Florida, Gainesville, Florida, USA.

Ultrasonography (US) allows pregnancy diagnosis 27 d after breeding and re-synchronization of open cows. The objective was to compare pregnancy rates (PR) in open cows at US on Day 27 after insemination and re-synchronized using Ovsynch or Heatsynch. A total of 315 open cows was assigned randomly on Day 0 to two groups. Cows in Ovsynch (n=155) received 100 µg GnRH (im; Cystorelin, Merial Ltd) on Day 0, 25 mg PGF_{2α} (im; Lutalyse, Pharmacia) on Day 7, 100 µg GnRH on Day 9, and time-inseminated 16 h later. Cows in Heatsynch (n=160) received 100 µg GnRH on Day 0, 25 mg PGF_{2α} on Day 7, 1 mg estradiol cypionate (im; ECP, Pharmacia, Kalamazoo, MI 49001) on Day 8, and time-inseminated 48 h later. In both groups, cows that showed estrus on Day 9 were inseminated. On Day 0 cows were classified in stages of the estrous cycle based on uterine and ovarian findings at rectal palpation and US (5 MHz, Aloka 500[®]). Stages were: diestrus-presence of a CL and a follicle > 12 mm; metestrus-uterine edema, a corpus hemorrhagicum and no follicles > 12 mm; proestrus-uterine tone and a follicle > 12 mm; cystic-multiple follicles > 20 mm, absence of CL and lack of uterine tone. On Day 0, season, parity, previous services and inseminator were recorded. PR was compared by multiple logistic regression (Proc Genmod, SAS). PR was 18.0% (28/155) for Ovsynch and 18.7% (30/160) for Heatsynch. The odds of pregnancy were similar between Heatsynch and Ovsynch (OR=0.9; 95% CI= 0.54-1.7; P=0.87). PR according stages of the estrous cycle for Ovsynch were: diestrus 19% (15/79), metestrus 9.5% (2/21), proestrus 14.7% (5/34), and cystic 28.6% (6/21). PR for Heatsynch were: diestrus 15.7% (11/70), metestrus 44.4% (12/27), proestrus 12.8% (5/39), and cystic 8.3% (2/24). For cows in metestrus

the odds of pregnancy were higher for Heatsynch (OR=7.6; 95% CI= 12.8-4.5; P<0.05). In contrast, for ovarian cysts, the odds of pregnancy were higher for Ovsynch (OR=4.4; 95% CI= 6.5-2.9; P<0.05). In conclusion, similar PR was obtained by using Ovsynch or Heatsynch for re-synchronization. However, Heatsynch increases PR for cows in metestrus, and Ovsynch for cows with ovarian cyst.

Key Words: Re-synchronization, Timed-insemination, Dairy cows

394 Incidence and timing of estrus, LH surge, and ovulation in cows treated with the Ovsynch protocol with estradiol cypionate (ECP) substituting for GnRH. J.S. Stevenson^{*1}, S.M. Tiffany¹, and M.C. Lucy², ¹Kansas State University, ²University of Missouri.

Our purpose was to determine whether ECP could be substituted for the second GnRH injection of the standard Ovsynch protocol (injection of GnRH given 7 d before and 48 h after PGF_{2α}; PGF) with timed AI (TAI) 16 h after the second GnRH. Lactating dairy cows ranging from 61 to 82 DIM at TAI were studied in 13 replicates. Four treatments using the Ovsynch protocol were created: GnRH used as the control 48 h after PGF (GnRH; n=28); as GnRH plus a CIDR in place for 7 d beginning at the first GnRH injection (GnRH+CIDR, n=20); ECP (same as GnRH but substituting 1 mg of ECP for GnRH 24 h after PGF and TAI 48 h later [n=37]); or ECP+CIDR (n=26). The largest follicle was identified by ultrasonography 24 h after PGF and continually monitored every 6 h beginning 70 h after PGF until its disappearance (ovulation). In three replicates, blood was collected from cows in tie stalls at 0-6, 8, and 10 h after GnRH and at 24-30 and every 2 h until 58 h after ECP to determine incidence, timing, duration, and peak of the induced LH surge. In four replicates, HeatWatch[®] devices were affixed to cows housed in free stalls to monitor estrus. Intervals from ECP to estrus were 253 h (n=16), to the LH surge (412 h; n=14), and to ovulation (611 h; n=35). More (P<0.01) cows showed estrus after PGF when given ECP (40%; n=63) than GnRH (8%; n=48), whereas incidence of ovulation was less (P<0.01; ECP=59%; n=59 vs. GnRH=83%; n=46). Incidences of LH surges after ECP (82%; n=11) and GnRH (90%; n=10) were similar, whereas the CIDR was detrimental before ECP (42%; n=12) but not before GnRH (89%; n=9). Duration of LH surges was less (P<0.01) after GnRH (6 h; n=17) than after ECP (11 h; n=14), but no difference in its peak after ECP (3.71 ng/mL, n=14) and GnRH (5.81 ng/mL; n=17). Conception was greater (P<0.05) for ECP+CIDR (39%, n=26) than for ECP alone (22%; n=37), whereas the reverse occurred with GnRH+CIDR (5%; n=20) than for GnRH alone (43%; n=28). We conclude that substituting ECP for GnRH resulted in more cows in estrus, fewer ovulating, with little effect on fertility.

Key Words: Ovulation, Estrogen, Estrus

395 Effects of differences in dietary protein on the production and quality of bovine embryos collected from superovulated donors. F.D. Jousan^{*}, M.D. Utt, and W.E. Beal, Virginia Polytechnic Institute and State University.

High levels of dietary protein may be detrimental to reproductive performance in cattle. The objective of this experiment was to determine the effects of differences in dietary protein on the production and quality of bovine embryos collected from superovulated donors. Angus cows were randomly assigned to receive one of three experimental diets: a daily ration of 5.7 kg broiler litter, 2.0 kg hay, 3.1 kg corn, and 0.5 kg peanut hulls (LITTER; n=15); a daily ration of 6.2 kg peanut hulls, 2.2 kg soybean meal, 2.0 kg hay, 0.5 kg corn, and 0.4 kg dicalcium phosphate (SBM; n=15); or a daily ration of 6.2 kg peanut hulls, 2.0 kg hay, and 3.1 kg corn (CON; n=19). Diets differed in the amount of total, soluble and degradable protein, but were comparable in energy (see table). After 30 d on the diets all cows were treated to induce superovulation (28.8 mg FSH/cow, Folltropin) and synchronize estrus. After the detection of estrus each cow was inseminated with semen from one of four Holstein bulls. Embryos were collected 7 d after estrus and evaluated for quality (IETS standards) and stage of development. Prior to treatment to induce superovulation blood samples were collected 6 h after feeding. Samples were analyzed to assess dietary effects on plasma urea nitrogen (PUN). Mean levels of PUN were higher (P<.01) in cows fed the LITTER or SBM diet (16.3 mg/dL LITTER; 21.8 mg/dL SBM; 9.7 mg/dL CON) than in cows fed the CON diet. PUN was higher in cows fed SBM than in those fed LITTER (P<.01). An average of 9.1 transferable embryos (Grade 1-3) were collected from each cow and

there were no significant differences in the number of transferable embryos collected among groups (9.2 LITTER; 9.3 SBM; 9.1 CON). The number of degenerate embryos or unfertilized ova did not differ among dietary groups. High-protein diets elevated PUN, but did not affect the number or quality of embryos collected.

Diet	CP (%)	Soluble CP (%)	Degradable CP (%)	TDN (%)
LITTER	16.4	78.0	71.1	65.6
SBM	17.9	27.9	64.8	55.1
CON	9.2	29.0	49.9	57.5

Key Words: Cattle, Dietary Protein, Embryo

396 Prostaglandin synchronization before synchronized ovulation for first insemination in lactating dairy cows. S.J. LeBlanc* and K.E. Leslie, *University of Guelph, Ontario, Canada.*

Previous research has shown that conception risk with the Ovsynch breeding program is maximized when the program is initiated 5 to 12 days after estrus. The objective of this double-blinded field trial was to assess the effect of one injection of prostaglandin F2α (PGF2α), 10 days before the Ovsynch program, on the risk of pregnancy at first insemination in lactating dairy cows. The hypothesis was that cows that underwent luteolysis in response to PGF2α would be between 5 and 8 days post-estrus at the start of Ovsynch. In 5 commercial dairy herds in Ontario, Canada, at 52 (±12) DIM, 506 cows were assigned at random to receive either one i.m. injection of 500 µg cloprostenol or saline. Ten days later, all cows received 100 µg GnRH i.m., followed in 7 days by 500 µg cloprostenol i.m. and 100 µg GnRH i.m. 48 hours later. All cows were artificially inseminated 0 to 20 hours after the second injection of GnRH, without regard to detection of estrus. Pregnancy was diagnosed by trans-rectal palpation at least 35 days after insemination. The probability of pregnancy after first insemination was modeled with logistic regression, accounting for the correlation of cows with herd. Overall, there was no difference in pregnancy risk between cows that received PGF2α presynchronization and controls (37.3% and 36.6%, respectively; odds ratio = 1.02, 95% confidence interval, 0.87 to 1.19, P = 0.84). Herd, parity, and DIM at insemination covariates were not significant. However, among 248 cows bred before 71 DIM, pregnancy risks were 34.2% and 39.8% for presynchronized and control cows, respectively. Conversely, among 258 cows bred after 70 DIM, pregnancy risks were 40.2% and 33.3%, respectively. These apparent differences may merit further investigation. Although progesterone measurements were not performed, we speculate that overall, many cows did not undergo luteolysis and subsequent estrus following the injection of PGF2α. These results are consistent with the necessity for cows to be cyclic to benefit from PGF2α pre-synchronization for increased pregnancy risk following Ovsynch timed insemination.

Key Words: Presynchronization, Prostaglandin, Timed Insemination

**Production, Management, and the Environment
Beef and Swine Management**

399 Cooling and feeding strategies to reduce heat load in feedlot cattle. J.B. Gaughan*¹, S.M. Holt², and T.L. Mader³, ¹*The University of Queensland,* ²*South Dakota State University,* ³*University of Nebraska.*

Six Bos taurus steers (mean wt = 288 kg) were used in a 102-d 2 x 2 Latin Square study. The steers were housed in individual stalls in a controlled climate room. Cooling treatments (ENV) were (i) sprinkling during hottest part of day (0800 # 1500 h) (DC), and (ii) sprinkling at night (1600 # 0700 h) (NC). The dietary treatments (DIET) were (i) control (CON), and (ii) protected fat (PF). The diets (60/% concentrate # sorghum based and 40/% roughage) were iso-caloric and iso-nitrogenous (90/% DM; 23.6/% NDF; 12 MJ ME/kg DM; 16.3/% CP/kg DM). A

397 Administration of human chorionic gonadotrophin (hCG) or gonadotrophin releasing hormone (GnRH) analogue at day 5 after oestrus and plasma progesterone in the cow. LM Hicking*, APF Flint, and GE Mann, *University Of Nottingham, UK.*

Adequate progesterone (P₄) secretion is critical during early pregnancy in the dairy cow. Low P₄ levels on day 5 lead to poor embryo development and pregnancy loss. In this study, cows were treated on day 5 of a synchronised cycle with hCG or GnRH, to investigate effects on P₄ secretion. In experiment 1, 4 non-lactating multiparous Holstein-Friesian cows were treated with GnRH analogue (Buserelin[®], 10µg i.m.) or left as untreated controls during two consecutive cycles in a Latin square design. Jugular venous blood samples were collected at 4-hourly intervals for 72 hours following GnRH administration. Plasma P₄ concentration was not affected by GnRH treatment (GnRH, 3.7±0.6ng/ml; control, 3.1±0.7ng/ml). In experiment 2, a similar protocol was employed with 12 cows receiving hCG (Chorulon[®], 1500 IU i.m.) or left as untreated controls during two consecutive cycles. On day 8 of the second cycle animals were slaughtered and ovaries recovered. Mean plasma P₄ was raised (P<0.05) throughout the sampling period (hCG, 5.6±0.5ng/ml; control, 4.0±0.3ng/ml). Original corpus luteum (CL) weight was higher (P<0.001) in treated animals (hCG, 8.4±0.5g; control, 5.4±0.4g). P₄ secretion by luteal tissue *in vitro* (30min incubation) revealed no effect of treatment (hCG, 8.3±1.7; control, 7.7±1.1ng/mg/ml). There was an increase (P<0.001, ng/mg luteal tissue; P<0.05, µg/CL) in P₄ production by luteal tissue from all animals when incubated with LH (100ng/ml). There was no treatment*LH interaction. P₄ content of the CL was greater (P<0.05) for treated animals prior to incubation. In conclusion, administration of hCG, but not GnRH, on day 5 resulted in sustained stimulation of P₄ production associated with increased CL size without a reduction in P₄ content. This treatment should provide a suitable approach to raising P₄ in animals exhibiting a deficiency and hence to improving postpartum pregnancy rates. Supported by Intervet UK Ltd, DEFRA, MDC. LMH was funded by the Dartington Cattle Breeding Trust.

Key Words: hCG, GnRH, Progesterone

398 The effect of bromocryptine on the ovulation rate of ewes of different fecundity and ovulation rate. V. Fuentes¹, R. Sanchez, and P. Fuentes, ¹*Centro Universitario de los Altos Universidad de Guadalajara, México.*

Bromocryptine was administered im in doses of 1 mg at 12 hour intervals, to ewes of different fecundity and ovulation rate with the objective of decreasing blood prolactin levels during a complete estrous cycle and to observe this effect on their ovulation mate. The experiment was carried out in November 1999 and repeated in January 2000. For this purpose Finnish Landrace and Scottish Black Face ewes were used because of their high and low ovulation rates respectively. On the first study ovulation rate was not affected by the low prolactin levels induced by the drug. Ovulation rate in Finish Landrace was 3.85 0.69 for the control and 3.42 0.53 for the treated group. Similar results were observed in Scottish Black Face ewes ovulation rate was 1.12. 0.35 in the control group in treated ewes ovulation rate was 1.37 0.51. When the experiment was repeated on January 2000 the results were similar.

Key Words: bromocryptyne, ewes, ovulation

rumen protected fat was added at the rate of 5/% to the PF diet. Feed was offered ad libitum. Mean THI between 0800 h # 1500 h was 89, and between 1600 # 0700 h was 78. Respiration rate (RR; breaths/min; bpm) and rectal temperature (oC; RT) were measured hourly over 12 24 h periods, while DMI was measured using load cells. ENV had a significant effect on mean daily RR (P<.001; DC = 88.3 2.4 bpm; NC = 56.1 2.4 bpm), and on mean daily RT (P<.001; DC = 39.2 .1 oC; NC = 38.7 .1 oC). The DC steers had a RR greater than 100 bpm (max 133) for 10 hours, and 80 bpm or lower for 10 h each day. The NC steers spent 3 hours per day with a RR greater than 100 bpm (max 200), and 17 h with a RR of 80 bpm or lower. There were no ENV x DIET interactions or DIET effects for RR or RT. There were ENV x DIET

interactions for total DMI. DMI was 6/% lower ($P < .05$) for DC steers fed PF (6152 268.6 g/h/d) vs CON fed steers (7280.9 382.4 g/h/d). There were no effects for NC steers. The DMI between 0800 h and 1500 h was greater ($P < .05$) for the DC steers fed CON (3233.1 190.6 g/h/d), than for DC (2671.3 133.9 g/h/d) and NC (2305.6 190.6) fed PF, and NC (2288.6 133.9) fed CON. The NC steers had greater ($P < .001$) DMI for the period 1600 h to 0700 h (PF = 4978.8 289.1; CON = 4752.9 203.7) than the DC steers (PF = 3481.4 203.1; CON = 4047.8 289.1). In conclusion, night cooling improved the overall comfort of the steers, and feeding PF did not improve DMI.

Key Words: Beef cattle, Cooling strategies

400 Effects of shade and implant strategy on performance by finishing heifers. J. E. Stockstill¹, F. M. Mitloehner^{*2}, M. L. Galyean¹, and J. J. McGlone¹, ¹Texas Tech University, Lubbock, ²University of California, Davis.

One hundred sixty-eight Angus and Angus-cross heifers (black hair coats) were used to evaluate the effects of shade and implant strategy during heat stress conditions in West Texas. Treatments were arranged factorially and included: 1) shade with a Revalor H (Intervet, Millsboro, DE) implant on d 0 (SHII); 2) shade with a Revalor H implant delayed until d 56 (SHDI); 3) no shade with a Revalor H implant on d 0 (NSII); and 4) no shade with a Revalor H implant delayed until d 56 (NSDI). Heifer performance (DMI, ADG, and feed:gain), carcass traits, behavior, and respiration rates were measured. Heifers that were initially implanted had a greater ($P < 0.05$) DMI (9.62 vs 9.38 kg/d) than heifers that received the delayed implant. For ADG (shade x implant strategy, $P < 0.07$), SHII heifers had a greater ADG (1.80 kg/d) than heifers in the SHDI, NSII, and NSDI groups (1.67, 1.71, and 1.69 kg/d, respectively). Similar shade x implant strategy ($P < 0.05$) interactions were noted for final BW and hot carcass weight, indicating that shade benefited heifers with an initial implant but not those with a delayed implant. Feed:gain ratio did not differ ($P > 0.10$) among treatments. Delayed implanting decreased carcass fat thickness in unshaded but not in shaded heifers (shade x implant strategy, $P < 0.07$). Shaded heifers had more ($P < 0.07$) kidney, pelvic, and heart fat than unshaded heifers, and delayed implanting tended to decrease ($P < 0.10$) carcass yield grade. With the exception of wk 6 and 7, respiration rates were less ($P < 0.06$) for shaded than for unshaded heifers. Under the conditions of this study, feedlot performance was best when shade was provided to heifers that received an implant at initial processing; however, shade did not benefit heifers implanted after 56 d on feed.

Key Words: Beef cattle, Shade, Implants

401 Implant strategies for production of high quality beef for Japanese export market. K. S. Eng^{*1}, R. Bechtel², and D. P. Hutcheson³, ¹Eng, Inc., San Antonio, TX, USA, ²Advance Agricultural Testing, Petersburg, Ont, Canada, ³Animal-Agricultural Consulting, Inc., Amarillo, TX, USA.

Recent research indicates early management practices may have a significant impact on the final performance and carcass quality grades of feed lot steers. However, most of these studies have been conducted on young lightweight calves as opposed to heavier yearling steers. The premium Japanese export market requires heavy high quality carcasses. The purpose of this experiment was to study the impact of three different low and medium initial implants followed by a high dose combination re-implant on interim and final performance and carcass characteristics. Three hundred and twenty four non-implanted black yearling steers from Western Canada were allotted to 3 implant treatments with 9 head per pen and 12 reps. Initial implant treatments were Synovex C, Ralgro or Synovex S and all treatments were re-implanted at 100 days with Synovex Plus. Average daily gain, dry matter consumption and feed conversions were calculated at reimplant time and at completion of trial (198 days). Carcass data was collected included carcass weight, dressing percentage, USDA quality grade and yield grade. Overall performance and carcass data is presented in Table 1. There were no differences in interim or final performance data due to implant strategies. Carcass data indicated an improvement in USDA retail yield grade for initial Synovex S treatment. There were no differences due to implant strategies for USDA quality grade. USDA quality grade was high and averaged 97.1 to 98.1 percent for Choice and Prime for the implant strategies. The results indicate a variety of low or medium dose initial implants

followed by a high dose combination final implant will give excellent overall performance and desirable final carcass quality grade.

Table 1	SYN C	RAL	SYN S
Final Weight, Kg	723.2	729.1	723.2
ADG, Kg/d	1.87	1.85	1.86
DMI, Kg/d	10.05	10.00	9.95
DM Feed/Gain	5.38	5.40	5.35
Choice and Prime, %	97.1	98.1	98.1
Select %	2.9	1.9	1.9
USDA Yield Grade	3.01 ^{a,b}	3.25 ^b	2.90 ^a

^{a,b} Means with the same superscript within a row are not significantly different ($P \geq 0.05$)

Key Words: Implant, Strategies, Beef

402 Effect of early calf weaning on cow and calf performance in Florida. J. D. Arthington^{*1} and R. S. Kalmbacher¹, ¹University of Florida, Range Cattle Research and Education Center, Ona.

Forages of central and south Florida are conducive to high yields, but are of limited quality, especially for supporting the reproductive performance of young post-partum cows. The objective of this study was to investigate the effectiveness of early calf weaning for improving the reproductive performance of these females. Forty, post-partum, 3 year-old Braford and Brangus sired heifers were randomly assigned to one of two treatments; early weaned (EW; n=20) and normal weaned (NW; n=20). At the time of early weaning (January 23) cow body condition score (BCS) was low but similar between treatments (3.90 and 3.88 for EW and NW cows, respectively). Calves were similar in age (84 d) and body weight at the time of early weaning (90.7 vs. 87.1 kg for EW and NW calves, respectively). Following EW all cows were returned to bahia-grass pastures with the mature cowherd and provided 2.27 kg of molasses supplement (16% CP) daily. Early -weaned calves were maintained on ryegrass pastures at a rate of 1.35 calves/ha and were provided supplemental grain (14% CP) at a rate of 1.0% BW daily. Normal-weaned calves remained with their dams in the mature cowherd. Over 112 d of ryegrass grazing, EW calves had a higher ($P < 0.01$) ADG compared to NW calves left with their dams (0.86 and 0.67 kg/day for EW and NW, respectively). Early weaning resulted in heavier ($P < 0.01$) cows that were in better body condition at the time of normal (August 1) weaning (487.1 and 445.4 kg/cow with a body condition score = 6.25 and 4.50 for EW and NW, respectively). This improvement in body condition was associated with a higher ($P < 0.05$) pregnancy rate and lower ($P < 0.05$) calving interval for EW vs. NW cows (89.5 vs. 50.0% pregnant and 391 vs. 412 d calving interval for EW and NW, respectively). These initial data suggests that EW will improve cow body condition resulting in an increased pregnancy rate for low body condition heifers maintained on winter ryegrass provide Florida cattlemen with the ability to optimize early weaned calf performance, while capitalizing on low cost of gain and favorable spring markets.

Key Words: Early Weaning, Ryegrass, Calves

403 Effects of periparturient disorders and other factors on calf related traits. M. L. Wiederhold^{*1}, M. A. Faust¹, and S. L. Berry², ¹Iowa State University, Ames, ²University of California, Davis.

Objectives were to evaluate cow related factors for calf traits at birth. Data were records for as many as 9,900 cows (parity ≥ 2) from 10 California dairy herds collected as part of a study of periparturient disorders. Health events were coded as 1 for cows that had at least one incidence of the event during the previous lactation and zero otherwise. Three categories of calving ease were defined: no, slight, and at least moderate assistance. Mixed model procedures were used to evaluate fixed effects of calving ease and season from the current lactation and mature equivalent yield, number of services, and incidences of cystic ovaries, lameness, and other health events for the previous lactation; year, herd and residual were random effects. Response variables studied included calf livability at birth, number of calves born (90.4%, 9.6%, 0.06% single,

twin, and triplet births, respectively) and calf sex. Dams that were not lame during the previous lactation had more female calves ($P < 0.01$). Number of calves was lowest for cows that conceived from May to July and greatest for third and fourth parity calvings ($P < 0.01$). Cows that did not experience cystic ovaries during the previous lactation had the fewest number of calves ($P < 0.01$). Livability was defined at birth as at least one live calf (coded as 1) or no live calves (0). Livability was lowest for calves born when conception required the greatest number of services ($P < 0.05$). However, livability rate was highest for female calves and calves born with no assistance; rates for no assistance and at least moderate assistance were $92.9 \pm 0.04\%$ and $66.7 \pm 0.05\%$ for twins and $98.3 \pm 0.01\%$ and $79.7 \pm 0.02\%$ for single calves, respectively. Single calves born to dams with highest milk yield had greatest livability ($P < 0.05$); livability was higher by 0.28% for each additional 1,000 kg milk during the previous lactation. Health disorders during the previous lactation may influence calf related traits for cows that conceived and calved subsequently.

Key Words: Calf Livability, Periparturient Disorders, Calving Ease

404 Development of antibiotic resistance among *Escherichia coli* in feedlot cattle. H.W. Busz^{*1}, T.A. McAllister¹, L.J. Yanke¹, M.E. Olson², D.W. Morck², and R.R. Read³, ¹Agriculture and Agri-Food Canada, Lethbridge, AB, ²University of Calgary, AB, ³Calgary Regional Health Authority, Calgary, AB.

Widespread feeding of subtherapeutic levels of antimicrobial agents (SAA) to livestock is commonly implicated in the emergence of antibiotic-resistant bacteria. To date, most research on this topic has focused on poultry and swine. This study examined development of antibiotic-resistant *Escherichia coli* in 300 feedlot steers receiving SAA ($n = 50$). Feedlot diets were top dressed with 1) no additive; 2) Aureo S-700 (350 mg/hd-d); 3) Aureomycin 100 (11 ppm); 4) Virginiamycin (240 mg/hd-d); 5) Monensin (26 ppm); or 6) Tylosin (11 ppm) beginning on d 18 of backgrounding. The SAA were fed for 56 d during backgrounding, withdrawn for 91 d, reintroduced for 42 d during finishing, and withdrawn 109 d prior to slaughter. Fecal swabs were plated on MacConkey agar \pm ampicillin (Amp, 50 μ g/mL), ciprofloxacin (Cf, 2 μ g/mL), gentamicin sulfate (Gm, 4 μ g/mL) or tetracycline hydrochloride (Tet, 4 μ g/mL) to assess populations of total and antibiotic-resistant *E. coli*. Irrespective of treatment, steers shedding antibiotic-resistant *E. coli* were notably more prevalent during finishing than during backgrounding. Withdrawing SAA did not lessen the prevalence of animals with resistant *E. coli*. No resistance to Cf was detected at any time, whereas across treatments, overall prevalences of steers carrying Gm-, Amp- or Tet-resistant *E. coli* were 23.3, 18.8 and 63.6%, respectively. Resistance to Tet was observed in 8.24% of total *E. coli* isolates, compared with 0.80% (Gm) and 0.007% (Amp). All 300 steers tested positive for Tet-resistant *E. coli* at least once during the study. The Aureo S-700 group consistently recorded higher ($P < 0.05$) prevalences of steers with Amp-resistant *E. coli* (44.4%) and steers with Tet-resistant strains (86.7%) than did the other groups (which averaged 13.7% and 58.9%, respectively). Feeding SAA did not promote Cf or Gm resistance, however high levels of Tet and Amp resistance were evident, particularly when Aureo S-700 was fed.

Key Words: *Escherichia coli*, Antibiotic Resistance, Cattle

405 Effects of the fibrolytic enzyme preparation Cattle-AseTM on growth of prepuberal crossbred heifers. T. A. Strauch^{*1}, D. A. Neuendorff¹, C. G. Brown¹, C. Cobb², J. L. Kerby¹, R. D. Randel¹, and F. M. Rouquette¹, ¹Texas Agricultural Experiment Station, Overton, TX, ²Loveland Industries, Hereford, TX.

Objectives were to determine the effects of Cattle-AseTM, a fibrolytic enzyme preparation, on growth of crossbred heifers. In trial 1 (TR1), Cattle-AseTM was delivered in a commercial molasses-urea lick (24% CP with 18% NPN, 3% fat) to 54 fall-born, prepuberal, crossbred heifers grazing coastal bermudagrass (CBG) for 84 d. Heifers were assigned to three treatments in two replicate pastures according to breedtype, age, and BW: pasture only (P), P + molasses-urea lick (M), and P + M + Cattle-AseTM (MC). Cattle-AseTM was added at 30g/8.8 kg to 60g/4.8 kg molasses. Average molasses consumed was 1.15 kg/hd/d; thus, urea intake was ~ 21 kg/hd/d. In trial 2 (TR2), heifers from TR1 were reassigned to two treatments: Cattle-Ase (CSE) or control (C). The MC heifers were assigned to CSE, M assigned to C, and P were divided equally between treatments. Heifers had ad libitum access to

CBG hay and were group fed 2:1 corn:soybean meal (33% CP) at 1% BW, with Cattle-AseTM provided to CSE heifers at 1.85 g/hd/d for 126 d. Supplement was adjusted for changing BW each 28 d. Weights and body condition scores (BCS) were recorded at initiation and 28 d intervals in TR1, and biweekly in TR2. Blood samples were collected at initiation and weekly throughout both trials. Serum samples from TR1 were assayed for concentration of IGF-I by RIA. There was no treatment effect ($P > .10$) on BW, BCS, or serum concentrations of IGF-I throughout TR1, nor was there an effect on ADG ($P = .36$) with ADG as follows: .54, .65, .64 \pm .06 kg/hd/d for P, M, MC, respectively. However, in TR2, Cattle-AseTM increased ADG ($P < .04$) as follows: .42 \pm .03 and .34 \pm .02 kg/hd/d for CSE and C, respectively. Molasses + urea supplement with or without Cattle-AseTM failed to improve ADG. Cattle-AseTM addition to a dry supplement, however, improved ADG. Differences in effects of Cattle-AseTM between trials may be related to the carrier, NPN, or to nutritive value of the forage offered.

Key Words: Fibrolytic enzyme, Heifers, Bermudagrass

406 Predicting the nutritional status of mature beef cows. D. S. Horsley^{*}, J. B. Hall, D. E. Eversole, J. P. Fontenot, and M. L. Wahlberg, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Improved prediction of forage quality and cow performance may enhance the nutritional management of beef cows. In two 12 mo trials, mature beef cows ($n=136$) grazing tall fescue pastures were used to compare estimates of forage quality and animal performance. Forage quality was estimated by proximate analysis of forage samples (FOR) or by near infrared reflectance spectroscopy of fecal samples (FNIR). Nutritional Balance Analyzer (NutBal), NutBalPro and 1996 NRC Nutrient Requirements of Beef Cattle (NRC) programs were used to predict animal performance. The objectives were to compare FOR and FNIR estimates of CP and TDN and to evaluate the accuracy of cow performance predicted by FNIR-NutBal, FNIR-NutBalPro and FOR-NRC systems. Initial BW, body condition score (BCS), hip height and breed were used to establish cow biotypes for prediction programs. Every 28 d, cow BW and BCS were measured and forage and fecal samples collected. Weather data, cow status and FOR or FNIR results were entered into NutBal, NutBalPro and NRC programs. Forage CP estimated by FNIR (CPFNR) or FOR (CPFOR) were similar. In trials 1 and 2, correlation coefficients between CPFNR and CPFOR were $r = .24$ and $r = .43$, respectively. Forage TDN estimated by FNIR was greater ($P < .05$) and lowly or moderately correlated to FOR estimates. Actual BW change between weigh periods (BWCHG) and ADG were similar to NRC predictions, but less ($P < .0001$) than predicted by NutBal or NutBalPro. The NutBal or NutBalPro mean BCS change between weigh periods (BCSCHG) were greater ($P < .001$) than NRC or Actual BCSCHG. Actual and NRC BCSCHG were similar ($P > .2$, trial 1) or tended ($P < .1$, trial 2) to be similar. Cow performance estimated by NRC was highly correlated to Actual. In trials 1 and 2, NutBal and NutBalPro over-predicted BWCHG, ADG and BCSCHG by 40 kg, 1.25 kg/d and .75 BCS, respectively, compared to actual cow performance. It appears that FNIR is a promising predictor of forage CP but not TDN. Also, the FOR-NRC is a satisfactory predictor of cow performance.

Key Words: Cow performance, Nutrition, Forage

407 Using adjusted 205-day weight ratios to predict beef cow-calf performance. T. R. Troxel^{*1}, Z. B. Johnson², and W. T. Wallace¹, ¹University of Arkansas Cooperative Extension Service, Little Rock, AR, ²University of Arkansas, Fayetteville, AR.

Twenty-one commercial beef herds were used to determine if future cow-calf performance could be predicted based on adjusted 205-d ratios. Adjusted 205-d ratios were determined within each herd and ranked in descending order. Each herd was divided into thirds - top (T), middle (M), and bottom (B). The data set included 8,928 cow records with 4,379 cows having records in two consecutive years and 1,958 cows having records in three consecutive years. Data were analyzed using chi-square, and the overall chi-square statistic was significant ($P < 0.001$). Cows ranked T had a 50.9%, 31.5% and 17.6% probability of ranking T, M and B, respectively, the next year. Cows ranked M had a 32.8%, 36.9% and 30.3% probability of ranking T, M and B, respectively, the next year. Cows ranked B had a 19.5%, 30.6% and 49.9% probability of ranking T, M and B, respectively, the next year. Cows ranked T and B had a 33.3% and 26.7% probability of ranking T and B, respectively, for each of the

next two consecutive years. The T ranked cows had a 17.7% probability of ranking B in their third year, and B cows had a 21.0% probability of ranking T in their third year. Stepwise regression analysis was used to determine which other production traits available affected ranking of cows. Included in the model were age of cow, ranking from the previous year, cow weight, preweaning ADG of calf, 205-d weight, adjusted hip height ratio, and muscle score for both current and previous years. All variables were kept in the model ($P < 0.15$) except age of dam and previous year adjusted hip ratio. Adjusted 205-d weights from the T, M, and B cows were 263.2 ± 0.41 , 237.2 ± 0.41 and 208.5 ± 0.41 kg, respectively ($P < 0.001$). Calf preweaning ADG from the T, M and B rankings were 1.08 ± 0.002 , 0.95 ± 0.002 and 0.81 ± 0.002 kg, respectively ($P < 0.001$). In conclusion, adjusted 205-d weight ratios can be used to predict future cow performance and assist in making culling decisions.

Key Words: Cow-calf performance, Ranking, 205-day ratios

408 Factors affecting the market value of cows sold through Arkansas auction barns, Part I: Management. M. S. Gadberry, T. R. Troxel*, D. Urell, J. Foley, R. Wiedower, S. Cline, and G. Ford, *University of Arkansas Cooperative Extension Service, Little Rock, AR.*

A study was conducted to determine the factors affecting the market price of cull cows. Data was collected from 15 auction barns in the spring (14 wk) and fall (13 wk) of 2001. The final dataset represented 43.5% of the cows marketed. Management aspects examined included pregnancy and stage of pregnancy, fill, brands, horns, health and USDA quality grade. Management factors were analyzed individually and included cow type, replacement cows (R) vs. slaughter cows (S), as a main effect, and their interaction. Week, cow age and weight were covariates. Values are reported on a 45.45 kg basis. There were significant interactions ($P < 0.001$) for cow type and each management factor. In all instances, except health, R received a higher price ($P < 0.001$) per unit than S. Third trimester R sold for a higher price ($P < 0.001$) than non-pregnant R, \$50.33 and \$43.86, respectively. Slaughter cow value was not affected by stage of pregnancy. Shrunk R received the highest price (\$49.78; $P < 0.001$), and tanked R received the lowest (\$44.35; $P < 0.01$). Gaunt (\$38.29) and full (\$38.43) fill S was lowest in value ($P < 0.001$) and did not differ ($P = 0.65$). Brands did not affect sale price of R ($P > 0.70$). Slaughter cows with 2 or more brands sold for \$40.98 compared to \$39.11 for S without brands ($P < 0.01$). Replacements with horns sold for less than R without horns ($P < 0.001$); however, S without horns sold for less than S with horns ($P = 0.02$). Healthy S sold at a higher price ($P < 0.001$) compared to S with lumps, sickness, bad eye(s) or lame S and did not differ from sick R. Market price for S quality grade differed ($P \leq 0.01$). Utility averaged the highest and canner the lowest, \$39.29 and \$34.96, respectively. The study showed that cow prices were affected by whether cows are purchased as R or S. The impact of cow characteristics, attributable to management, on sale price differed between R and S.

Key Words: Value, Replacement cows, Slaughter cows

409 Evaluation of ultrasound exam at feedlot entry as a predictor of carcass grade at slaughter. G Keefe*, I Dohoo, J Valcourt, and R Milton, *Atlantic Veterinary College.*

Five hundred and thirty-six feeders, 347 steers and 189 heifers, from 8 Prince Edward Island feedlots were scanned ultrasonically at entry into the feedlot. Duplicate ultrasonic images, in the longissimus dorsi muscle region between ribs 12 and 13 were created by a certified technician using an ALOKA 500 ultrasound unit with a 3.5 MHz 17 cm ultrasound probe. Critical Vision analysis software was used in the assessment of back fat depth, rib eye area and, using image analysis, to create a score for intramuscular fat. Data were analyzed using an adjacent category ordinal regression model in STATA version 7.0 with carcass grade at slaughter (A, A, AAA) as the outcome. This model assumes that the effect of a factor on the odds of moving from A to AA is the same as on the odds of moving from AA to AAA. For analysis, the two measurements for each of the ultrasound variables were averaged. Intramuscular fat values less than 1.85 were set to a value of 1.85 to reflect the lower detection threshold level of the ultrasound equipment. In total, 487 animals had a complete set of all data required for the analysis. Several factors were significantly associated with grade. Two of the 8 feedlots were significantly different than the reference farm. From the regression model, heifers were 1.73 times more likely than steers to be AA than

A and a further 1.73 times more likely to be AAA than AA. Animals weighing less at scanning were more likely (Odds Ratio 1.22/100 lbs) to be in the lower grade classes versus the next highest one. Feeders that were on feed for 100 days more than comparison animals were 2.1 times more likely to be in a higher category. For each increase in back fat of 1 mm at scanning, animals were 1.27 times more likely to be in a higher-grade class. For each 1 sq cm increase in ribeye area an animal would be 1.08 times less likely to be in a higher category. For each percentage increase in marbling at scanning feeders were 1.57 times more likely to be in a higher-grade class. Ultrasound scanning at feedlot entry can be used to predict carcass traits at slaughter.

Key Words: Ultrasound, Feedlot, Intramuscular Fat

410 Use of a modified yeast cell wall preparation to alleviate endophyte toxicosis in cattle. I. Production characteristics. D. G. Ely*, D. K. Aaron¹, B. T. Burden¹, C. L. Schultz¹, J. Wyles¹, V. Akay², and K. A. Dawson², ¹University of Kentucky, Lexington, KY, ²Alltech Biotechnology, Inc., Nicholasville, KY.

Ninety-two Angus and Angus x Beefmaster cow/calf pairs were randomly allotted to nine, 10.5#ha KY 31 tall fescue endophyte-infected pastures (> 90%) on May 2 to evaluate the potential of a modified yeast cell wall (MYCW) preparation, from *S. cerevisiae*, to adsorb toxins contained in fescue forage. Three replicate pastures were randomly allotted to each of the following treatments: MYCW [0.45 kg/d⁻¹ ground shelled corn (95.6%) + MYCW (4.4%) supplement], PC (positive control, ground shelled corn only), and NC (negative control, no supplement). Initial cow and calf weights were taken on two consecutive days (May 2, 3). Cows averaged 5.4 yr of age, weighed 539 kg, and expressed an average BCS of 6.3 when the experimental period began. Calves were 67 d of age and weighed an average of 107 kg on these days. Interim weights of cows and calves and BCS and rectal temperatures of cows were taken at 35-d intervals until weaning on October 22 (consecutive weights on October 22, 23). Cow weight changes from May 2 to July 12 were +0.7, -8.9, and +2.3 kg/hd for NC, PC, and MYCW, respectively. From July 12 to October 22, gains were +12.2, +20.2, and +30.0 kg/hd ($P < 0.05$). Body condition scores were 6.3, 6.1, and 5.9 on May 2, 6.3, 6.0, and 6.0 ($P < 0.05$) on July 12, and 6.4, 6.2, and 6.3 ($P < 0.10$) on October 22 for NC, PC, and MYCW, respectively. Rectal temperature differences were nonsignificant on all dates. Overall calf ADG (175 d) values were .89, .85, and .91 kg/hd for NC, PC, and MYCW, respectively. Results of this study indicate consumption of MYCW by cows grazing tall fescue has the potential to alleviate some of the endophyte toxicosis associated with consumption of this forage. The MYCW appears to exert its greatest influence from July to late October.

Key Words: Fescue, Cows, Calves

411 Use of a modified yeast cell wall preparation to alleviate endophyte toxicosis in cattle. II. Tympanic temperature response. D. K. Aaron*, D. G. Ely¹, B. T. Burden¹, C. L. Schultz¹, J. Wyles¹, V. Akay², and K. A. Dawson², ¹University of Kentucky, Lexington, KY, ²Alltech Biotechnology, Inc., Nicholasville, KY.

Tympanic temperatures were continuously measured at 30-min intervals during three, 3-d trials (June 14-17, July 17-20, August 20-23) to evaluate effects of a modified yeast cell wall (MYCW) preparation on deep body temperatures of 27 Angus and Angus x Beefmaster cows grazing endophyte-infected KY 31 tall fescue. Three cows were randomly selected from each of nine pastures previously allotted (May 2) to MYCW [0.45 kg/d⁻¹ ground shelled corn (96.6%) + MYCW preparation (4.4%)]; PC (positive control, ground shelled corn only), and NC (negative control, no supplement) treatments. Temperature data collection began at 1700 of each trial start date and ended at 1700 of the last day of the trial (72-h period). Data logger difficulties allowed only 24, 20, and 25 cows to be instrumented during the June, July, and August trials. Each cow's average, maximum, and minimum tympanic temperatures were found for each day of the trial. Daily diurnal ranges and daily differences between maximum and average tympanic temperatures (partial differences) were calculated. Data were averaged for each trial. Average maximum and minimum ambient temperatures were 30.6 and 19.2, 30.5 and 19.7, and 28.1 and 16.1°C for the June, July, and August trials. Maximum tympanic temperatures were lower ($P < 0.10$) for MYCW

than NC cows in all trials (June: 39.1 vs. 39.6; July: 39.1 vs. 39.3; August: 38.9 vs. 39.2°C). Daily diurnal ranges and partial differences were lower for MYCW than NC cows in June (1.13 and 0.64 vs. 1.40 and 0.84°C; $P < 0.05$) and August (1.11 and 0.54 vs. 1.29 and 0.70°C; $P < 0.05$). Although not statistically significant, temperature differences between MYCW and PC cows also tended to support MYCW supplementation as a potential means of alleviating the problem of elevated body temperature associated with fescue toxicosis.

Key Words: Temperature, Fescue, Cows

412 Comparison of an early weaning management system with a conventional weaning system on cow and calf performance while grazing tall fescue pastures. C. L. Schultz*, D. G. Ely, B. T. Burden, D. K. Aaron, and J. Wyles, *University of Kentucky, Lexington, KY.*

Twenty-four, Angus x Beefmaster 2-yr-old heifers and their calves were used in a completely randomized design to compare cow and calf performance in two management systems. In the early weaning (EW) system, calves were weaned at 100 d (May 21) to fescue pastures and supplemented with a concentrate mix. Calves in the normal weaning (NW) system grazed fescue pastures with their dams until weaning at 210 d. Twelve EW calves and 12 NW cow/calf pairs were allotted to eight pastures on June 6 with four pastures per treatment. Cow and calf weights and cow BCS changes were measured at 28-d intervals from May 21 (EW) to September 4 (NW). Cow gain, from EW to NW, was greater ($P < 0.05$) for cows with EW calves (50.5 vs. -3.2 kg). Cows with EW calves gained .5 BCS; those with NW calves lost .5 BCS ($P < 0.05$). Calf gains were not different (.88 vs. .83 kg/d; EW vs. NW). To determine DMI and nutrient digestibility, steers in each pasture were dosed with n-alkane boluses on June 18, July 20, and August 20 [Period (P) 1, 2 and 3, respectively]. Fecal grab samples were collected once daily from d 10 through d 14 post-bolus. Total DMI was similar in P1 and 2, but EW calves consumed more ($P < 0.01$) during P3. Although forage DMI was greater ($P < 0.01$) for NW calves during P1 and 2, CP intake was greater ($P < 0.05$) for EW calves in P1. Intake of NDF and ADF was greater for EW calves during P3. Digestibility of DM and CP was ($P < 0.10$) higher in the NW treatment in P1 and 2 and digestibility of NDF and ADF was greater ($P < 0.08$) for NW calves during all periods. These data indicate weaning beef calves at 100 d can improve cow gains and condition, but calf gains from fescue pasture are

not increased because neither dietary intake nor nutrient digestibility are increased above that of NW calves.

Key Words: Gain, Dry Matter Intake, Digestibility

413 Evaluation of four ractopamine use programs on pig growth and carcass characteristics. S.A. Trapp*, J.P. Rice, D.T. Kelly, A. Bundy, A.P. Schinckel, and B.T. Richert, *Purdue University, West Lafayette, IN.*

Barrows (n=143) and gilts (n = 149) were used in a six week study evaluating different ractopamine use programs for late finishing pigs. Pigs were allotted by weight (Initial BW = 70.8 kg), sex and ancestry to one of five ractopamine (RAC) treatments (trt): 1) control, no RAC; 2) 5 ppm RAC wk 0-6; 3) 5 ppm RAC wk 0-4, 10 ppm RAC wk 5-6; 4) 5 ppm RAC wk 0-3, 10 ppm RAC wk 4-6; 5) 5 ppm RAC wk 0-2, 7.5 ppm RAC wk 3-4, 10 ppm RAC wk 5-6. Barrows were fed a 1.1% Lys diet and gilts were fed a 1.2% Lys diet. Pigs fed RAC had increased ADG (1089 vs 984 g/d; $P < .002$) and increased G:F (.390 vs .363 $P < .03$) compared to the control trt during wks 0-2. RAC trts during weeks 2-6 had greater ADG (911, 969, 1015, 1041, 1003 g/d; trt 1-5 respectively, $P < .05$) than the control trt. Pigs fed trt 4 had greater ADG ($P < .02$) than trt 2 during wk 2-6. Overall, pigs fed RAC had increased ADG (936, 1015, 1033, 1083, 1008 g/d; trt 1-5 respectively, $P < .01$) and G:F (.359 vs .324; $P < .001$) compared to pigs fed control, with no significant differences in ADFI among trts. Pigs fed trt 4 had greater overall ADG ($P < .05$) than the other RAC trts. Pigs fed RAC had increased final BW (110, 113.5, 114.2, 116.2, and 112.7 kg; trt 1-5 respectively, $P < .01$) and trt 4 had greater ($P < .05$) final BW than the other RAC trts. Pigs fed RAC had increased hot carcass weight (83.0 vs 87.5 kg; $P < .001$) and yielded greater dressing percent (76.41% vs 75.40%; $P < .02$) than the control trt. Loin eye area (LEA) was greater for pigs fed RAC (41.0, 43.2, 43.9, 44.2, 43.2 cm²; trt 1-5 respectively, $P < .01$) than the control trt. No significant differences in backfat measurements were found among trts. All RAC use programs increased pig growth rate and feed efficiency. The RAC step up programs sustained the RAC growth response during weeks 5 and 6 better than constant level of RAC. However, the 3 wk-3 wk RAC program with levels of 5 and 10 ppm, respectively, had the greatest increase in pig growth rate and provides an effective step-up program that will maximize pig performance while using RAC.

Key Words: Ractopamine, Pig, Growth

Ruminant Nutrition Feed Additives and Fiber

414 Use of feed enzymes to improve feed utilization by ruminants. K. A. Beauchemin¹, D. Colombatto¹, W. Z. Yang¹, and D. P. Morgavi², ¹*Agriculture and Agri-Food Canada, Research Centre, Lethbridge, Alberta, Canada*, ²*INRA Centre Clermont-Theix, Saint-Genes-Champanelle, France.*

Research has demonstrated that supplementing dairy cow and feedlot cattle diets with fiber-degrading enzymes has significant potential to improve feed utilization and animal performance. Ruminant feed enzyme additives are concentrated fermentation products with specific enzyme activities, primarily xylanases and cellulases. Improvements in animal performance through enzyme supplementation can be attributed mainly to improvements in ruminal fiber digestion resulting in increased digestible energy intake. Animal responses are greatest when fiber digestion is compromised and when energy is the first limiting nutrient in the diet. When viewed across a variety of enzyme products and experimental conditions the response to feed enzymes by ruminants has been variable. This variation can be attributed to experimental conditions in which energy is not the limiting nutrient, as well as the activities and characteristics of the enzymes supplied, under or over-supplementation of enzyme activity, and inappropriate method of adding the enzyme to the diet. A limited number of ruminant enzyme products are now commercially available and this list of products is expected to grow. However, random use of enzymes on feeds, without consideration for specific situations and substrate targets, will only discourage or delay on-farm adoption of enzyme technology. Research is needed to understand the mode of action of feed enzymes so that efficacy can be assured. While much progress has been made in advancing enzyme technology for ruminants, considerable research is still required to reduce the variability

of response. With increasing consumer concern about the use of growth promoters and antibiotics in livestock production, and the magnitude of increased animal performance obtainable using feed enzymes, there is no doubt that these products will play an increasingly important role in the future. This paper reviews the research on enzyme selection, the animal responses to feed enzymes and the mechanisms by which these products improve nutrient utilization.

Key Words: Feed Enzymes, Fiber Digestion, Nutrient Utilization

415 Bacterial direct-fed microbials in ruminant diets: Performance response and mode of action. C.R. Krehbiel* and S.E. Gilliland, *Oklahoma State University.*

Direct-fed microbials (DFM) have been shown to increase daily gain and feed efficiency in feedlot cattle, enhance milk production in dairy cows, and improve health and performance of young calves. However, effects of DFM on performance have been mixed, and the mode of action remains unclear. Bacteria used as DFM have been defined as mono or mixed cultures of live organisms that beneficially affect the host by improving the properties of the indigenous microflora. The original concept of feeding DFM to livestock was based on potential intestinal effects, including improved establishment of gut microflora and prevention of the establishment of pathogenic organisms. More recently, however, there has been some indication that certain bacterial DFM may have beneficial effects in the rumen, such as reducing the potential for ruminal acidosis. In 13 experiments, supplementing feedlot steers with lactate-utilizing and (or) lactate-producing bacteria has been shown to improve feed efficiency (range = -3.0 to 9.6%; avg = 3.3%) and daily

gain (range = -5.4 to 5.0%; avg = 2.2%) with little change in DMI. In addition, increased milk yield has been reported in studies in dairy cows fed DFM, with little change in milk composition. Few attempts have been made to determine the mechanisms responsible for the beneficial effects of DFM; attempts made have involved the potential for a reduction in subacute acidosis. Responses to bacterial DFM have included a reduction in area below subacute ruminal pH, increases in propionate and butyrate concentrations, increased protozoal numbers, and changes in viable bacterial counts. Some blood variables (lower CO₂ and LDH) also have indicated a reduced risk of metabolic acidosis. Recent research has shown reduced or inhibited fecal shedding of *Escherichia coli* O157:H7 from experimentally infected calves. Therefore, a possible application for DFM might be to reduce shedding of this pathogen from cattle. Overall, data indicate that DFM have the potential to reduce ruminal acidosis in feedlot cattle and dairy cows, and improve immune response in stressed calves. More research is needed to describe the mode of action, and thereby improve the efficiency of DFM use.

Key Words: Direct-fed microbials, Ruminant, Ruminal fermentation

416 Effects of Tasco (a brown seaweed) and heat stress on immune function and antioxidant activity of wether lambs. K.E. Saker^{*1}, J.H. Fike¹, H.P. Veit¹, and D.L. Ward¹, *Virginia Tech, Blacksburg, Virginia, USA.*

Effects of Tasco (a brown seaweed) and heat stress on immune function and antioxidant activity of wether lambs
K.E. Saker¹, J.H. Fike², H.P. Viet¹, D.L. Ward¹. 1VA-MD Regional College of Veterinary Medicine and 2 Crop and Soil Environmental Sciences, Virginia Tech, Blacksburg, VA
Twenty-seven wether lambs (initial avg BW 40 kg) were used to evaluate select innate immunity and oxidative stress in response to diet and heat stress. Endophyte-infested tall fescue-based pasture received 0 or 3 kg / ha of Tasco-Forage (an extract of the brown kelp *Ascophyllum nodosum*) prior to harvest and was compared to direct-feeding Tasco-EX. Lambs, blocked by weight, were randomly assigned to one of three diets. Diets were 1) control hay, 2) treated hay, and 3) diet 1 + Tasco-EX fed at an additional 1% of the as-fed diet. Heat stress was applied for 10 d following a 27-d diet adjustment period with measurements obtained at d 4 and 10. Tasco-EX application increased monocyte phagocytic activity (P=0.01) in lambs compared with pre-harvest (Tasco-Forage) and control diets. Heat stress influenced cell activity across all treatments (P<0.0001). Phagocytic cells from Tasco-EX treatment lambs exhibited increased (P<0.05) capacity for oxidative burst as compared to Tasco-Forage and control lambs. Phagocytes obtained from the Tasco-EX lambs maintained their capacity for oxidative burst throughout the heat stress period (P<0.01). Cell function decreased in response to heat in Control and Tasco-Forage lambs. A heat x diet interaction was apparent (P=0.10). Superoxide dismutase (SOD) and glutathione peroxidase (GPx) was consistently higher in leukocytes from Tasco-treatment lambs during heat stress periods. Minimal (P<0.001) cell peroxidation occurred due to Tasco-EX during heat stress. Tasco-Forage treatment of tall fescue hay appeared to provide residual effects on animal antioxidant availability in short-duration heat stress. Tasco-EX supplementation with tall fescue hay enhanced immune function and protected against prolonged heat-induced oxidative stress. Hay treatment with Tasco has the potential to provide substantial health benefits to ruminants in sub-optimal production scenarios.

Key Words: Seaweed, immunity, antioxidant

417 Effects of a fibrolytic enzyme supplement on digestion and nutrient utilization by dairy cows fed alfalfa hay and grass silage-based rations. S.E. Adams^{*1}, C.J. Sniffen², J.H. White¹, and J.R. Knapp¹, ¹*U. of Vermont*, ²*W.H. Miner Institute.*

Two experiments were conducted to evaluate the effects of a fibrolytic enzyme supplement on dry matter (DM) intake, digestibility, microbial protein production, volatile fatty acid (VFA) and ammonia concentrations, and lactational performance. The supplement was a direct-fed mixture of cellulase, xylanase, and amylase enzymes. In experiment 1, nine multiparous lactating Holstein cows were blocked by parity and randomly assigned to diets. Diets were (DM basis) 50% concentrate and 20% corn silage with either 1) 30% alfalfa hay, 2) 15% alfalfa hay and 15% grass silage, or 3) 30% grass silage. Cows were offered the diet without enzyme supplementation for one collection period followed by a second period with enzyme supplementation. The enzyme increased

DM intake for diets 1 and 3 and total tract apparent digestibility of starch and sugars for all three diets. Crude protein (CP) and sugar digestibilities were lower for diet 3 than diets 1 and 2. The enzyme did not affect milk yield or milk protein, but milk fat percent was lower with enzyme by 0.6% and with diet 1 by 0.3%. In experiment 2, four ruminally-fistulated, lactating Holstein cows were fed diets 1 and 3 with and without enzyme. Enzyme supplementation did not affect DM intake or lactational performance. Percent milk fat was 0.3% lower for diet 1. Total VFA and ammonia concentrations were higher for diet 3, but neither these nor the molar proportions of VFA were affected by enzyme supplementation. The enzyme did not affect rumen digestibility of DM, NDF, or ADF, but diet 3 degraded at a faster rate than diet 1. These results indicate that this enzyme supplement can increase the intake of digestible organic matter and the total tract digestibility of starch and sugars and that the digestion and utilization of nutrients in rations containing alfalfa hay and grass silage differ. More research is needed to determine why milk fat was decreased with enzyme supplementation in experiment 1.

Key Words: fibrolytic enzymes, fiber digestion, starch digestion

418 Volatile fatty acid production rates of Holstein dairy cows provided monensin during the transition period. X. Markantonatos¹, G. A. Varga^{*1}, T.W. Cassidy¹, R. K. McGuffey², R. Tucker², and L. F. Richardson², ¹*The Pennsylvania State University, PA*, ²*Elanco Animal Health, IN.*

Eight multiparous Holstein rumen cannulated cows were used in a completely randomized design to evaluate the effects of monensin (M) inclusion during the transition period on ruminal VFA production rates. Treatments were a TMR topdressed with 300 mg M/d, or without M. Cows received M from d -30 prepartum (**Pre**) to d +56 postpartum (**Post**). All cows received the same diet consisting of 58:42 forage:concentrate (F:C) Pre or of 51:49 (F:C) Post. Isotopic tracers (1-13C3Na, 1-13C2Na, 1-13C4Na) at 12% enrichment were intraruminally infused using the single injection technique. Tracers were infused on d 13 d 1.97 prior to calving and on d 19 1.60 after parturition. Sampling times were -30, -20, -10, 5, 10, 15, 25, 35, 45, 60, 75, 90, 110, 130, 150, 170, 210, 230, 260, 290, and 320 min relative to tracer infusion time. Three days prior to sampling, cows were fed every 4h for 2d followed by 2h feeding intervals 1d prior to and the day of sampling. Daily DMI, milk production, and weekly milk composition were measured. Blood metabolites for NEFA, BUN, and glucose were measured weekly. Pre acetate production rate was lower (P = 0.03) for cows provided M (1.24 mol/h vs. 1.62 mol/h 0.09), whereas propionate production rate was not affected by treatment. Production rate for butyrate was slightly lower for cows given M (P = 0.19) Pre. Supplementation of M did not alter VFA production rates Pre vs. Post. All VFA production rates were higher (P < 0.07) Post vs. Pre. No effects on Pre or Post DMI or blood metabolites were observed between treatments. Lower DMI (13.5 kg/d Pre vs 19.4 kg/d Post; P< 0.01) resulted in significantly lower VFA production rates, (P< 0.01) and lower propionate endogenous pool (P<0.01) Pre vs Post. Supplementation of M did not affect milk yield or milk composition. This study suggests that M supplementation Pre may alter ruminal VFA production rates. However, DMI showed a greater overall effect on VFA production rates than M supplementation.

Key Words: Monensin, VFA Production Rates

419 The influence of low concentrations of supplemental enzymes on ruminal fermentation and milk production in dairy cows. J. Tricarico^{*1}, J. D. Johnston², and K. A. Dawson¹, ¹*Alltech Biotechnology Inc., Nicholasville, KY*, ²*Ritchie Feed&Seed, Ottawa, Ontario, Canada.*

Twenty intact and four ruminally-fistulated lactating Holstein cows were used in a replicated 4x4 latin square design, to examine the effects of four concentrations of a supplemental enzyme preparation on milk production, milk composition, and ruminal digestibility and fermentation. The cows were allotted to one of six replicate squares based on days in milk and presence or absence of ruminal fistulas. The treatments included enzyme supplementation at 0, 6000, 12000 and 18000 units fungal alpha-amylase per cow per d. Treatment periods included a 14-d adaptation period prior to a 7-d collection period. Enzyme supplementation had a quadratic effect on milk production (P=0.02). The maximum milk yield was obtained with 6000 units fungal alpha-amylase per cow per d. Percent fat and protein in milk were not different in

the absence or presence of enzyme supplement and therefore resulted in greater ($P < 0.05$) total fat and protein in milk. Enzyme supplementation had a significant cubic effect ($P = 0.03$) on MUN. The addition of 6000 units fungal alpha-amylase per cow per d resulted in lower MUN than in any other treatment. Enzyme addition did not affect ruminal starch or NDF digestibility of corn silage but increased ($P < 0.01$) the ruminal starch digestibility of grain corn by 7.8 % after *in situ* incubation for 24 h. The addition of 6000 units fungal alpha-amylase per cow per d did not affect total VFA concentrations in the rumen but reduced ($P < 0.01$) propionate by 9.1 % and increased ($P < 0.01$) acetate and butyrate proportions by 1.5 and 9.3 %, respectively. These results indicate that low concentrations of enzyme enhance performance in ruminant animals by modifying fermentation in the rumen without having a significant impact in digestibility.

Key Words: Enzymes, Amylase, Dairy cows.

420 Predicting chewing and ruminal pH by measuring physically effective NDF of dairy cow diets. W. Z. Yang* and K. A. Beauchemin, *Agriculture and Agri-Food Canada, Lethbridge, Canada.*

Recently, the concept of physically effective (pe) NDF was introduced to relate the physical characteristics of feeds to rumen pH. The peNDF content of the diet is determined by multiplying the NDF content of the diet by a pe factor. Several systems have been proposed for quantifying pe factors, including estimates based on chewing activity (peNDF_M) or particle length. The pe factors based on particle length can be estimated as the proportion of material retained on a 1.18 mm screen (peNDF_{P>1.18}) or as the sum of the material retained by the two sieves of the Penn State Particle Separator (peNDF_{PS}). The objectives of this study were to validate these systems and to establish the peNDF requirements for dairy cows. The study examined the peNDF content of a range of lactating dairy cow diets used in two studies in which chewing and rumen pH variables were assessed. The peNDF_{PS} content of the diets was about 40 to 60% lower ($P < 0.01$) than the peNDF_M and peNDF_{P>1.18} contents, which were similar. Eating time was generally not affected by the peNDF content of the diet, but ruminating time was increased ($P < 0.05$) with increased peNDF content. The peNDF_M and peNDF_{P>1.18} were correlated ($r = 0.55$, $P < 0.03$) to total chewing activity when the values ranged from 18 to 24%, but no correlation was observed beyond that range of peNDF. Increased peNDF content of the diets increased ($P < 0.05$) mean rumen pH and improved ($P < 0.01$) ruminal pH status: time during which ruminal pH was below 5.8 decreased when the peNDF_M and peNDF_{P>1.18} content increased from 18 to 24%. These results suggest that the peNDF content of the diet is a reliable indicator of chewing activity and rumen pH, particularly with diets low in fiber. However, there can be substantial variation in the estimates of peNDF content of diets depending upon the method used to determine the pe factor.

Key Words: Physically Effective NDF, Chewing Behavior, Ruminal pH, Dairy Cows

421 Is fibrosity better evaluated by dietary mean particle size or percentage of dry matter retained by a 2-mm sieve ? D. Sauvant*¹ and D. Mertens², ¹*Institut National Agronomique Paris-Grignon - INRA*, ²*US Dairy Forage Research Center.*

Mean particle size (MPS) includes the impact of small particles on particle size distribution ; whereas the percentage retained on a sieve with 2-mm apertures ($P > 2$ mm) includes only the effects of larger particles. A database was compiled from 20 publications that included 42 experiments (nexp) and 99 treatments (n) in which indicators of fibrosity and feed particle size were measured. All treatments reported measures of MPS (mean sd: 3.1 1.2 mm, range = .8 to 8.0 mm) and $P > 2$ mm (40.7 16.3 %, range = 4.4 to 85 %). The GLM procedure was used in a meta analysis to evaluate relationships across experiments (global) or to partition within and among experiment variation (EXP included in the model). Both the linear and quadratic functions of $P > 2$ mm and MPS were tested. Although they were related globally ($P > 2$ mm = $7.44 \text{ MPS} + 18.2$, $R^2 = .30$, $\text{rsd} = 13.7 \%$), the low R^2 suggested that $P > 2$ mm and MPS were different measures of particle size. Each was compared to indicators of dietary fibrosity : mastication time per day (MAST = $661 - 152 \text{ min/d}$, $n = 93$, $\text{nexp} = 39$) or per kg of dry matter intake (IM = $34.3 - 18.6 \text{ min/kg DMI}$, $n = 93$, $\text{nexp} = 39$), rumen pH

(pH = $6.14 - 0.31$, $n = 42$, $\text{nexp} = 18$), acetate/propionate ratio ($A/P = 2.70 - 0.60$, $n = 67$, $\text{nexp} = 27$), milk fat content (MFC = $3.49 - 0.65 \%$, $n = 94$, $\text{nexp} = 40$). Except for $P > 2$ mm in fitting A/P, all the models included linear and quadratic influences of MPS and $P > 2$ mm. The R^2 and residual standard deviations were: .89 vs .90 and 68.1 vs 64.1 for MAST ; .98 vs .98 and 3.1 vs 3.0 for IM; .86 vs .91 and 0.16 vs 0.13 for Ph ; .84 and .85 and 0.32 vs 0.30 for A/P; and .93 vs .91 and 0.22 vs 0.21 % for MFC ; for MPS vs $P > 2$ mm, respectively. Differences were small but favored $P > 2$ mm as an indicator of fibrosity. When dietary NDF was included in the model, the ranking between $P > 2$ mm and MPS remained similar for all variables. In conclusion, $P > 2$ mm is easier to assess than MPS and provided slightly more accurate relationships with indicators of diet fibrosity.

Key Words: effective fiber, chewing, particle size

422 Interaction of corn silage processing and replacement of concentrate with nonforage sources of fiber on performance and digestion characteristics of lactating dairy cows. J. A. Mills* and R. J. Grant, *University of Nebraska.*

Effects of corn silage crop-processing and replacement of concentrate with nonforage sources of fiber [wet corn gluten feed (WCGF), soybean hulls (SH)] on intake, carbohydrate digestion, and milk production were evaluated. Corn silage was harvested at 38% whole-plant moisture and approximately 1.2 cm TLC without processing, or approximately 1.9 cm TLC with processing, at a 2-mm roll clearance. Eighteen Holstein cows (12 primiparous) averaging 86 DIM were fed in a replicated 6×6 Latin square with 21-d period. Two control diets contained 40% of either unprocessed or processed corn silage, 10% alfalfa silage, and 50% concentrate mixture (DM basis; 29% dietary NDF). The concentrate mixture of the two control diets was replaced with 30% WCGF, or 20% SH to make up the remaining four diets (38 and 39% dietary NDF, respectively). There were few significant interactions between corn silage processing and use of nonforage fiber sources. Corn silage processing had no significant effect on DMI, NDF intake, milk yield, milk fat, 4% FCM, and FCM efficiency. Dry matter intake was greatest ($P < 0.001$) when cows were fed diets containing WCGF. Milk yield tended to be greater ($P < 0.14$) for diets containing either WCGF or SH compared with control. However, diets containing WCGF had significantly greater ($P < 0.05$) milk yield than SH treatments (37.7 vs. 36.4 kg/d, respectively). Milk protein percentage and lactose yield increased ($P < 0.05$) with corn silage processing. There were no effects of treatment on ruminal pH (average 6.08), but acetate to propionate ratio was highest for SH diet. Processing had no effect on total tract DM, NDF, or starch digestibility. However, DM, NDF, and starch digestion were significantly higher ($P < 0.05$) when WCGF or SH replaced concentrate. Corn silage processing had little effect on lactational performance; however, replacement of concentrate with WCGF and SH significantly improved dairy cattle performance and carbohydrate digestion.

Key Words: Corn silage processing, Wet corn gluten feed, Soybean hulls

423 Meta-analysis of relationships between particle outflow rate and mastication in cattle. D. Sauvant*¹ and D. Mertens², ¹*Institut National Agronomique Paris-Grignon - INRA*, ²*US Dairy Forage Research Center.*

A database of 26 publications, 43 experiments (nexp) and 106 treatments (n) was compiled to explore the relationships between the hourly outflow rate of particles (kp = $4.7 - 1.7 \%$ /h, range = 0.9 to 8.9) and daily mastication (MAST = $12.47 - 2.96$ h/d, range = 3.15 to 17.80). Other measured variables were dietary NDF (NDF = $38.4 - 12.8\%$ DM) and dry matter intake as a percentage of live weight (DMI = $3.0 - 0.7 \%$). A meta analysis partitioned variation into mean responses of kp, MAST, DMI, NDF among the experiments and residuals from the mean response within experiments. The relationship among experiments between kp and MAST was negative (kp = $7.7 \pm 0.26 \text{ MAST}$, $n = 43$, $R^2 = 19.4 \%$, $\text{rsd} = 1.5$), as was the relationship between DMI and NDF (DMI = $4.92 \pm 0.50 \text{ NDF}$, $n = 43$, $R^2 = 80.6 \%$, $\text{rsd} = 0.3$). Among experiments, dietary NDF influenced both kp (kp = $6.67 \pm 0.056 \text{ NDF}$, $n = 43$, $R^2 = 17.2 \%$, $\text{rsd} = 1.5$) and MAST (MAST = $6.85 + 0.148 \text{ NDF}$, $n = 43$, $R^2 = 40.9 \%$, $\text{rsd} = 2.2$). The influences of DMI were the opposite of NDF for kp (kp = $1.44 + 1.02 \text{ DMI}$, $n = 43$, $R^2 = 17.4 \%$, $\text{rsd} = 1.5$) and MAST (MAST = $19.2 \pm 2.21 \text{ DMI}$, $n = 43$, $R^2 = 28.2 \%$, $\text{rsd} = 2.4$). The within experiment relationship was positive between the residuals of kp (reskp, $\text{sd} = 0.47$) and MAST (resMAST, $\text{sd} = 0.98$):

reskp = 0.12 resMAST, $n = 106$, $rsd = 0.4$. The within experiment influences of dietary NDF residuals (resNDF, $sd = 3.0$) was negative for kp (reskp = - 0.059 resNDF, $rsd = 0.4$) and positive for MAST (resMAST = 0.088 resNDF, $rsd = 0.9$). For DMI the corresponding relationships were: reskp = 1.03 resDMI, $rsd = 0.4$; resMAST = 0.73 resDMI, $rsd = 1.0$. The influences of DMI and NDF remained similar among and within experiments for kp but not for MAST. When DMI

decreased as dietary fill (as indicated by NDF and MAST) increased among experiments there was a mean decrease of kp of 0.26 %/h per hour of increase of MAST. In contrast, within the same experiments there was an increase of kp of 0.12 %/h per hour of increase of MAST.

Key Words: particle outflow rate, mastication

Ruminant Nutrition Minerals

424 Effect of trace mineral source on performance of dairy cattle: lactation and reproduction responses. H. T. Ballantine^{*1}, M. T. Socha², D. J. Tomlinson², A. B. Johnson², A. S. Fielding³, J. K. Shearer⁴, S van Amstel⁵, and C. J. Rapp², ¹*Ballantine Consulting*, ²*Zinpro Corporation*, ³*Purina Mills, LLC*, ⁴*University of Florida*, ⁵*University of Tennessee*.

Three hundred multiparous Holstein cows (150 cows/treatment) were blocked according to calving date and randomly assigned to a study to determine effect of trace mineral source on performance. Treatments were 1) all trace minerals supplied by sulfates or 2) 360 mg of zinc, 200 mg of manganese, 125 mg of copper and 12 mg of cobalt per day of sulfate trace minerals replaced with complexed sources (Avala[®], Zinpro Corporation). Cows received their respective treatments from 21 d prior to calving through 250 d of lactation. Lactation diets were formulated to provide (DM basis) 155 mg/kg zinc, 119 mg/kg manganese, 23 mg/kg copper and 1.5 mg/kg cobalt. Cows were milked 3X/d and milk yield recorded. Liver biopsies were collected from cows (30 cows/treatment) prior to treatment assignment and at approximately 14 weeks postcalving. Feeding complexed trace minerals increased yields of milk (41.8 vs. 40.6 kg/d), energy-corrected milk (40.5 vs. 39.3 kg/d) and 3.5% fat-corrected milk (40.7 vs. 39.5 kg/d) and increased yields of milk fat and protein by 0.04 kg/d. There was no effect of treatment on milk composition or somatic cell counts. Replacing sulfate trace minerals with complexed trace minerals decreased days open by 22 days (169 vs. 147 d) and tended to increase % of cows pregnant by 150 DIM (54.8 vs. 42.7%) and first service conception rates (27.4 vs. 18.4%). Despite differences in performance between cows fed different sources of trace minerals, there was no effect of treatment on zinc, manganese and copper content of liver. Replacing zinc, manganese, copper and cobalt from sulfates with complexed sources improved lactation and reproductive performance of dairy cattle.

Key Words: Complexed Trace Minerals, Dairy Cattle, Reproduction

425 Effect of trace mineral source on performance of dairy cattle: claw integrity. H. T. Ballantine¹, C. J. Rapp^{*2}, M. T. Socha², D. J. Tomlinson², A. B. Johnson², A. S. Fielding³, J. K. Shearer⁴, and S. van Amstel⁵, ¹*Ballantine Consulting*, ²*Zinpro Corporation*, ³*Purina Mills LLC*, ⁴*University of Florida*, ⁵*University of Tennessee*.

Three hundred multiparous Holstein cows (150 cows/treatment) were blocked according to calving date and randomly assigned to a study to determine effect of trace mineral source on performance. Treatments were 1) all trace minerals supplied by sulfates or 2) 360 mg of zinc, 200 mg of manganese, 125 mg of copper and 12 mg of cobalt per day of sulfate trace minerals replaced with complexed sources (Avala[®], Zinpro Corporation). Cows received their respective treatments from 21 d prior to calving through 250 d of lactation. Lactation diets were formulated to provide (DM basis) 155 mg/kg zinc, 119 mg/kg manganese, 23 mg/kg copper and 1.5 mg/kg cobalt. Claws were examined prior to initiation of treatments and at 75 and 250 d postcalving. Claw evaluators were graduates of the Master Hoof Care Program and were not informed of cow treatment assignment. Lesions were noted in the seven zones of the claw and scored for degree of pain (1 = no pain, 3 = severe pain). For cows exhibiting a noted claw disorder, a claw lesion index was calculated by multiplying the average pain score of the lesions by the number of zones affected. Data collected prior to treatment assignment was used to covariately adjustment data collected at 75 and 250 d postpartum. Replacing sulfate trace minerals with complexed trace minerals tended to reduce incidence of claw disorders at 75 d postpartum (23.6 vs. 34.1%) and incidence of white line disease at 75 (9.5 vs. 14.6%) and 250 d postpartum (4.9 vs. 8.8%). Complexed trace minerals reduced claw lesion indexes (indicator of lesion severity) for white line disease at 75 d

postpartum (1.3 vs. 2.6) and tended to reduce claw lesion indexes for heel erosion at 75 d postpartum (6.7 vs. 8.9), white line disease at 250 d postpartum (1.7 vs. 2.7), and sole ulcers at 250 d postpartum (2.5 vs. 4.2). Replacing zinc, manganese, copper and cobalt from sulfates with complexed sources improved claw integrity of lactating dairy cattle.

Key Words: Complexed Trace Minerals, Dairy Cattle, Claws

426 Summary of twelve trials evaluating the effect of feeding complexed zinc methionine on lactation performance of dairy cattle. D. J. Tomlinson^{*}, M. T. Socha, C. J. Rapp, and A. B. Johnson, *Zinpro Corporation, Eden Prairie, MN*.

The objective of this review was to summarize twelve trials (13 comparisons) evaluating the effect of feeding complexed zinc methionine (ZINPRO[®], Zinpro Corporation, Eden Prairie, Minnesota) on lactation performance and udder health, as measured by somatic cell count, of dairy cattle. Summarized trials were conducted at Washington State (2), Colorado State (2), Cornell, Illinois State, Arkansas, Missouri, Georgia, Great Britain, Germany and Israel. In five of the trials, ZINPRO provided between 180 and 200 mg of zinc per head per day. In the remaining seven trials (eight comparisons) ZINPRO supplied 360 to 400 mg of zinc. In all diets, cows received additional zinc from inorganic sources. The control diet in one of the Missouri comparisons, the Germany study, the Cornell study and one of the Colorado State studies did not meet NRC (2001) recommendations for zinc (43 ppm, calculated for a lactating Holstein dairy cow: 42 months of age, 2nd lactation, 658 kg BW, 110 DIM, 31.7 kg milk at 3.48% fat, 2.91% true protein and 22.6 kg DMI). Both control and treatment diets fed in the Illinois State study were below NRC (2001) zinc recommendations. All other diets met or exceeded NRC (2001) zinc recommendations. Each trial was a block with each treatment is mean within a trial treated as an observation. Cows fed the complexed zinc produced more ($P < 0.01$) milk (31.8 vs. 30.5 kg/d), energy-corrected milk (31.7 vs. 30.4 kg/d) and fat-corrected milk (31.6 vs. 30.0 kg/d). Milk composition did not differ between treatment and control cows, although cows receiving complexed zinc produced more ($P < 0.05$) milk fat (1.10 vs. 1.06 kg/d) and more ($P < 0.01$) milk protein (0.99 vs. 0.96 kg/d). Somatic cell count (1,000s/ml) was reduced from 294 to 196 ($P < 0.01$). This summary of twelve dairy trials indicates that feeding complexed zinc methionine increases lactation performance and improves udder health as evidenced by a 33.3% reduction in somatic cell count.

Key Words: Trace Minerals, Dairy Cattle, Somatic Cell Count

427 Effect of chelated trace mineral supplementation for inorganic sources on production and health of Holstein cows. J.E. Nocek¹ and R.S. Patton², ¹*Auburn, NY*, ²*Galisteo, NM*.

Multiparous Holstein cows were used to evaluate the effect of chelated trace minerals (Keylated Proteinated Minerals, Chelated Minerals Corp., Salt Lake City, UT) on production performance. Prior to dry off, cows were balanced by parity, 305ME and assigned to control ($n=324$) or treatment ($n=318$) from -60 to 150 days in milk (DIM). Culling resulted in 261 cows per group at trial end. Control cows received Zn, Cu and Mn added to the total mixed ration (TMR) at 120% of NRC as inorganics. Treatment cows received the same total supplementation as 50% inorganics and 50% chelates. Diets were corn and grass silage based during the dry period and corn silage and alfalfa silage based during transition and lactation. Data on milk production, reproduction, disease and hoof health was collected to 150 DIM. Cows supplemented with chelates produced more ($P = .02$) milk than controls (38.6 vs 38.3 kg/d). Milk protein, fat and SCC were not different. Chelate supplemented cows

tended ($P = .06$) to have fewer displaced abomasums compared to controls (3.1 vs 6.5% respectively). Chelate supplemented cows had fewer ($P = .04$) days to first heat (45.8 vs 50.3d), fewer ($P = .01$) days to first breeding (62.8 vs 66.8d) and fewer ($P = .04$) days open for cows pregnant at 150DIM (83.6 vs 90.3d) than controls. Services per conception were not different. At start of lactation, the incidence of sole hemorrhage averaged 40.85% in the hind feet of chelate supplemented cows and 39.25% for the controls. At 150DIM, the incidence of hind feet sole hemorrhage for chelate fed cows increased 8.6% to 49.45%, which tended to be less ($P = .14$) than control cows, that increased 17.2% to 56.45%. Incidence of white line separation followed a similar trend ($P = .14$) favoring chelate supplemented cows that increased 3.1% compared to 10.15% for controls. Supplementing cows with 50% supplemented trace minerals from chelated Zn, Cu and Mn improved reproductive performance compared to all inorganic sources.

Key Words: Chelated trace elements, Milk yield, Reproduction

428 Predicting cattle phosphorus excretion. T.P. Tylutki*, D.G. Fox, and L.E. Chase, *Cornell University*.

Accurately predicting manure phosphorus excretion is critical to aid in evaluating current dairy rations and to estimate the impact of changes in rations and potential crops on phosphorus balance at the farm level. Current phosphorus requirement systems (INRA, 1989; NRC, 2001) have focused on predicting requirements and need to be evaluated for their ability to predict excretion. A data base developed for this purpose from from six balance trials from three sites contains 89 cows and 149 data points. Cows at one site were sampled four to six times throughout one lactation (sample one collected during the dry period). Dietary P concentration ranged from 0.27 to 0.72% DM (mean of 0.45%); DMI ranged from 8.4 to 31.1 kg/d (mean of 22.9 kg/d); cow BW ranged from 489 to 832 kg (mean of 604 kg); milk production ranged from 0.0 to 58.2 kg/d (mean of 39.5 kg/d). Models evaluated were INRA (1989), 2002 Nutrient Requirements of Dairy Cattle (NRC), and a simple balance model (SIMPLE). The simple balance model (intake - P milk - P pregnancy - P growth) uses 1 gram of P per kilogram of raw milk. Data were analyzed using predicted versus observed techniques (R square, slope, intercept, standard error of the y estimate, and bias). Manure (fecal plus urinary) was calculated allowing positive P balance or forcing P balance to be zero or negative for NRC and INRA (assumes that all P in excess of requirements is excreted). Milk P tended to be under-predicted by INRA (-7.7% bias) and NRC (-8.7% bias) and over-predicted by SIMPLE (+10.4% bias), all with similar accuracy (R square of 89, 96, and 93% for INRA, NRC, and SIMPLE, respectively). Residual analysis suggests all models contain systematic errors. Manure P was predicted poorly by NRC and INRA when a positive P balance was allowed (bias of -21.2% for NRC, -12.1% for INRA) with residuals exhibiting a systematic error. Forcing excess P to be excreted improved the predictions (bias of +10.1% for NRC, +10.2% for INRA). The three models had similar R squares (84 to 87%) and standard errors (10.5 to 11.9 grams); however SIMPLE had the lowest bias (-0.6%) and intercept (0.06; not different than zero), and slope (0.99). These results suggest that P excretion can be accurately predicted for dairy cattle using a simple balance model.

Key Words: Phosphorus, Excretion, Models

429 Utilization of phosphorus in lactating cows fed two levels of forage. Z. Wu*, V. A. Ishler, and D. D. Archibald, *Pennsylvania State University, University Park, PA*.

Fecal P includes P originating from saliva, and forage intake stimulates the secretion of saliva. The effect of dietary forage level on P utilization in lactating dairy cows was determined. The following 4 dietary treatments were formed in a 2 x 2 arrangement of factors: low P, low forage (LPLF), low P, high forage (LPHF), high P, low forage (HPLF), and high P, high forage (HPHF). The diets were formulated to contain 0.38 or 0.48% P, and included 48 or 58% forage (DM basis). The P amount was varied by using monosodium phosphate, and the forage amount by changing the proportions of alfalfa silage and corn grain. The diets were fed to 44 Holsteins (105 ± 44 DIM) for 15 wk. Analyzed dietary total Kjeldahl P was lower than formulated, being 0.32 and 0.40% for the low and high P diets, respectively. Dietary P content did not ($P > 0.10$) affect DMI, milk yield, or milk composition, but resulted in higher fecal P content. Increasing dietary forage resulted in reduced milk yield but increased milk fat content. No interaction between dietary forage and

P amounts was determined in fecal P content or production measurements. Varying the forage level of the diet may not affect P utilization by lactating dairy cows fed relatively low P.

Item	LPLF	LPHF	HPLF	HPHF	SEM	P ¹	F ¹	P x F ¹
Milk, kg/d	36.4	33.8	36.5	34.2	1.1	0.83	0.03	0.90
Milk fat, %	3.19	3.54	3.32	3.79	0.13	0.15	0.01	0.66
Milk protein, %	3.02	3.01	3.09	3.09	0.07	0.35	0.96	0.90
Fecal P, %	0.70	0.74	0.93	0.93	0.03	0.01	0.44	0.55

¹ P values for the effect of P, forage, and their interaction.

Key Words: Phosphorus, Forage, Dairy cows

430 The effect of *Solanum glaucophyllum* on calcium and phosphorus utilization in lactating cows. Y. Cheng¹, J. P. Goff², and R. L. Horst^{*2}, ¹Iowa State University, Ames, IA, ²National Animal Disease Center, USDA/ARS, Ames, IA.

The purpose of the study was to determine if *Solanum glaucophyllum* (Sg) could serve as a source of 1,25(OH)₂D₃ to increase calcium (Ca) and phosphorus (P) utilization and, therefore, decrease fecal Ca and P excretion in lactating cows. Ten primiparous, lactating, Holstein cows were used. Four cows received a diet supplying 0.7% Ca and 0.37% P (control). The remaining 6 cows were fed a diet containing 0.6% Ca and 0.27% P (basal). Dry matter intake was restricted to 13.5 kg/cow/day to ensure the cows consumed all of the experimental diet. Ytterbium (Yb) was used as an indigestible marker to estimate Ca and P digestibility. Following a 2-week adjustment period, 2g Sg/cow/day was administered via bolus to 3 cows fed the basal diet (basal + Sg). Sg administration continued for 7 days, and its effect on fecal Ca and P excretion was compared to cows fed the basal and control diets. Body weight and milk yield were not significantly different among treatments. There was no significant difference in fecal Ca excretion between the control (93 g/d) and basal (84 g/d) groups. Fecal Ca excretion, however, was significantly ($p < 0.1$) decreased to 54.3 g/d in the basal + Sg group. Fecal P excretion was significantly ($p < 0.01$) decreased in animals receiving the basal diet (17.1 g/d) and further reduced in the basal + Sg group (13.3 g/d) compared to those on the control diet (33.2 g/d). Although P excretion was less in the basal + Sg group compared to basal group, the difference was not significant. Plasma 1,25(OH)₂D₃, Ca and P concentrations were significantly ($p < 0.01$) elevated in the basal + Sg group compared to basal and control groups. Total fecal dry matter was lowest in the basal + Sg group (4.2 kg/d) compared to the control (5.0 kg/d) and basal (5.0 kg/d) groups. The difference, however, was not significant. The data suggest that Sg could be used to affect changes in Ca and perhaps P utilization in cows. The most dramatic effect on fecal P excretion, however, was achieved by reducing P intake.

Key Words: Calcium, Phosphorus, *Solanum glaucophyllum*

431 Altering electrolyte balance of diets for lactating dairy cows to reduce phosphorus excretion to the environment. S.I. Borucki Castro^{*1}, L.E. Phillip¹, V. Girard², and A. Tremblay³, ¹McGill University - Montreal, Qc / Canada, ²Institut de recherche et de développement en agroenvironnement - Deschambault, Qc / Canada, ³Universite de Montreal - St. Hyacinthe, Qc / Canada.

A study was conducted with dairy cattle to determine the impact of dietary electrolyte balance (DEB) on phosphorus (P) excretion to the environment. Four early-lactating Holstein cows were randomly allocated to four diets with calculated DEB {(Na+K)-(Cl+S)} of 50, 100, 200 and 400 meq/kg of dry matter (DM). Diets were formulated to contain 1.51 Mcal of NE_L /kg DM, 38% NDF, 0.76% Ca and 0.46% P, and to provide 3.044 kg/d of metabolizable protein. Salts of MgSO₄, MgCl₂, K₂CO₃ and NaHCO₃ were utilized to alter DEB. The experiment was conducted as a 4x4 Latin square design with 21-d periods. During the last five days, diets were offered at a restricted level, and samples of jugular blood, milk, feces and urine were collected. Actual DEB levels, based analysis of diets, were: 139, 176, 242 and 454 meq/kg DM. P intake and DM intake were not significantly different between treatments ($P > 0.05$). Estimates of pH and bicarbonate outputs in urine increased as DEB increased: urine pH = $7.2 + 0.0077x - 9.88 \times 10^{-6} x^2$ ($b_2 P = 0.0043$) and urine bicarbonate (meq/L) = $-47.97 + 1.014x - 6.9 \times 10^{-4} x^2$ ($b_2 P = 0.0536$). Phosphorus excretion in urine showed a

curvilinear response, explained by the equation: $g\ P/d = 6.45 - 0.036x + 6 \times 10^{-5} x^2$ ($b_2\ P=0.0047$). However, there were no significant effects ($P>0.05$) of DEB on P excretion in feces. Blood pH, pCO_2 , HCO_3 and plasma phosphate levels were unaffected ($P>0.05$) by treatment. Milk yield (MY) decreased with extreme levels of DEB ($MY\ kg/d = 20 + 0.045x - 7 \times 10^{-5} x^2$ $b_2\ P=0.0007$). Results showed that DEB influenced P excretion by affecting urinary P, minimizing P output in urine at a DEB value of 300 - 350 meq/kg DM.

Key Words: Phosphorus, Dietary Electrolyte Balance, Dairy Cattle

432 Effects of dietary supplementation with biotin and a B-vitamin blend on lactation performance by dairy cows. D. Majee^{*1}, E. C. Schwab¹, W. M. Seymour², and R. D. Shaver¹, ¹University of Wisconsin - Madison, ²Roche Vitamins Inc.

The objective of this trial was to evaluate the effects of dietary supplementation with biotin and a B-vitamin blend on intake and milk yield, composition and component yields by dairy cows. Treatments were control (C), biotin (B), biotin plus B-vitamin blend at 1x dose (BBVIT1x), and biotin plus B-vitamin blend at 2x dose (BBVIT2x). Biotin was supplemented at 20 mg/cow/d in B and BBVIT1x and 40 mg/cow/d in BBVIT2x. Supplemental B-vitamins (mg/cow/d) in BBVIT1x and BBVIT2x, respectively, were: thiamin (150 and 300), riboflavin (150 and 300), pyridoxine (120 and 240), B12 (0.5 and 1.0), niacin (3,000 and 6,000), pantothenic acid (475 and 950), and folic acid (100 and 200). The B, BBVIT1x, and BBVIT2x treatments were added as premixes (114 g/cow/d) to the TMR. For C, the carrier premix (114 g/cow/d) was added to the TMR. The TMR comprised of 50% alfalfa silage and 50% ground shelled corn-soy hulls-expeller soybean meal based concentrate (DM basis) were fed twice daily for ad libitum consumption. Twenty-four multiparous Holstein cows averaging 46 days in milk were used in a replicated 4x4 Latin Square design with 28 d periods. Cows were housed and fed individually in tie stalls. Average dry matter intake (DMI) was higher for B (25.7 kg/d) than C and BBVIT1x (25.0 kg/d; $P < 0.05$) and BBVIT2x (24.4 kg/d; $P < 0.001$). Milk yield was higher ($P < 0.05$) for B (38.9 kg/d) and tended to be higher ($P < 0.10$) for BBVIT1x (38.3 kg/d) than C (37.2 kg/d). Milk yield was lower ($P < 0.05$) for BBVIT2x (37.5 kg/d) than B. The treatment response for milk true protein yield followed the same pattern as for milk yield. Milk fat percentage tended to be lower ($P < 0.10$) for BBVIT2x (3.20%) than C (3.34%), while milk true protein percentage was unaffected by treatment. Milk fat yields for B and BBVIT1x (1.25 kg/d) were not different from C (1.23 kg/d), but for BBVIT2x (1.19 kg/d) it was lower than B and BBVIT1x ($P < 0.05$). Biotin increased DMI and milk and true protein yields relative to the control. The B-vitamin supplement did not augment the response to biotin. The 2x dose of biotin plus B-vitamin blend was not beneficial.

Key Words: biotin, B-vitamins, milk yield

433 Effect of copper deficiency on the acute phase protein response to inflammatory challenge in beef heifers. J. D. Arthington^{*1}, F. Blecha², and C. K. Swensen³, ¹University of Florida, Range Cattle Research and Education Center, Ona, ²Kansas State University, College of Veterinary Medicine, Manhattan, ³Zinpro Corporation, Eden Prairie, MN.

The objective of this study was to characterize the effect of molybdenum-induced copper (Cu) deficiency on the acute phase protein response following inflammatory challenge in beef heifers. Twelve non-lactating, Braford heifers were allocated randomly to one of two pre-study treatments for 90 d (depletion phase). Treatments consisted of a daily ration of 454 g of ground corn fortified with 0.7 g of sodium molybdate and 18.5 g of sulfur (DEF; n=6) or 454 g of ground corn alone (CON; n=6). Following depletion, DEF heifers had lower liver Cu compared to CON (62 vs. 344 ppm DM). Heifers were moved into individual pens (114 m²) and offered access to free-choice, long-stem limpograss hay. To investigate the influence of Cu status and inflammatory challenge on the acute phase protein response, all heifers received a single subcutaneous injection (3 mL) of Freund's complete adjuvant (Challenge 1). Blood samples were collected on d 0, 2, 4, 7, 9, 11, 14, 16, 18, and 21. Following Challenge 1, heifers within each Cu status were randomly assigned to receive 75 mg of supplemental Cu/d. Change in Cu status was assessed by the collection of liver biopsies on d 0, 10, 21, 30, and 51. Following 51 d of Cu supplementation, all heifers were again challenged as previously described (Challenge 2) and blood samples were collected on d 0, 2, 5, 7, 9, 12, 14, 16, 19, and 21. Plasma was harvested from blood at

each collection and analyzed for ceruloplasmin, fibrinogen, haptoglobin, and alpha-acid glycoprotein concentrations. Liver Cu concentration increased in DEF, but not CON heifers following Cu supplementation. Blood concentration of each acute phase protein increased following adjuvant challenge. Plasma ceruloplasmin concentrations were lower in DEF heifers in Challenge 1, but were similar to CON heifers following Cu-supplementation (Challenge 2). Conversely, fibrinogen concentrations were higher in DEF heifers in Challenge 1, but not Challenge 2. Alpha-acid glycoprotein concentrations were lower for DEF heifers after both challenges. Haptoglobin concentrations were not affected by Cu status. These results indicate that the Cu status of beef heifers is directly linked to their acute phase protein response following inflammatory challenge.

Key Words: Copper, Acute Phase Protein, Inflammation

434 Effect of dietary strong ions on milk yield, milk composition, and chewing activity in lactating dairy cows. C. S. Mooney^{*} and M. S. Allen, Michigan State University, East Lansing.

The objective of this study was to determine effects of strong ions on short-term lactational performance and chewing activity of dairy cows. Forty multiparous Holstein cows were used in replicated 5 x 5 Latin square design with a 2 x 2 factorial arrangement of treatments for cations (Na and K), anions (Cl and HCO_3), plus control. Periods were 14 d in length with the last 4 days for data and sample collection. Diets were formulated to 29% NDF and 17.5% CP. $NaHCO_3$ was included at 1% of DM in one treatment diet and other treatments (NaCl, KCl, and $KHCO_3$) were added to be equi-molar to $NaHCO_3$ in their respective diets. Chewing activity was recorded every 5 minutes for the last 24 hours of each period. DMI averaged 27.9 kg/d and was not affected by treatment. Cations did not affect any measured variable ($P > 0.15$). Ruminating time was reduced 22.6 min/d (4.4%) by ion treatments compared to control ($P < 0.01$) but no differences were detected among ion treatments. Ion treatments increased yield of milk (37.0 vs. 36.2 kg/d, $P < 0.05$), milk protein (1.15 vs. 1.12 kg/d, $P < 0.05$) and milk lactose (1.75 vs. 1.71 kg/d, $P < 0.05$) but not solids corrected milk (SCM) or 4% fat-corrected milk (FCM) compared to control. Ion treatments had no effect on milk composition, body weight or body condition score compared to control. HCO_3 increased milk yield (37.3 vs. 36.7 kg/d, $P < 0.05$), milk fat (3.89 vs. 3.77%, $P < 0.01$), milk lactose (4.73 vs. 4.67%, $P < 0.01$), 4% FCM (36.7 vs. 35.4 kg/d, $P < 0.01$), and efficiency of FCM yield (1.31 vs. 1.27 kg FCM/kg DMI, $P < 0.01$) and decreased BW gain (8.9 vs. 13.0 kg/14 d, $P < 0.05$) compared to Cl treatment. No differences between anions were detected for milk protein concentration and yield. Increased FCM yield and decreased BW gain for HCO_3 compared to Cl suggests that fuels were partitioned more toward milk for HCO_3 treatment and more toward adipose for Cl treatment. This might have been from reduced temporal variation in absorbed fuels because of rumen buffering by HCO_3 treatment.

Key Words: Strong ions, Buffers, Lactational performance

435 Effects of chloride fertilization on alfalfa dietary cation-anion content. S. J. Henning¹, R. K. Doorenbos¹, E. C. Brummer¹, J. P. Goff², and R. L. Horst^{*2}, ¹Iowa State University, Ames IA, ²National Animal Disease Center, USDA/ARS, Ames, IA.

Manipulation of diet cation-anion difference (DCAD) has proved a useful means of reducing hypocalcemia in cows. The importance of producing low potassium forage is widely accepted. However, increasing forage chloride (Cl) can also improve DCAD. We studied this possibility by fertilization of small plots of alfalfa located in Nashua, IA, with varying levels of Cl from 2 sources. In this randomized, complete block design, either ammonium chloride (NH_4Cl), calcium chloride ($CaCl_2$), or a mix of NH_4Cl and $CaCl_2$ (MIX) at one of 3 doses (50, 100, or 150 lbs Cl / acre) were applied to small plots in 4 replicates for each treatment-dose. Control plots received no Cl treatment. Four cuttings were harvested from each plot. Chloride fertilization, regardless of Cl source, resulted in a significant ($p \leq 0.05$) increase in Cl content of the plants in all four cuttings. No major differences in Cl were observed between the different treatments. Plant dry matter yield and concentrations of potassium, sodium, calcium, and magnesium content were also measured. Effects of treatment on the first and fourth cutting plant Cl content are summarized in the table below.

Cl Source	Dose (lbs/acre)	1st cutting %Cl	4th cutting %Cl
Control	0	.25 .08	.30 .14
NH ₄ Cl	50	.60 .04	.60 .12
NH ₄ Cl	100	.69 .08	.71 .08
NH ₄ Cl	150	.73 .03	.66 .20
MIX	50	.60 .09	.58 .18
MIX	100	.72 .02	.68 .14
MIX	150	.75 .07	.70 .09
CaCl ₂	50	.55 .12	.52 .10
CaCl ₂	100	.72 .13	.66 .16
CaCl ₂	150	.83 .08	.72 .15

Key Words: Chloride fertilization, Alfalfa, DCAD

436 Productive and rumen reponses of lactating cows to buffer supplementation. F. Meschy¹, D. Bravo², and D. Sauvart^{*1}, ¹INRA-INAPG Physiologie de la Nutrition et Alimentation Paris France, ²Ets UCAAB Chateau-Thierry France.

Avoid the consequences of (sub)acidosis is an important target in dairy cows nutrition especially in early lactation and when the animals are fed high-concentrate diets. Several studies have dealt with the effects of buffer supplementation on dry matter intake (DMI), milk fat content (MF) and rumen parameters in lactating cows. In order to obtain multiple marginal responses to buffer supplementation a meta-analysis was performed on a database extracted from literature. This database (30 publications, 51 experiments, 101 treatments) only gathered data from experiments where the buffer was well identified in the publication (33 experiments with sodium bicarbonate, 10 with sodium carbonate, 7 with magnesium oxide and only one with potassium bicarbonate). In the database the concentrate percentage was $52\% \pm 26$ and ADF content was $18\% \pm 6$. Statistical analysis was performed using a model of variance-covariance including dose of buffer as percentage of DMI (DOSE) as covariable and experiment as between-group factor. No significant difference was observed according to buffer source. Buffer supplementation significantly increased intake ($DMI = 19.63 + 0.59 \text{ DOSE}$, $n = 44$ $R^2 = 0.94$ $rsd = 0.86$), milk fat% ($MF = 3.33 + 0.18 \text{ DOSE}$, $n = 50$ $R^2 = 0.92$ $rsd = 0.17$) and fat corrected milk 4%(FCM = $24.95 + 0.92 \text{ DOSE}$, $n = 50$ $R^2 = 0.97$ $rsd = 1.4$). No significant effect was detected on raw milk production. Buffer supplementation had no effect on total volatile fatty acid production, but increased acetate ($C2\% = 55.6 + 1.39 \text{ DOSE}$, $n = 28$ $R^2 = 0.85$ $rsd = 2.29$), butyrate ($C4\% = 10.24 + 0.94 \text{ DOSE}$, $n = 22$ $R^2 = 0.94$ $rsd = 1.11$) and decreased propionate ($C3\% = 28.51 - 2.95 \text{ DOSE}$, $n = 28$ $R^2 = 0.92$ $rsd = 2.30$). Acetate: propionate ratio was increased by buffer supplementation ($C2/C3 = 2.07 + 0.28 \text{ DOSE}$, $n = 28$ $R^2 = 0.88$ $rsd = 0.26$). These analyses indicate that buffer supplementation could help the animals to maintain these rumen parameters in a range which is favorable for microbial activity and milk performances when dietary conditions may induce metabolic disorders such as acidosis.

Key Words: Buffer, Dairy Cows, Rumen

439 Sow hulls for gestating sow diets. PJ McKinnon* and SX Shi, *American Soybean Association*.

Two feeding trials were conducted on commercial farms in two different years to study the effects of unheated soy hulls in gestation diets on reproductive performance of mature crossbred (YxL) gestating sows. Treatments consisted of standard corn-soy control diets and 20 or 18 % soy hulls in trials 1 and 2 respectively. Reproductive performance was studied for one parity in trial 1 and two consecutive parities in trial 2. Sows were individually fed 2-2.2 kg of the control diet (CP 14.9 %, lysine 0.65 %, ME 3000 kcal/kg-est), depending on body condition and 2.2-2.4 kg/day of the soy hulls diet (CP 13.8 %, lysine 0.83 %, ME 2850 kcal/kg-est). All sows were fed a common corn-soy diet ad libitum in

437 Effect of dietary cobalt supplementation on cobalt metabolism in dairy cows. R. L. Kincaid^{*1}, J. D. Cronrath¹, and Socha M. T.², ¹Washington State University, Pullman, WA, ²Zinpro Corporation, Edina Prairie, MN.

To determine the effect of Co supplementation on Co metabolism in dairy cows, prepartum Holstein cows ($n = 36$) were assigned to dietary treatments of low, medium, and high Co. Dry cows were fed hay (0.16 ppm Co) and 1 of 3 supplements that contained 0.51, 3.74, or 6.71 ppm Co (Co added as Co glucoheptonate) from 21 d prepartum until parturition. Estimated Co intakes of the dry cows were 3, 14, and 24 mg/d. From parturition until 120 DIM, cows were fed their respective TMR that contained 0.36, 0.68, or 1.26 ppm Co. Supplemental Co did not affect ($P > 0.05$) concentrations of Co in either serum (95 ng/ml) or whole blood (98 ng/ml), however, serum Co was higher at 7 DIM (116 ng/ml) than at 120 DIM (75 ng/ml). Liver samples, taken via biopsy at 120 DIM, had Co concentrations of 2.2, 2.5, and 1.3 ppm, respectively. Compared to multiparous cows, primiparous cows had higher concentrations of Co in colostrum (93 vs 119 ng/ml) and milk (94 vs 99 ng/ml). Serum B12 concentrations, although not affected by diet, were higher ($P < 0.05$) in primiparous than multiparous cows (1.81 vs 0.96 ng/ml) and higher ($P < 0.05$) at 21 d prepartum (2.36 ng/ml) than at 120 DIM (1.24 ng/ml). There were no treatment effects on BW, BCS, or concentrations of glucose, NEFA, Zn and Cu in serum. These results indicate that gestation and lactation reduce endogenous reserves of Co and B12 in dairy cows.

Key Words: Cobalt, Vitamin B12, Cows

438 The effect of barley varieties on phosphorus utilization and fecal excretion in lactating dairy cows. T. D. Nennich^{*2}, J. H. Harrison², R. L. Kincaid¹, L. Johnson², and D. Davidson², ¹Washington State University, Pullman, WA, ²Washington State University, Puyallup, WA.

Four barley varieties common to the Pacific Northwest were evaluated to determine the effect of variety difference on P digestibility, absorption, and excretion. Eight lactating Holstein dairy cows were used in an unbalanced double 5×4 Latin square design with 14 d periods. Barley varieties replaced corn in the diets and were fed at 24.3% of the diet dry matter. The 5 dietary treatments consisted of a control corn diet (CORN), and 4 diets containing equal amounts of Steptoe (STEP), Idagold (IDGD), Harrington (HGTN), or Baroness (BRNS) varieties of barley. Total mixed rations, orts, urine, and feces were collected during the last 4 d of each period and analyzed for P content. Phosphorus intake, fecal excretion, absorption, and digestibility were determined. Data listed below show the results of P utilization and excretion when corn and different barley varieties were fed. Differences in P digestibility and fecal output between corn and different barley varieties indicate that it may be possible to select feedstuffs to reduce levels of phosphorus entering the environment from livestock manure.

Item	CORN	STEP	IDGD	HGTN	BRNS
P intake, g/d	118 ^a	114 ^{ab}	97 ^d	101 ^{cd}	107 ^{bc}
Fecal P, g/d	70 ^c	79 ^b	83 ^{ab}	77 ^{bc}	85 ^a
P digestibility, %	37.4 ^a	29.2 ^{ab}	11.7 ^d	22.1 ^{bc}	19.1 ^{cd}
P absorption, g/d	26 ^a	12 ^b	-7 ^c	1 ^c	0 ^c

^{abcd}Values with different superscripts vary ($P < 0.05$).

Key Words: phosphorus, barley, dairy cows

Swine Species

lactation. Sows were weaned at 21 days in trial 1 and 28 days in trial 2. Statistical analyses of the two trials were performed separately but in trial 2, results for the first and second parities were combined, because there were no significant differences in traits measured. With the exception of gestation weight gain in trial 1, where the sows on the soy hulls diet gained 8.4 kg BW less than sows fed the control diet, no other significant differences were observed. Since it was not possible to collect gestation feed intakes, it is not known whether this is due to feed intake differences or other factors. In trial 2, gestation body weight gain was lower than expected, but is in line with NRC (1998) data for mature gestating sows of >2 litters. Lactation weight loss in trial 2 is considerably greater than in trial 1, but litter birth and weaning weights are

considerably greater, even if allowance is made for longer lactation. The results indicate that 18-20 % unheated soy hulls can be fed to gestating sows without depression of reproductive performance.

	Trial 1		Trial 2	
	Corn	Soy hulls	Corn	Soy hulls
n (1st/2nd parity of trial)	96	89	(50/42)	(52/45)
Gestn wt gain, kg	48.2	39.8	23.7	24.0
Lactn wt loss, kg	9.6	8.1	22.2	22.8
Lactn ADFI, kg	5.3	5.3	6.1	6.5
Wean to estrus, d	6.5	5.5	6.3	6.2
Av no pigs born alive	8.9	9.4	11.2	11.5
Av birth wt, kg	1.51	1.45	1.51	1.54
Litter birth wt, kg	13.2	13.4	17.0	17.6
No pigs 21 d	8.7	8.5	10.4	10.9
Av wean wt kg (21 or 28 d)	5.7	5.7	7.5	7.6

Key Words: Soy hulls, Sows, Gestation

440 Reducing odor in swine production: effect of a natural carbon-mineral supplement on odor reduction. S. W. Kim*, F. Ji, and J. J. McGlone, *Texas Tech University*.

A natural, carbon-mineral source (NCM) is a feed supplement that is mined and minimally processed (Promax®, HumaTech, Houston, TX). Carbon compounds include humic acid, fulvic acid, and other organic compounds and minerals include bioavailable iron and other trace minerals. Ninety-six pigs, weaned at d 21 of age, were used. Pigs were allotted to one of two treatments, control and NCM. Each treatment had 6 replicates and a group of 8 pigs was housed to each pen-replicate. The NCM was supplemented to the treatment diet at the level of 0.5%, but to the control diet. After weaning, pigs were fed based on a 3-phase feeding program. Phase 1 was 1-wk postweaning, phase 2 was 2-wk after phase 1, and phase 3 was 4-wk after phase 2. A group of 8 pigs from each pen-replicate was 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 2-d during which aerial ammonia was measured. The temperature inside of the chamber was maintained at 24°C and the fan was working continuously during the experimental period. A gas monitor with the sensors for ammonia, and hydrogen sulfide was used to measure the changes of these compounds during the 2 d collection period with 5 min intervals. Feed intake of pigs during the 2-d collection period was measured. The initial and final body weights were measured before and after moving pigs to the chamber. Feed intake and initial body weight were used as covariates in analyzing the data. The first 24 hr period was considered an acclimation period and the last 24 hr period was considered the primary data collection period. Hydrogen sulfide was very low and generally not detectable in our model. The main effect of treatment was not significant ($P>0.10$). The treatment by time interaction, however, was highly significant ($P<0.01$). Pigs given dietary NCM produced 5 to 40% less air ammonia. The regression models showed a clear diurnal variation in air ammonia. The increase in ammonia was associated with pig activity. Pig activity probably increased air ammonia by both producing more ammonia through more excretions and by mixing the air more when pigs were active. Using our model system, this formulation of NCM may reduce air ammonia to different degrees depending upon the time of day and pig activity levels

Key Words: Pigs, Natural carbon mineral, Odor

441 Response of growing pigs to dietary threonine:lysine ratio and protein level. P.B. Lynch*, P.G. Lawlor¹, and S. van Cauwenbergh², ¹Teagasc, Moorepark Research Centre, Fermoy, Co. Cork, Ireland, ²Ajinomoto-Eurolysine, Paris, France.

The objective of this trial was to assess the response of pigs from 50 to 95kg to variation in threonine to lysine ratio in diets of high (16%) and low (14%) crude protein content. Fifty single sex (gilts and boars) groups of 14 crossbred pigs (mean = 50kg), blocked on sex and weight were assigned at random to the following diets - (A) Low protein with THR:LYS ratio of 50% (LP/0.5); (B) Low protein with THR:LYS ratio of 60% (LP/0.6); (C) Low protein with THR:LYS ratio of 70% (LP/0.7); (D) High protein with THR:LYS ratio of 60% (HP/0.6); (E) High protein with THR:LYS ratio of 70% (HP/0.7). Diets, based on wheat, barley,

wheat middlings and soybeanmeal, contained 13.5 MJ/kg digestible energy, 9.0g/kg total lysine (set at a limiting level on purpose to assess ratio response), nutritionally adequate levels of other essential amino acids and were fed ad libitum as dry pellets. Daily feed intake, daily weight gain and feed conversion ratio (FCR) were 2338, 2377, 2389, 2310 and 2333g (s.e. 37, $P>0.10$); 708, 792, 806, 755 and 773g (s.e. 16, $P<0.01$); 3.32, 3.01, 2.97, 3.07 and 3.03 (s.e. 0.05; $P<0.01$) for treatments A to E respectively. Backfat depths and carcass lean meat percentages (measured by Hennessy Grading Probe) were 11.5, 11.0, 11.4, 11.0 and 10.5mm (s.e. 0.35; $P>0.10$); 58.1, 59.0, 58.4, 58.6 and 59.4% (s.e. 0.30, $P>0.10$) for treatments A to E respectively. On the LP diets (A, B and C), there was a significant linear response ($P<0.01$) in daily gain to increasing the THR:LYS ratio and a tendency towards a quadratic effect ($P=0.09$). In FCR both linear ($P<0.01$) and quadratic ($P<0.05$) effects were significant. Feeding a lower protein diet (treatments B and C v. D and E) resulted in improved growth rate ($P<0.05$) and a tendency towards increased feed intake ($P=0.11$) with no effect on FCR ($P>0.10$). The small numerical improvement in FCR at the lower dietary protein is consistent with the energy sparing effect of low protein diets combined with the higher digestibility of lysine, threonine and methionine in these diets.

Key Words: Threonine, Crude protein, Growing swine

442 Effects of feeding echinacea purpurea to nursery pigs on performance and viremia. J.R. Hermann*, M.S. Honeyman¹, J.J. Zimmerman¹, and C.C. Chang^{1,2}, ¹Iowa State University, ²Pig Research Institute.

Our objective was to determine the effectiveness of Echinacea purpurea on growth performance and viremia when challenged with porcine reproductive and respiratory syndrome (PRRS). Three replicate trials involving a total of 120 pigs were conducted at the Iowa State University Livestock Infectious Disease Isolation Facility. The pigs and feeders were initially weighed and at 7 d intervals until the completion of each 42 d trial. Average daily gain (ADG) and average daily feed intake (ADFI) were recorded for each pen. Blood was collected at 7 d intervals. A commercial ELISA kit was used to detect PRRS specific antibody titers in serum. Sample-to-positive (S/P) values of 0.4 or greater were considered positive. A decedent clone of North American prototype PRRS virus isolate ATCC VR-2332 that had been passaged in pigs for 67 days was used in the study. Four complete meal-form dietary treatments were fed, containing carbadox (.055 g/kg), control, Echinacea I (2%), and Echinacea II (4%). Echinacea purpurea was added to the diets at 2 and 4% levels by weight. Diets were isocaloric and isolysin based on calculated analysis. Pigs were initially allotted by weight to one of eight treatments. There were five pigs in a pen per treatment for each of three replications. In the PRRS positive pigs there was no difference in ADG for the dietary treatments ($P>.10$). There was a trend toward lower titer values for the Echinacea fed pigs from day 21 to day 35. Echinacea I (2%) compared to the control had a slightly lower titer ($P<.10$). Echinacea II (4%) compared to the control also had a lower PRRS specific antibody titer ($P<.06$). Overall in the PRRS negative pigs there were no differences in ADG for the dietary treatments. The PRRS negative group of pigs showed no positive titers. In the PRRS virus challenged pigs, the antibody titers trended lower for the Echinacea fed pigs compared to the control. More work is needed to clarify the possible mechanism of dietary Echinacea in viral infections.

Key Words: Echinacea, PRRS, pig

443 Growth rate and age at first estrus in relation to efficient gilt pool management. Jennifer Patterson*, Murray Pettitt¹, George Foxcroft², and Eduardo Beltranena¹, ¹Prairie Swine Centre Inc., Saskatoon, Saskatchewan, Canada, ²University of Alberta, Edmonton, Alberta, Canada.

Identifying "select"(cyclic) gilts below market weight and avoiding excessive weights at breeding are two essential features of efficient gilt management systems. Prepubertal Camborough 22 gilts (PIC Canada Ltd; n=148) were used to examine relationships between growth rate and age puberty. Gilts were allocated to the study at 103.7 d of age and 62.2 kg weight, had ad libitum access to feed and water, were housed in groups of twenty and received approximately 20 min direct exposure to a vasectomized boar daily as a pen group for pubertal stimulation starting at 141.1±4.7 d (mean±SD) of age. Puberty was determined as the first day gilts exhibited the standing reflex in response to contact

with a boar; gilts not exhibiting estrus by 180 d of age were considered non pubertal. There was no relationship between growth rate at 100d of age and age at puberty ($P=0.67$, $r=0.04$). As a consequence, inherent differences in age at puberty (lsmean \pm sem) (Early, 150.4 \pm 1.0 d; $n=28$: Intermediate, 158.4 \pm 6 d; $n=74$: Late, 174.2 \pm 9 d; $n=33$: or non pubertal, $n=13$) affected ($P\leq 0.05$) weight (109.7 \pm 2.3, 115.7 \pm 1.4, 126.9 \pm 2.1 and 134.0 \pm 3.5 kg, respectively) and backfat depth (12.0 \pm 8, 14.1 \pm 5, 15.2 \pm 7 and 15.2 \pm 1.0 mm, respectively) but not growth rate ($P\geq 0.05$) (.72 \pm 0.01, .72 \pm 0.01, .73 \pm 0.01 and .76 \pm 0.02 kg/d, respectively) at puberty. Additionally, the Late puberty group averaged 33.1 \pm 9 d from stimulation to first estrus. Litter of origin affected age at puberty ($P\leq 0.04$) and is clearly an important contributing factor to inherent differences in the rate of sexual maturity. These results indicate that: 1) with average growth rates exceeding .7kg/d to puberty, gilts would need to cycle by 171 days (31 days after start of stimulation at 140d) to be "selected" below market weight; 22% of gilts failed to meet this target. 2) Later maturing (≥ 175 d) and faster growing (≥ 8 kg/d) gilts weighed ≥ 140 kg at first estrus and constitute potentially overweight gilts at breeding and farrowing.

Key Words: Gilts, Puberty, Growth rate

444 The effects of including a blend of encapsulated organic and inorganic acids in diets for weanling pigs. H. H. Stein^{*1}, D. Peters¹, B. T. Christopherson¹, and E. Cerchiari², ¹*South Dakota State University*, ²*SODA Feed Ingredients, Monaco*.

One hundred and twenty weanling pigs were used in a five-week nursery experiment to evaluate the effect of including the acidifier Aciprol[®] in

the phase 1 and the phase 2 diets for nursery pigs. Aciprol[®] consists of a blend of organic and inorganic acids that have been encapsulated during the manufacturing process. Four experimental groups were included in the experiment. Treatment group 1 was the negative control group # pigs in this group were fed unsupplemented phase 1 and phase 2 diets. Treatment group 2 was the Aciprol[®] supplemented group (0.5 and 0.3% in the phase 1 and the phase 2 diet, respectively) while pigs on treatment groups 3 and 4 were fed diets supplemented with 3000 ppm of zinc oxide and 50 ppm carbadox, respectively. Pigs were weaned at an age of 20 d, and they were placed in groups of five pigs per pen. There were six pen replicates per treatment group. The phase 1 diet was offered on an ad libitum basis during the initial two weeks post-weaning, while in the next three weeks, the phase 2 diet was provided. During the initial two weeks post-weaning, pigs fed the diet containing zinc oxide grew faster ($PP < 0.05$) and had a higher ($P < 0.05$) daily feed intake than had pigs fed any of the other diets. However, during the following 3 weeks and overall for the entire experimental period, no differences ($PP > 0.05$) between the four groups were observed for daily gain or for average daily feed intake. Pigs fed the Aciprol[®] supplemented diets had a greater ($P < 0.1$) gain to feed ratio during the second phase of the experiment and overall for the entire experimental period than had pigs fed diets 1 and 3. The results for the Aciprol[®] supplemented diet were not different ($PP > 0.1$) from those obtained for the carbadox-supplemented diet. From the present investigation, it is concluded that the dietary supplementation with Aciprol[®] during the nursery phase may be as beneficial as the supplementation with carbadox. [®]

Key Words: Protected acids, Weanling pigs

Alpharma Beef Cattle Nutrition Factors Affecting Feed Intake in Beef Cattle

445 The multifactorial nature of food intake control. J.M. Forbes^{*}, *Centre for Animal Sciences, University of Leeds, England*.

In some situations it is apparent that intake of forage by ruminant animals is limited by the capacity of the digestive tract while in others it seems that metabolic factors control intake. It has sometimes been argued that physical limitation on intake is more apparent than real because positive relationships between rate of digestion and intake can be ascribed to causes other than gut capacity. However, there are receptors in the rumen wall sensitive to stretch and their afferent pathways converge with those from other classes of receptor thereby providing the means for several types of stimulus to be combined before reaching the controlling circuits of the brain. In addition there is experimental evidence of additivity of intake-limiting factors in sheep and dairy cows. The fact that various signals affecting intake (physical, metabolic, behavioral, environmental) are in different currencies has proved a barrier to the development of models; it is proposed that abdominal stimuli resulting from the ingestion of food, as well as climatic and social factors, generate discomforts which animals prefer to avoid and learn to minimize. There is considerable evidence that ruminants can learn to avoid toxic or imbalanced foods and to choose between two foods of different nutritional value in order to avoid either an excess or a deficiency of the nutrient in which the two foods differ. From this it can be deduced that the intake of a single food may be eaten in quantities that minimize the total discomfort whereas when two or more foods are available both the mixture of foods and their total intake are varied to achieve this state. Animals fed ad libitum have naturally fluctuating daily intakes which allows their daily intake to settle in the region of their most comfortable state. While these theories have not yet been properly quantified they provide a framework for integrating the various factors known to affect intake and should lead the way to better understanding and, possibly, prediction of voluntary feed intake and diet selection by beef cattle.

Key Words: Ruminants, Feed intake, Minimal Total Discomfort

446 Effects of roughage source and level on intake by feedlot cattle. M. L. Galyean^{*1} and P. J. Defoor², ¹*Texas Tech Univeristy*, ²*Nutrition Service Associates, Pratt, KS*.

Intake by beef cattle fed high-concentrate, grain-based diets is likely controlled by metabolic factors and not limited by bulk fill. Small changes (e.g., 5% of DM or less) in the level of bulky roughage and changing from

less fibrous to more fibrous sources of roughage typically increase DMI by feedlot cattle. Reasons for increased DMI with changes in roughage level and source are not fully understood. Energy dilution effects caused by added dietary fiber might be responsible for altered DMI, but the quantity of dietary NEg provided by roughage shows little relationship to changes in DMI with roughage source and level. Altered rate of ruminal fermentation and/or acid production as a result of roughage source and level might affect DMI via various mechanisms, including: 1) increased chewing and/or rumination, with increased saliva flow; 2) inherent buffering properties of roughages; and 3) altered ruminal and/or intestinal digesta kinetics. We hypothesized that much of the effect of roughage source and level on DMI by feedlot cattle could be accounted for by changes in dietary NDF. Data from 11 trials in the published literature involving roughage source and level effects on intake by feedlot cattle were compiled. The dataset included 48 treatment means with roughage sources including hays, straws, byproducts, and silages. Roughage level ranged from 0 to 30% of DM. Effects of dietary roughage level (% of DM), NDF (% of dietary NDF from roughage), or effective NDF (eNDF, % of dietary eNDF from roughage) and the random effects of trial on DMI (% of BW) were evaluated using the MIXED procedure of SAS (SAS Inst., Inc., Cary, NC). Tabular values were used to obtain estimates of NDF and eNDF. Using trial-adjusted means, dietary roughage level accounted for 69.9% of the variation in DMI, whereas the percentage of dietary NDF and eNDF supplied by roughage accounted for 92.0 and 93.1%, respectively, of the variation in DMI. The relationship between dietary NDF (% supplied by roughage) and DMI (% of BW) for trial-adjusted data was given by: $DMI = 1.8562 - 0.02751 \times NDF$ ($P < 0.01$; $RMSE = 0.0447$). Based on these results, percentage of dietary NDF supplied by roughage seems useful for predicting effects of roughage source and level on DMI by feedlot cattle.

Key Words: Feedlot cattle, Feed intake, Neutral detergent fiber

447 Metabolic consequences of feeding behavior and intake in feedlot cattle. T.A. McAllister^{*1}, K.S. SchwartzkopfGenswein², K.A. Beauchemin¹, D.J. Gibb¹, M.N. Streeter³, D.D. Hickman¹, and D.H. Crews, Jr.¹, ¹*Agriculture and Agri-Food Canada, Lethbridge, AB*, ²*Alberta Agriculture, Food and Rural Development, Lethbridge, AB*, ³*Alpharma Inc., Fort Lee, NJ*.

Nutritionists and feedlot managers commonly attribute metabolic digestive disturbances such as subclinical acidosis to abnormal feeding

behavior and erratic feed intake by cattle. This perception is based on the belief that variability in intake of high grain diets compromises the maintenance of ruminal pH at levels high enough for optimal fibre digestion and rumen function (i.e., >5.6 to 5.8). Periodic abundance in starch availability allows amylolytic bacteria (e.g., *Ruminobacter amylophilus*, *Streptococcus bovis*, *Lactobacillus* spp.) to proliferate and produce excessive quantities of fermentation acids. It has been proposed that heightened VFA production stimulates satiety receptors in cattle, which in turn results in the commonly observed "off-feed" or low intake syndrome. Despite this well accepted relationship, comparatively few studies have actually demonstrated that variability in ad libitum feed intake impairs growth performance of cattle. Ruminal pH profiles differ substantially among cattle, even among those with identical diet composition, feed quantity and delivery schedules. It is apparent, therefore, that factors other than meal size and feeding regime determine an animal's susceptibility to subclinical acidosis and ultimately, its growth performance. Feedlot management practices developed to regulate feeding behavior and reduce variations in feed intake by penned cattle include programmed feeding, multiple feed deliveries per day, and consistent timing of feed delivery. However, the efficacy of these practices is assessed largely on the basis of intake per pen, with little or no appreciation of the variation in feed intake among individuals. Further characterization of this variability in feeding behaviors among penmates could provide the foundation for effective refinement of present feeding practices.

Key Words: Acidosis, Bunk Management, Rumen

448 Controlling variation in feed intake through bunk management. R. H. Pritchard^{*1}, ¹*South Dakota State University*.

Controlling variation of daily feed intake stems from the obvious concern that a significant aberration in grain intake can lead to clinical acidosis

or death. Less dramatic aberrations also occur when cattle have unrestricted access to feed. A cyclic pattern of higher and lower daily DMI can cause gain efficiency to be less than that predicted from the mean DMI since ADG responses to changes in DMI are not linear. If bunk management (BM) is a means of ameliorating either of these events, it is presumed that management ascribed to the pen is affecting variability in daily DMI by individuals within the pen. Two likely mechanisms are limiting availability of feed to prevent overconsumption events, or affecting animal behavior so that daily intake is more consistent. BM approaches that have been evaluated for their impact on production rates and in some instances on day to day variability in DMI include: limiting the quantity of feed available or the amount of time feed is available each day, the timing and frequency of feed deliveries, linear bunk space allocation, and mixed diet or segregated ingredient feeding. When BM approaches do alter responses, it may be that the approach has a direct biological and/or behavioral impact on the animal, or that the approach itself involves less variation, which is consequently favorable to the animal (or the data). The causes of variable results in BM research can be ambiguous. Management and feeding systems are difficult to standardize which can cause the definitions of controls, the characterizations of treatments, and the context of responses to be inconsistent. A rudimentary limitation is that in systems where individual daily DMI is known, competition for access to feed is usually not comparable to typical pen feeding. There is evidence of favorable responses to some BM approaches that could be used commercially. Impact on production efficiency in these studies is of significant biological and economic importance. These mechanisms must be more fully characterized to allow broad application.

Key Words: cattle, management, feedlot

Breeding and Genetics Applications of Functional Genomics in Animal Breeding and Genetics

449 Novel approaches for complex trait analysis. B. Bowen^{*}, *Lynx Therapeutics, Inc.*

Complex traits include the majority of human diseases and commercially important targets of selection in agriculture, such as yield or hybrid vigor. Unlike monogenic traits, they are controlled or influenced by the interplay of multiple genes and environmental factors. Although it is not clear to what extent complex traits are controlled by alleles that qualitatively affect the function of proteins or quantitatively affect gene expression, both types of genetic variation are likely to be important. Lynx's Massively Parallel Signature Sequencing (MPSS™) technology is a gene expression profiling system that can help understand the genetic architecture of complex traits at the molecular level by addressing two fundamental questions in quantitative genetics:

1. How much variation in gene expression between individuals is controlled by cis-acting alleles vs. segregation of trans-acting factors? 2. How many genes that differ in expression between parents and offspring behave non-additively?

I will demonstrate how an understanding of these two questions can be exploited to help identify candidate genes for quantitative trait loci controlling a complex trait in a model plant species on the one hand and candidate genes for heterosis in a poorly characterized animal species on the other.

Key Words: Gene Expression, Quantitative Trait Loci, Genetic Variation

450 Integrating molecular marker information into national beef cattle evaluation. R. L. Quaas^{*}, *Cornell University, Ithaca, New York*.

Information from molecular markers has the potential to increase the accuracy of genetic evaluation, especially for traits for which phenotypes are difficult and/or expensive to obtain. Several problems remain for this potential to be realized. The purpose of this paper is to discuss some of these and offer some suggestions. Among these problems is the likelihood that the number of animals in the pedigree will exceed the number with phenotypes which will greatly exceed those with genotypes. Suggestions as to how to combine many phenotypic data with

limited marker data will be discussed in more detail. Emphasis is on approximations practicable for routine national beef cattle evaluation.

Key Words: Genetic Markers, Genetic Evaluation, National Beef Cattle Evaluation

451 Using gene expression profiling to study disease resistance in the chicken: honing in on candidate genes. J. Burnside^{*1}, R. Morgan¹, and H. Cheng², ¹*Delaware Biotechnology Institute, University of Delaware*, ²*USDA/ARS, Avian Disease and Oncology Laboratory*.

Poultry disease is a major threat to chickens raised in a production environment, where birds are exposed to a variety of pathogens. Of particular economic importance is Marek's Disease (MD), which is caused by the MD virus (MDV), an oncogenic herpesvirus of chickens that latently infects T lymphocytes and induces T-cell lymphomas. A study of the gene regulatory pathways that control development of the immune system as well as an understanding of the host response to MDV will improve our understanding and our control of this disease. Using a functional genomics approach, we have sequenced over 6,000 ESTs from chicken lymphoid libraries and used a selected subset of these ESTs for the preparation of DNA arrays for gene expression profiling studies. These arrays have been used to assess developmental changes in gene expression in the immune system. Expression of cell surface markers (MHC class I, MHC class II invariant chain, CD8, CD18, and beta-2 microglobulin), and genes involved in the innate immune response (NK lysin) increased with age, and these patterns were consistent with an increase in the immune-responsiveness of young chicks. We also evaluated changes in viral and cellular gene expression that accompany infection of chicken embryo fibroblasts (CEF) with MDV. MIP, quiescence specific protein and MHC class I genes were among the host genes that were induced by infection with MDV. In parallel studies, these arrays have been used to identify genes that confer genetic resistance to MD, by comparing expression profiles in genetically resistant and susceptible birds. Differential expression of candidate genes has been detected, and at least one maps near a QTL conferring resistance to MD. Using

microarray technology to study global changes in gene expression of the immune system will provide considerable insight for improving strategies for MD prevention, and understanding the pathogenesis of this disease.

Key Words: Chickens, DNA array, Disease resistance

452 Power calculation in microarray experiments using Bayesian mixture models. R. Rekaya^{*1}, ¹*Dept. of Animal and Dairy Science, University of Georgia.*

Comparison of gene expression patterns of tissues or cells under several conditions provides important information to answer several biological questions. Using the simple fold changes in expression based on the ratio of intensities in the red and green channels, as was done in the earlier days of this technology, is unreliable and inefficient. The statistical power or the probability of detecting a given magnitude of expression change in microarray experiments is of crucial interest as a result of the noisy data used. The calculation of power depends on the specified magnitude of change and the false positive rate. Data used in this study consisted of the expression levels of 8,150 cDNA of individuals with and without cutaneous malignant melanoma. Eight arrays under two experimental conditions (4 melanoma and 4 controls) were used. A global normalization was applied to the raw data. A mixture model with 2 and 3 components was implemented and compared with a parametric Gaussian model using Bayesian information criteria (BIC). Both the Gaussian model and the mixture model with two components were superior to the model with three components. Although there was no strong evidence against the parametric Gaussian model, there was around 5% change in the number of genes differentially expressed using both models. Using a Gaussian model and a false positive rate of 0.1%, the power was 0.16, 0.48 and 0.78 for 2, 3 and 4 fold change in expression, respectively. With the same setting, but using a mixture model with two components, the power was 0.15, 0.50 and 0.81 for 2, 3 and 4 fold change in expression, respectively.

Key Words: Gene, Expression, Mixture

453 Detection of quantitative trait loci for mastitis resistance in Canadian Holsteins. J. Moro-Mendez^{*}, J.F. Hayes, and D. Zadworny, *McGill University, Department of Animal Science (Macdonald Campus), Montreal, Quebec, Canada.*

A granddaughter design, consisting of 20 grandsires and 1747 sons, was used to test the hypothesis of associations between genetic markers and mastitis resistance in Canadian Holsteins. The grandsires and sons were genotyped for 10 genetic markers (6 in the growth hormone (GH) region, 2 in the GH receptor region, and 2 in the Ornithine Decarboxylase region). The raw phenotypic information consisted of 1,561,631 lactation records from 969,747 Holstein cows enrolled in the Quebec Dairy Analysis Service (PATLQ). The final data set after editing consisted of 67,908 first lactation records from daughters of 612 sons (19 grandsire families). The response variable was the frequency of culling due to mastitis in first lactation daughters of each son. The GENMOD procedure of SAS was used to fit a model which included year of birth of the son, grandsire, and marker nested within grandsire. The number of informative grandsire families for individual markers ranged from 3 to 17, and the number of informative sons by grandsire ranged from 3 to 77. No effect of marker within grandsire was found ($P < 0.05$). These results suggest that in the data under study there is no association between the above genetic markers and quantitative trait loci for the frequency of culling due to mastitis in first lactation. A larger marker data set is being constructed for further studies of associations of markers with mastitis.

Key Words: Genetic Markers, Mastitis Resistance, Holstein

454 Application of daughter and granddaughter designs in a study of microsatellite markers in a large A.I. breeding company. E.B. Burnside^{*1,2}, Y. Pan^{1,2}, G.B. Jansen³, Y. Plante⁴, N. Caron¹, and D. Petitclerc⁵, ¹*The Semex Alliance, Saint-Hyacinthe, Quebec, Canada*, ²*L#Alliance Boviteq, Saint-Hyacinthe, Quebec, Canada*, ³*University of Guelph, Ontario, Canada*, ⁴*The Saskatchewan Research Council, Saskatoon, Saskatchewan, Canada*, ⁵*Agriculture and Agri-Food Canada, Lennoxville, Quebec, Canada.*

To apply marker assisted-selection (MAS) in a large A.I. breeding company, a study of a Holstein sire's female and male progeny was undertaken to confirm microsatellite markers closely linked to economically important QTLs. Two designs, daughter and granddaughter, were carried out for corroboration of 24 informative markers, first via genotyping approximately 400 daughters of the sire for each informative marker, and subsequently by genotyping 88 A.I. proven sons for the same markers. The daughter design was based on heifers selected for extremely high and low estimated breeding values (EBV) adjusted by regression of daughters' (EBV) on dams' EBV for protein yield and mammary system. When the selected daughters were genotyped, 68.3% and 69.2% of them were informative for protein yield and mammary system, respectively. A logistic regression analysis yielded four of the 24 microsatellite markers that significantly affected protein yield ($P < 0.05$ to 0.008), while one marker approached significance for mammary system ($P = 0.07$). These markers explained from 7.1% to 15.6% of the standard deviation of adjusted EBVs for protein yield. Canadian Test Day Record EBVs for production, conformation, and health traits were also used to analyze the 88 proven sons for the same 24 informative markers. Results from the two designs were compared to throw light on efficacy of the daughter design to provide preliminary information for MAS in A.I. progeny testing schemes.

Key Words: Microsatellite marker, Daughter design, Granddaughter design

455 Development of a cattle population for mapping economic trait loci (ETL) affecting parasite resistance. Tad S Sonstegard^{*1}, Louis C Gasbarre², Curtis P Van Tassel¹, and Terazinha Padilha², ¹*Gene Evaluation & Mapping Laboratory*, ²*Immunology & Disease Resistance Laboratory.*

The natural genetic variability of the bovine immune system provides an alternative means to control gastro-intestinal (GI) parasite infection without anthelmintics. However, the paradigm of traditional selection has not been applied to parasite resistance due to the difficulty and expense of gathering accurate phenotypes. To validate the potential effectiveness of selection and create a population amenable for mapping, divergent selection was initiated using founder animals from the University of Maryland Wye Angus herd previously observed to be segregating for GI nematode resistance and susceptibility to *Ostertagia ostertagi*. After nine years of selection, five generations of half-sib progeny ($N > 350$) with phenotypic records from controlled infections have been produced. These progeny fall into three distinct phenotypic classes based on response as measured by eggs per gram (EPG) of fecal matter: innately immune, acquired immune, and immunologically non-responsive. The respective ratio of these calves in the first generation was approximately 1:2:1. Selection based on expected progeny difference (EPD) values for EPG has effectively increased the fraction of innately immune and non-responsive calves. In addition, the range of EPD values has been reduced to half the mean EPG value for calves tested to date, further supporting the role of host genetics in parasite transmission. Currently, this phenotypic data and genotypic data generated using microsatellite markers ($N=199$) is being analyzed using a multiple locus allelic peeling algorithm (GenoProb) designed to identify the genomic locations of ETL segregating in looped, complex pedigrees. Analysis of the individual pedigrees revealed that $> 90\%$ of the test progeny were paternally descended from a single historic sire, and marker genotypes from 68 sires spanning 8 generations in this paternal pedigree have been added to the ETL analysis. Preliminary analysis of marker information ($N=103$) revealed an expected heterozygosity index of 50% and polymorphic information content of 45 with an average of four alleles per marker. Although power of ETL detection in this population is limited by half-sib family size, genetic analysis of the historic pedigree will provide additional statistical power for refining map position of potential ETL.

Key Words: Economic Trait Loci, Parasite resistance, Mapping

456 Genetic variation among sheep breeds at the insulin-like growth factor-1 receptor locus. C.J. Otieno and A. Farid, *Nova Scotia Agricultural College*.

Heterologous polymerase chain reaction (PCR) primers based on the mouse insulin-like growth factor-1 receptor (IGF1-R) gene sequence amplified a 601 bp fragment in sheep consisting of exon 21 and the 3' UTR. Sequencing of the PCR products revealed a polymorphic GC repeat 29 bp 3' to the stop codon and a mononucleotide deletion. A new pair of primers was designed to amplify the polymorphic region, and genotype of animals was determined using an ABI 377 DNA sequencer. The 216 bp fragment contained a (GC)₅, and the combination of an additional GC and the deletion generated 215, 217 and 218 bp fragments. Genotypes of 182 sheep from 13 breeds with diverse developmental histories and production performance were determined at this locus. The breeds were Romanov (RO), Suffolk (SU), Finnsheep (FI), Scottish Blackface (SB), Cheviot (CH), Icelandic (IC), Border Leicester (BL), Black Welsh Mountain (BW), Hexham Leicester (HL), Karakul (KA), Red Masai (RM, Kenya), Newala (NE, Tanzania) and Djallonke (WD, Nigeria). Except RO, all the breeds were polymorphic and allele frequencies were different ($P < 0.01$) among the breeds. FI, NE, WD and MAS had lower frequency (0.41 to 0.50) of allele 216 and high frequency (0.31 to 0.56) of allele 217, while other breeds had high frequency of allele 216 (0.65 to 1.00) and low frequency of allele 217 (0.0 to 0.29). The allele 218 was detected only in FI, KA, MAS and WD, and allele 215 was not detected in BW, FI, IC, RO and SU. There was no clear relationship between allele frequencies and the evolutionary histories of the breeds. Most of the breeds that have been intensely selected for production traits (SU, RO) had only 216 and 217 alleles, while all four alleles were segregating in the less intensely-selected breeds (KA, MAS, WD). The data suggest that the IGF1-R gene may be linked with other genes that contributed to the differences in production performance among the breeds.

Key Words: IGF1-R, Sheep breeds, Polymorphism

457 Genetic diversity of Chinese indigenous pig breed resources by microsatellites and near-complete mitochondrial genome. K Li*, *Huazhong Agricultural University, Wuhan 430070, China*.

Over 100 indigenous pig breeds currently exist in China, comprising almost one-third of the pig breeds in the world. Some Chinese local breeds are known internationally, particularly for their high prolificacy and meat quality. However, both the number of Chinese local breeds and the population sizes of the remaining breeds have decreased dramatically in recent years, because their performance, particularly in growth rate, food conversion efficiency and lean meat percentage, is much lower than that of commercial breeds of European and American origin. Special efforts are therefore required to conserve the genetic resources of these Chinese local breeds. A total of 1,581 Chinese indigenous pigs, which belong to 30 Chinese local breeds have been genotyped using 27 microsatellite markers recommended by FAO and ISAG. Twenty breeds, one sample from each breed, have been studied using the nearly complete mitochondrial genome. The genetic variation between breeds and within breed variation have been calculated. NJ dendrogram based on Nei standard genetic distances between the breeds studied has been obtained. The systematic evaluation of genetic diversity of these important breeds will enable us to better understand the relative distinctiveness of these animal genetic resources and to assist in developing a rational plan for conservation.

Key Words: Genetic diversity, Chinese indigenous pig breeds, Microsatellites

458 A novel and highly effective method to generate transgenic cows and goats: linker-based sperm-mediated gene transfer (LB-SMGT). J. Qian^{*1}, K. Chang^{2,3}, C. Lai², C. Chen², T. Keng², C. Huang², F. Wu³, H. Huang¹, and K. Wang, ¹BioAgri Corp., City of Industry, CA, USA, ²BioAgri Corp.-Taiwan Branch, Taipei, Taiwan, ³Dept. of Chemistry, Soochow University, Taipei, Taiwan.

Genetic modification of domestic animal traits can be used to improve productivity and quality or to produce bioreactors for modern medicine. DNA microinjection, the current method to produce transgenic livestock, is time consuming and requires extensive training and special

equipment. More importantly, except in mice, microinjection has reported only limited success in larger or higher species. Sperm-mediated gene transfer has been recognized as a potentially powerful alternative method, but the original results have been difficult to duplicate. We have developed a linker (mAb C) to bind with sperm and DNA. Using flow cytometry, it has shown cross-reactivity with sperm cells from all tested species including pig, mouse, chicken, cow, goat, sheep, and human. We have successfully applied a novel linker-based sperm-mediated gene transfer method (LB-SMGT) in mice, pigs, and chickens at a high germ-line transmission rate (30-40%). We report here the use of LB-SMGT to successfully generate transgenic cows and goats. Sperm from bulls or goats were treated first with mAb C and then combined with a linearized DNA fragment containing the human interferon β gene or lactoferrin. The sperm-linker-DNA complexes were used in standard artificial inseminations. The transgenic gene was detected in 4 of 5 calves (F0 generation) and in 4 of 9 kids (F0 generation) by PCR and verified by a ³²P-labeled 3rd oligo. The expression of human lactoferrin in sera was also detected in 1 of 10 kids (F0 generation) by ELISA. We expect a high germ-line transmission rate, based on our results in transgenic pigs, mice, and chickens. Our data demonstrate that LB-SMGT can efficiently generate transgenic goats and cows.

Key Words: Transgenic, Cow, Goat

459 Generation of transgenic pigs at a high efficiency by linker based sperm-mediated gene transfer. K. Chang^{2,3}, J. Qian¹, C. Chen², C. Lai², I. Ho², M. Wu⁴, and K. Wang*, ¹BioAgri Corp. City of Industry, CA, USA, ²BioAgri Corp.-Taiwan Branch, Taipei, Taiwan, ³Dept. of Chemistry, Soochow University, Taipei, Taiwan, ⁴Dept. of Physiology, Taiwan Livestock Research Center, Tainan, Taiwan.

Sperm-mediated gene transfer (SMGT) has been recognized as a potentially powerful method to make transgenic animals for many years. The current method of gene transfer, microinjection, used widely in transgenic mouse production, has had only limited success in producing transgenic animals from larger or higher species. Last year, we reported a linker based sperm-mediated gene transfer method (LB-SMGT) that greatly improves the production efficiency of large transgenic animals. The linker protein, a monoclonal antibody (mAb C), is reactive to a surface antigen on sperm of all tested species including pig, mouse, chicken, cow, goat, sheep, and human. Sperm from pigs were treated first with mAb C and then combined with a linearized DNA fragment (pSEAP-2 control from Clontech Laboratories Inc.). After surgical oviduct fertilization of the egg, the DNA is shown to successfully integrate into the chromosome genome of viable pig offspring with germ-line transfer to the F1 generation at a highly efficient rate, 37.5%, by Southern blot analysis. Expression of the transgene was detected in 60% of transgenic pigs (F0 generation). We report here that the integration of the transgene is further demonstrated by FISH. The transgenic pigs have also been bred into the F2 generation to demonstrate that the transgene is stably transmitted. Standard artificial insemination can also be used with LB-SMGT to generate transgenic pigs (F0 generation) at a similar efficiency as surgical oviduct fertilization. These results demonstrate that transgenic pigs can be generated with a very simple protocol at a significantly improved efficiency by sperm-mediated gene transfer using the linker protein, mAb C.

Key Words: Transgenic, Pigs, Linker based sperm-mediated gene transfer (LB-SMGT)

Dairy Foods

Lactic Acid Bacteria and Exopolysaccharides

460 The genetic basis for diversity in exopolysaccharide structure and production. G LaPointe*¹, ¹STELA Dairy Research Centre.

The functional properties of polysaccharides are related to their charge, molecular mass and sugar composition. The structure of the repeating units of bacterial heteropolysaccharides is determined by the action of glycosyltransferase enzymes with specific substrates, the sugar nucleotide precursors. Modifications include such reactions as acetylation or pyruvylation, and the addition of phosphate or sulphate substituents. The length of the polymers produced is controlled by a complex polymerization mechanism. Gene transfer and recombination events also contribute to the variety of polysaccharide structures synthesized by lactic acid bacteria. Mapping the number and type of glycosyltransferase genes present has thus been useful in predicting the structure of the repeating unit. Physiological studies have revealed the effect of such factors as temperature, pH, oxygen tension and carbon/nitrogen ratio on the availability of the sugar nucleotide precursors and thus on EPS production. However, the regulation of EPS biosynthesis is still very poorly understood. Numerous regulatory circuits require reversible phosphorylation events. Kinase and phosphatase activities have recently been shown to modulate polysaccharide production at the polymerization level. In effect, the genes coding for these activities are conserved within many *eps* and *cps* operons, suggesting a common biosynthetic mechanism. More knowledge of the genetics and biochemistry of EPS biosynthesis is necessary in order to be able to successfully engineer polysaccharide properties by modifying composition and chain length. The diversity in enzymatic capability of lactic acid bacteria will thus facilitate the design of novel polysaccharides for food and pharmaceutical applications.

Key Words: Exopolysaccharide biosynthesis, Glycosyltransferases, Regulation

461 Structure determination of exopolysaccharides from lactic acid bacteria. Marie-Rose Van Calsteren*, *Food Research and Development Centre, Agriculture and Agri-Food Canada.*

Exopolysaccharides (EPS) are exocellular microbial polysaccharides. To date, EPS produced by lactic acid bacteria (LAB) have received increasing interest, mainly because of their generally recognized as safe (GRAS) status, their rheological properties in food, and their potential health-beneficial properties. Most EPS from LAB are heteropolysaccharides. Their structure consists of a repeating unit containing three to seven sugar residues, combinations of D-Glc, D-Gal, L-Rha, D-GlcNAc, D-GalNAc and D-GlcA. Each hexose could adopt the pyranose or furanose ring configuration, and be linked with the α or β anomeric configuration to other residues at several possible positions. Furthermore, substituents, such as acetate, phosphate, glycerol or pyruvate, could be present. Differences in the properties of EPS are due to the large number of possible configurations and linkages. Hence, the study of the structure of EPS is crucial to understand their physicochemical and biological properties, and for the exploitation of EPS-producing LAB in industrial or medical applications. Several chemical and physical techniques are used to determine the primary structure of EPS. Chemical degradation and derivatization combined with chromatographic methods, often coupled to mass spectrometry (MS), are used to determine the sugar composition, together with the absolute configuration, their positions of substitution, and the substituent composition. Nuclear magnetic resonance (NMR), in particular two-dimensional ¹H and ¹³C NMR, is the most powerful technique to obtain information on the nature and configuration of sugar residues, their interconnectivity, and the nature and location of substituents, to ultimately determine the sequence of the repeating unit. Sometimes, chemical or enzymatic fractionation of the polysaccharide is required to produce smaller fragments, more easily analyzed by NMR or MS. Examples of the application of these methods to the structure elucidation of EPS from several species of LAB will be presented.

Key Words: Heteropolysaccharides, Sequence of the Repeating Unit, Nuclear Magnetic Resonance (NMR)

462 Applications of EPS production by LAB. C. J. Oberg*¹, J. R. Broadbent², and D. J. McMahon², ¹Weber State University, Ogden, Utah, ²Utah State University, Logan, Utah.

Many strains of dairy lactic acid bacteria (LAB) manufacture extracellular polysaccharides (EPS). In nature, bacterial EPS fulfills a variety of diverse functions including cell protection, adhesion of bacteria to solid surfaces, and participate in cell-cell interactions. Incorporation of EPS or EPS-producing (EPS+) cultures in dairy foods can provide viscosifying, stabilizing, and water-binding functions. EPS also contributes to the mouth-feel, texture, and taste perception of fermented dairy products. EPS may even play a role in the probiotic activity of certain LAB. Milk fermented with EPS+ dairy LAB generally develops a ropy or viscous texture, and EPS+ strains of LAB are widely used in yogurt manufacture to enhance viscosity and reduce syneresis. Besides yogurt, other dairy products where LAB EPS has been shown to affect product quality include sour cream and traditional fermented milks in Nordic countries. More recently, researchers have shown EPS+ LAB can enhance the functional properties of cheese. Because LAB EPS have excellent water-binding properties and moisture retention is vital to functionality in low fat cheese, the use of an EPS+ starter has been shown to improve the moisture and melt properties of low fat Mozzarella cheese. As the genetics and physiology of LAB EPS continue to be better understood, further applications inside and outside the realm of dairy products will occur.

Key Words: Exopolysaccharide, Lactic acid bacteria, Applications

463 Visualization of bacterial exopolysaccharide in dairy products using confocal laser scanning microscopy. J F Frank*¹ and A N Hassan¹, ¹Department of Food Science and Technology, University of Georgia.

Understanding the role exopolysaccharide (EPS) produced by lactic acid bacteria plays in the microstructure and physical properties of dairy products has been difficult because of the inability to visualize EPS within product structures. EPS produced in dairy products is highly hydrated and its structure collapses upon dehydration leaving void areas. Void areas in samples observed using scanning electron microscopy may originate with water, EPS, or air, making interpretation of micrographs difficult. Confocal laser scanning microscopy (CSLM) allows observation of fully hydrated samples which preserves the EPS structural component. Capsular EPS of lactic acid bacteria in milk can be visualized by using CSLM in reflectance mode, as the casein micelles reflect light and are excluded by the capsule, resulting in a clear zone surrounding the bacterial cell. Ropy (slime) EPS can be visualized by CSLM after staining with fluorescent-labelled lectins. Selection of lectins for this purpose is partially by trial and error, as one lectin type does not bind to the EPS of all strains. We visualized ropy EPS in yogurt and feta cheese by staining samples with wheat germ agglutinin labeled with Alexa fluor 488 or concanavalin A 488. EPS was observed to fill pores in the casein structure. Stirring yogurt made with ropy culture produced longer and larger strands of EPS. This technique should lead to improved understanding of the role of EPS in dairy product structure and function.

Key Words: exocellular polysaccharide, confocal scanning laser microscopy, lectin

464 Does EPS protect LAB against phages? S. Moineau*, D. Tremblay, and H. Deveau, *Universite Laval.*

Virulent phages are the most significant cause of fermentation failures in the dairy industry worldwide. It has been proposed that the production of exopolysaccharides (EPS) by lactic acid bacteria (LAB) may protect the starter culture against phage infection. However, phage-sensitive and phage-insensitive LAB strains that produce EPS are currently used by the dairy industry. Thus, the involvement of EPS in the phage infection process of LAB is still unclear. Recent data from our laboratory indicated that for *Lactococcus lactis* and for *Streptococcus thermophilus*: i) phages infecting *eps*⁺ strains are not fundamentally distinct from those infecting *eps*⁻ strains; ii) EPS are not necessary for the phage infection process; iii) in few cases, loosely bound EPS may provide, at best, a very weak protection against phage infection by

partially hindering the phage receptors on the cell surface. Moreover, it is possible that the production of EPS increases the viscosity of the medium and perhaps, this molecular crowding slightly affect the spread of the phage infection. It remains to be seen if the sugar composition or the structure of some EPS produced by LAB may be involved in phage sensitivity or insensitivity. Nonetheless, it is now clear from the

above evidences that we should not solely rely on the EPS production to protect starter cultures against phages.

Key Words: Exopolysaccharide (EPS), Bacteriophage, Lactic acid bacteria (LAB)

Physiology

Basic Mechanisms Regulating Anovulatory States

465 Neuroendocrine mechanisms underlying seasonal breeding in the ewe. RL Goodman^{*1}, GM Anderson¹, VL Adams¹, SL Hardy¹, JM Connors¹, and MN Lehman², ¹West Virginia University, ²University of Cincinnati.

It is now clear that an increase in response to the negative feedback action of estradiol (E) is responsible for the inhibition of ovarian function in anestrus ewes. In early work, we demonstrated that A15 dopaminergic (DA) neurons play a key role in this response. These neurons mediate E negative feedback in anestrus and their response to E varies seasonally. Because A15 cells do not contain estrogen receptors (ER), other neurons most likely provide information on E levels to them in anestrus. In more recent work, we have focused on the E-responsive component of this circuitry and have identified two important areas: the ventromedial preoptic area (vmPOA) and retrochiasmatic area (RCh). ER-positive cells in both areas project to the A15, and local administration of E to either area inhibits LH secretion in anestrus, but not during the breeding season. Furthermore, the inhibition of LH in anestrus can be overcome by a DA-receptor antagonist. We thus postulated that the neural circuit mediating E negative feedback in anestrus includes E-responsive perikarya in the vmPOA and RCh that project to the A15 and stimulate these DA neurons, which in turn inhibit GnRH release. This hypothesis raises the possibility that structural changes within this circuit may contribute to the seasonal alterations in response to E negative feedback. Therefore, we tested if there is a seasonal variation in synaptic input to A15 perikarya using dual immunocytochemistry to stain for synaptic varicosities (synapsin I) and DA perikarya (tyrosine hydroxylase). Confocal microscopic analysis indicated a significant increase in synaptic close contacts on A15 dendrites in anestrus ewes. This increase in synaptic input correlated with a significant increase in the dendritic arborization of these neurons. Thus seasonal morphological changes within the neural system mediating E negative feedback may well play an important role in the mechanisms responsible for seasonal breeding in the ewe. Supported by NIH HD-17864

Key Words: Seasonal breeding, estrogen negative feedback, sheep

466 Nutrition and suckling mediated anovulation in beef cattle. R.P. Wettemann^{*}, C.A. Lents, N.H. Ciccioli, F.J. White, and I. Rubio, *Oklahoma Agricultural Experiment Station, Stillwater.*

Nutrient intake, body energy reserves, and suckling are major regulators of reproductive performance of beef cows. Inadequate body energy reserves at parturition increase the interval to first estrus and ovulation, and postpartum nutrient intake can influence length of the interval in cows with thin to moderate body condition (BCS). Suckling can increase the postpartum anestrus interval in thin cows but has little effect on mature cows with adequate body energy reserves. Reduced nutrient intake can delay the onset of puberty and cause cessation of estrous cycles. The objective of this presentation is to evaluate signals by which nutrient intake and body energy reserves may regulate ovarian function. Nutritional restriction causes decreased secretion of LH, reduced follicular growth, and decrease concentrations of estradiol in plasma. Pituitary concentrations of LH were reduced and concentrations of FSH were greater in nutritionally induced anovulatory cows that were ovariectomized compared with proestrous cows. Acute energy restriction of postpubertal heifers resulted in decreased IGF-I in plasma, inhibition of the proestrus increase in estradiol and the ovulatory surge of LH, and anovulation. In addition to direct and indirect effects of decreased energy intake on the hypothalamus and pituitary, nutrition may influence ovarian function. Metabolic signals such as insulin, IGF-I, and leptin may regulate functions of the pituitary and ovary. Concentrations of IGF-I in plasma during late gestation are correlated ($r = 0.33$; $P < 0.01$) with BCS, and concentrations of IGF-I and

leptin in plasma are greater in postpartum cows that have increased energy intake. Concentrations of IGF-I in plasma increase preceding ovulation when nutritionally induced anovulatory cows are realimented. Nutrient intake and BCS alter metabolic signals at the hypothalamus and pituitary that control secretion of LH, and reduced stimulation by metabolic signal at the ovary may compromise the ability of follicles to respond to gonadotropins.

Key Words: Anovulation, Nutrition, Beef Cattle

467 Nitric oxide and the ovary. Carlo Tamanini^{*}, Giuseppina Basini, and Francesca Grasselli, *Dip. Prod. Anim., Biotec. Vet., Qual. Sic. Alim., University of Parma-Italy.*

Nitric oxide (NO) is synthesized from L-arginine by NO synthase (NOS), an enzyme with three isoforms; two of them, neuronal and endothelial (n and eNOS) are constitutive, while the third one, iNOS, is inducible. NO is effective in mediating multiple biological effects, at least in part through the activation of soluble guanylate cyclase (cGMP); among these, smooth muscle cell tone, platelet aggregation and adhesion, cell growth, apoptosis and neurotransmission. Being that these mechanisms are associated with the pathophysiology of several reproductive processes, it became clear that NO could play a key role in reproduction. Apart from its effects through the modulation of LHRH release, NO has been proven to act directly at the ovarian level, where it has been demonstrated to be produced by the vasculature and neurons as well as by various cell types, including granulosa, theca and luteal cells; its production is modulated by several hormones (P4, LH, FSH and hCG) and cytokines which interfere with either eNOS or iNOS expression and activity. Experiments performed with NO donors and/or NO synthase inhibitors have demonstrated that NO reduces apoptosis and inhibits both E2 and P4 production by granulosa cells (at least in part via cGMP). NO is possibly involved in follicle growth. In fact, it is a potent mitogen in the presence of basic fibroblast growth factor (bFGF), it increases the receptors for epidermal growth factor on granulosa cells and, as mentioned above, it regulates the programmed cell death (which is an important part of folliculogenesis). The gonadotropin-stimulated eNOS and iNOS expression as well as the inhibition of ovulation by NOS inhibitors suggest that NO participates in the ovulatory process. After ovulation, iNOS is expressed in luteal cells but its activity diminishes with the corpus luteum development; during the luteolysis phase NO stimulates PGF2 α synthesis while reducing P4 secretion. The overall information provides convincing evidence that NO plays a critical role in the ovarian physiology with regard to follicle growth, ovulation and corpus luteum function, even if its clinical implications have not been clarified yet.

Key Words: Folliculogenesis, Ovulation, Corpus luteum

ADSA Southern Branch Symposium

Potential for Dairying in the Southeast—Challenges and Opportunities

468 Regional production differences. L. O. Ely*, J. W. Smith, and G. H. Oleggini, *University of Georgia, Athens, GA.*

DHI records from 37 states were grouped into North, Midsouth, and South regions and six herd sizes (20-49, 50-99, 100-149, 150-249, 250-449, and > 449 cows). Data was analyzed by region and by herd size for the year 1998. The North region had higher IOFC, milk, fat and protein rolling herd averages, summit milk, standardized 150 day milk and % cows in milk than the other regions. These variables declined for the Midsouth and were lowest for the South. Cost/cwt., days open, days dry and SCC were lowest in the North and highest in the South. Large herds had higher total feed cost, IOFC, milk, fat, and protein rolling herd averages, summit milk, standardized 150 day milk, %cows entering and %cows leaving the herd than smaller herds. For the period 1990 to 1999, the data were analyzed for the trend in change over time for each of the regions. Milk production per cow, total feed cost, feed cost/cwt. of milk, IOFC, days open and herd sizes increased in the period from 1990 to 1999. The percentage of cows in milk did not show significant variation and SCS decreased. Different rates of change over the last decade have made differences among regions larger for milk production, total feed cost, feed cost/cwt. of milk, IOFC, herd size, and SCS. There were no differences in either the rate of change for days open or percentage of cows in milk among regions. Milk production per cow and total feed cost increased at higher rates in larger herds, making the gap between these and smaller herds larger over time. Feed cost/cwt. of milk, IOFC, days open, % cows in milk, and herd size changes had a similar rate of change during the decade keeping differences among herd sizes constant over time. The SCS decreased at a more rapid rate in small herds than in larger herds, resulting in smaller differences between them.

Key Words: dairy production, regions, trends

469 Heat stress effects on reproduction. E.R. Jordan*, *The Texas A&M University System.*

When dairy cattle are subjected to heat stress reproductive efficiency declines. Dairy cattle under heat stress have reduced duration and intensity of estrus, altered follicular development and impaired embryonic development. The most common avenues to ameliorate the effects of heat stress have been to provide cooling in the form of shades, soakers, fans or evaporative coolers. Estrous synchronization tools have been developed which eliminate or greatly reduce the need for estrous detection. Researchers have found that pregnancy rates were more consistent over season when estrous synchronization programs were used compared to AI after detected estrus. Recently, season of calving has been reported to impact success of a programmed first insemination between 70 and 76 days postpartum. Other techniques that have been investigated to reduce the negative impact of heat stress on reproduction include: embryo transfer, addition of antioxidants to the ration, and manipulation of hormone levels.

Key Words: Reproductive Efficiency, Heat Stress

470 Multi-cropped forages for nutrient management. G.L. Newton*, G.J. Gaschol¹, J.K. Bernard¹, J.R. Allison¹, R.K. Hubbard², R.N. Gates², and G. Vellidis¹, ¹University of Georgia, ²USDA-ARS.

The Southern US climate provides opportunities and problems for manure management. The extended growing season provided by a warm-temperate and humid climate allows multi-cropping, such that manure can be applied to growing forages throughout most of the year; potentially improving nutrient uptake per land area and decreasing the amount of manure in storage. Multi-cropping allows land and equipment to be utilized throughout the year, improving the economics of ownership. On the contrary, rainfall increases the potential for movement of potential pollutants in runoff and percolation. Streams and wetlands are also usual features. High temperatures are less conducive to the production of some high quality forages than more moderate climates, and pest and disease pressures are often high. These factors limit the locations and the selection of crops available for managing manure, and may also lower the economic returns to cropping programs. Double and triple cropping systems can produce in excess of 30 Mg/ha/yr of forage DM and recover 600 kg of N and 100 kg of P/ha/yr. Cropping systems which include a deep rooted perennial often provide better

protection from undesirable leaching than do systems with only annual crops. Forage quality can be higher for annual crop systems, but they usually have greater input costs. The potentially competing objectives of environmental protection, forage quality, and net returns may require site specific resolution. Increasing awareness of the water quality protection benefits of buffers and riparian zones demands that they be considered as part of the cropping/nutrient management system.

Key Words: Manure, Forages, Water quality

471 Rearing dairy herd replacements in the Southeast. R. E. James*, *Virginia Polytechnic Institute and State University.*

DHI data from Dairy Records Management Systems and the NAHMS surveys of 1991 and 1996 provide information to describe the dairy heifer enterprise in the Southeast. DHI herds in the Southeast are larger but produce less milk/cow annually than herds in other regions of the U.S. Peak yields and lactation yields are lower, 1st calving body weight is smaller and age at first calving is higher than in other regions of the U.S. The nationwide NAHMS surveys of 1991 and 1996 revealed a strong positive relationship between heifer growth and rolling herd average milk yield. Heifers were largest in the Midwest, intermediate in the West and Northeast and smallest in the Southeast. Differences were attributed to feeding strategies. A retrospective analysis of survey data revealed death losses were 8.5% of live births in the Southeast as compared to 10% in the West, 8.3% in the Midwest and 6.9% in the Northeast. These data suggests the need to develop management systems to enhance neonatal health and foster improved growth in the more extensive rearing systems common in the Southeastern U.S.

Key Words: Heifers, Southeast

472 Economic evaluation of dairy production in the southeastern United States. A. de Vries*,¹ R. G. Giesy¹, and L. O. Ely², ¹University of Florida, ¹University of Florida, ²University of Georgia.

The objective of this study was to evaluate the economics of dairy production in the southeastern US (SE) in comparison to other regions in the US. Data was available from the Florida/Georgia Dairy Business Analysis Project (FL/GA), the North Carolina Dairy Farm Financial Performance Pilot Project (NC), the New York Dairy Farm Business Summary > 300 cows (NY), Milk Production Costs on Selected Wisconsin Dairy Farms (WI), all by universities, and Dairy Farm Operating Trends by Moore Stephens Frazer and Torbet, LLP (Southern California (SCal), San Joaquin Valley (SJV), Arizona (AZ), Idaho (ID), and New Mexico (NM)). For 2000, the average total revenues / cwt were \$18.03 (FL/GA), \$17.37 (NC), \$15.58 (NY), \$11.76 (ID), \$12.39 (NM), \$12.33 (AZ), \$12.28 (SJV), and \$12.34 (SCal). The average total cost / cwt were \$17.03 (FL/GA), \$15.08 (NC), \$14.92 (NY), \$13.20 (WI), \$10.65 (ID), \$11.46 (NM), \$12.21 (AZ), \$11.33 (SJV), and \$11.24 (SCal). The average feed cost / cwt ranged from \$4.76 (ID) to \$7.35 (FL/GA). The average rate of return on assets (ROA) was highest in FL/GA with 7.0% and lowest in AZ with 0.6% with most regions reporting 3 to 4%. The variability within the regions is considerable. Total revenues / cwt for the SE ranged from \$15.62 to \$23.14 (FL/GA, 22 farms) and from \$16.23 to \$19.11 (NC, 7 farms). Total feed cost / cwt for FL/GA ranged from \$4.60 to \$10.78. Total cost / cwt for the SE ranged from \$13.28 to \$21.75 (FL/GA) and from \$11.92 to \$16.84 (NC). The ROA for the SE ranged from #7.2% to 22.9% (FL/GA) and from 0.2% to 20.1% (NC). Average total revenues / cwt from 1995 to 1999 for FL/GA were \$17.03, \$19.93, \$18.31, \$19.41, \$19.07, respectively. Average total cost / cwt from 1995 to 1999 for FL/GA were \$18.51, \$17.79, \$18.02, \$17.57, \$16.40, respectively. The reported data is not necessarily representative for the average economic performance in the regions. Based on these data, the conclusion is that both average returns and cost are higher in the southeastern US, but the margin and ROA are competitive with other regions in the US. Considerable variation in the SE exists, which indicates opportunity for well-managed herds.

Key Words: Economics, Southeast, Dairy

473 The effects of supplementing yeast culture during the transition period on performance of Holstein cows during hot humid weather. J. D. Ward*, *LSU AgCenter Southeast Research Station.*

During the summer and early fall of 2000, 32 multiparous Holstein cows were used to investigate the effects of yeast culture supplementation during the transition period on performance during hot humid weather. Cows being supplemented with yeast culture received 56.7 g of yeast culture for 3 wk prior to expected calving date and then received 113.4 g of yeast culture for 21 d after parturition. All cows were component fed and the yeast culture was top dressed onto the pellet portion of the diet. Prior to calving cows were offered 4.5 kg (as fed basis) of a commercially available pellet once per day, given ad libitum access to bermudagrass hay, and allowed to graze bermudagrass pasture. After parturition, cows were offered 5.0 kg (as fed basis) of the same pellet twice per day. They were given ad libitum access to a partial mixed ration (PMR) consisting of (DM basis) 32.7% alfalfa hay, 20.9% whole cottonseed, 28.5% corn silage, and 17.9% ryegrass haylage. Grain was offered individually in a stanchion barn and PMR was offered behind Calan[®] gate doors. Daily milk production and DMI were recorded for the first 60 d of lactation. Plasma β -hydroxy butyrate (BHBA) was determined every 10 d during the 60 d trial. Milk fat and protein were determined 20, 40, and 60 d after parturition. Milk production, DMI, milk component, and BHBA data were analyzed using the mixed model procedures of SAS. Peak milk production and days to peak milk production data were analyzed using the general linear models of SAS. Peak milk production (48.1 kg) and days to peak milk (40.5) were not affected ($P > 0.80$) by yeast culture supplementation. Yeast culture supplementation did not ($P > 0.85$) affect grain refusals but did increase ($P < 0.03$) PMR consumption (12.7 vs 12.2 kg of DM per d). Therefore, total DMI was increased ($P < 0.03$) by yeast culture supplementation (21.5 vs 21.0 kg of DM per d). Milk production was also increased ($P = 0.08$) by yeast culture supplementation (39.5 vs 38.3 kg per d). However yeast culture supplementation had no effect on milk fat ($P > 0.80$) or protein ($P = 0.19$). Plasma BHBA was not affected by treatment. The results of this experiment indicate that feeding yeast culture during the transition period was beneficial and increased DMI and milk production.

Key Words: Yeast Culture, Transition Cow, Heat Stress

474 Comparison of nutrient content and digestibility of traditional versus genetically modified whole cottonseed. J. A. Bertrand*¹, T. C. Jenkins¹, and M. Calhoun², ¹*Clemson University*, ²*Texas A&M University*.

The objective of this study was to determine if the in vitro dry matter digestibility (IVDMD) and nutrient and gossypol contents of genetically modified whole cottonseed (WCS) differed from traditional varieties. Varieties included traditional (no genetic modifications) (TRAD), and those with the following gene insertions: Round-Up Ready[®] (RR), *Bacillus thuringiensis* (Bt), and both gene insertions (RR/Bt). Samples from 1998, 1999, and 2000 were analyzed for IVDMD, dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), gossypol, and fat content. Fatty acids and amino acids were determined on samples harvested in 2000. Only ADF content was different by type of seed. ADF content of RR/Bt, 45.4%, was significantly higher than that of RR, 42.6%, and there was a trend, $P = 0.06$, for ADF of RR/Bt to be different from TRAD, 43.4%. There was a significant type by year interaction for CP content. The overall effect of year was significant for all variables. Gossypol content was not significantly different by type but was significantly different by year and increased from 0.485% in 1998 to 0.509% in 1999 to 0.743% in 2000. This was quite high and should be monitored. There were no differences in fatty acid or amino acid content by type for seed produced in 2000. In conclusion, IVDMD of traditional versus genetically modified WCS was not different and nutrient content differences were minimal.

	LSM, %				Average SE
	TRAD	Bt	RR	Bt/RR	
IVDMD ^a	58.5	59.0	58.6	58.6	0.62
Nutrient content					
DM ^a	93.1	93.5	93.1	93.5	0.18
CP ^{a,c}	24.1	24.3	24.3	25.0	0.26
Fat ^a	15.7	16.9	16.9	16.4	0.57
NDF ^a	60.5	61.4	60.2	62.3	0.74
ADF ^{a,b}	43.4	44.6	42.6	45.4	0.72
Gossypol ^a	0.58	0.59	0.59	0.59	0.03

^a Effect of year was significantly different ($P < 0.05$). ^b Effect of seed type was significantly different ($P < 0.05$). ^c Effect of year*seed type was significantly different ($P < 0.05$).

Key Words: genetically modified, whole cottonseed

475 Use of DairyMetrics to compare Jersey and Holstein dairy herds of different herd sizes in the southern U.S. J.A. Pennington*¹, J.S. Clay², and C.N. Vierhout², ¹*University of Arkansas Cooperative Extension Service, Little Rock, AR*, ²*Dairy Records Management Systems, Raleigh, NC*.

DairyMetrics from Dairy Records Management Systems was used to compare 72 traits of Jersey and Holstein herds in the southern states by different herd sizes. Holstein herds had greater days in milk, % cows leaving the herd, % herd bred to non-AI bulls, milk production, calving interval, days to first service, and somatic cell counts than Jersey herds; Jersey herds had greater % cows identified by sire and % heats observed compared to Holstein herds. Larger Holstein herds had greater increase in herd size and less % cows identified by sire than smaller Holstein herds but had only a slight increase in % cows leaving the herd compared to smaller herds. There were smaller differences in other parameters for these herds with less than 1000 cows.

	Cows/Herd					
	0-49	50-99	100-199	200-299	300-599	600-999
—Holstein Herds						
Number of cows/herd	39	77	142	242	418	756
Change in number of cows	-6	-4	-2	0	5	3
Days in milk	188	185	183	181	184	185
% cows left herd	33	34	34	35	37	36
% herd bred to non-AI bulls	27	37	43	39	50	44
% cows identified by sire	62	53	50	49	31	31
Rolling milk (kg)	8002	8032	8267	8245	8349	8805
Actual calving interval (mon)	14.7	14.3	14.2	14.3	14.4	14.2
Days to 1st service-herd	114	107	106	101	105	98
% heats observed for year	33	30	31	34	30	40
SCC actual (x1000)	458	430	408	406	403	323
—Jersey Herds						
Number of cows/herd	35	74	140	250	442	683
Change in number of cows	-14	1	0	9	19	27
Days in milk	172	177	161	185	171	169
% cows left herd	30	31	32	26	29	31
% herd bred to non-AI bulls	18	24	24	25	9	13
% cows identified by sire	87	87	84	91	85	87
Rolling milk (kg)	6211	6502	6776	6583	6255	6354
Actual calving interval (mon)	13.6	13.6	13.5	14.2	13.7	13.6
Days to 1st service-herd	82	89	84	94	83	79
% heats observed for year	43	42	47	48	51	54
SCC actual (x1000)	351	406	342	384	388	366

Key Words: DairyMetrics, Dairy Breeds, Herd Size

476 Measurement of moisture in high lactose whey products. Michel Pouliot*, Josee Beauchemin, and Jacques Rolland, *Agropur Dairy Cooperative, Granby, Qc, Canada.*

Dry whey products contain amorphous lactose (or lactose glass) and α -lactose monohydrate crystals. The monohydrate crystal is a non-hygroscopic and non-thermoplastic product whereas amorphous lactose is highly hygroscopic and thermoplastic. The more important is the proportion of amorphous lactose in a powder, the more susceptible it is to caking. The water of hydration in the pure α -lactose monohydrate crystal is tightly held and can only be vaporised at 120 °C. This complicates the measurement of moisture by the use of conventional loss on drying methods. We have noticed over 3 years that the moisture contents of deproteinised whey powder (whey UF permeate) were higher in winter than in summer. This study evaluates the effect of the relative humidity of the air in the oven (dry or humid) on the measurement of moisture in deproteinised whey. Moisture measurements were done according to Agriculture Canada official method (oven 100 +/- 2 °C, 16 hr) with the difference that dry (CaSO₄) or humid (water bubbling) air at room temperature was used to continuously flush the oven (4 volumes/hr). The temperature in the oven was monitored at 100 +/- 2 °C. Two deproteinised whey powders coming from different plants were used. Their moisture contents were measured by Karl Fischer titration. The powders were kept in high glass jars until used. Each powder was measured at 3 different occasions using 4 replicates each time in dry or humid air condition. Results showed that moisture measured using dry air was significantly ($p < 0.001$) higher than with humid air. This difference can be as high as 1.1 g water/100g powder. This might explain the higher moisture content measured in winter compared to summer. Repeatability of the method is fair but reproducibility is poor with a significant difference ($p < 0.001$) within the 3 occasions of measurements. It can be concluded that the loss on drying method is not appropriate for measurement of moisture in high lactose whey powders. Karl Fischer titration is the method of choice for these products.

Key Words: moisture, lactose, whey

477 Effect of kappa-carrageenan on microstructure of milk protein: polysaccharide mixed systems. H. D. Goff*, S. Thaiudom, and R. A. Andrew, *University of Guelph, ON, Canada.*

Milk proteins and polysaccharide stabilizers commonly exhibit phase separation when they are mixed in solution, typical of many stabilized dairy products such as ice cream mix or chocolate milk. Practical experience has shown that kappa-carrageenan can prevent phase separation, but the various phenomena are not well understood. In this study, locust bean gum, guar or xanthan (0.36%) were incorporated individually in solutions of milk solids-not-fat (11%). Phase diagrams and transmission electron microscopy (TEM) were used to investigate structural formation at the macroscopic and microscopic levels, respectively. During the evolution of phase separation, water-in-water emulsion droplets were seen to coalesce and stream, giving rise to visual mottling, and finally distinct phase separation. Electrophoresis results showed that the clear phase was devoid of casein micelles but slightly enriched in whey protein. Disappearance of phase separation between milk proteins and primary stabilizers in sucrose solution at the macroscopic level was evident with added kappa-carrageenan at concentrations of 0.025% or 0.05%, but the existence of phase separation at the microscopic level was still present. Phase separation was attributed to a depletion flocculation mechanism while disappearance of this phenomenon was attributed either to a weak filament gel-network of kappa-carrageenan, adsorbed on caseins via electrostatic interaction, or to a gelation of excess kappa-carrageenan itself.

Key Words: Stabilizer, Phase separation, Carrageenan

478 Effects of enzymatic crosslinking on the consistency and structure of probiotic goat milk yogurt. J. Farnsworth*, G. Hendricks², V. Gotcheva¹, R. Akuzawa³, and M. Guo¹, ¹University of Vermont, Burlington VT 05405, ²University of Massachusetts, Worcester, MA 01655, ³Nippon Veterinary and Animal Science University, Tokyo, Japan.

Goat milk products are becoming increasingly popular as specialty products in the United States. However, because of its low casein content and seasonal changes in composition, it is difficult to produce goat milk

yogurt with good consistency. In this study, the effects of enzymatic crosslinking by addition of microbial transglutaminase (MTGase) on the viscosity, microstructure, and probiotic culture survivability of goat milk yogurt containing *Lactobacillus acidophilus*, *Bifidobacterium*, and *Lactobacillus paracasei subsp. casei*, were investigated. The consistency of the yogurt was greatly improved by the addition of MTGase. The viscosity was 4.46×10^3 mPa.s for control goat milk yogurt. The values were increased to 2.72×10^5 mPa.s with two units MTGase and to 1.12×10^6 mPa.s with four units MTGase added per gram protein. Scanning electron micrographs of the yogurt showed that the microstructure of the treated yogurt seemed denser compared to that of the control sample. Survivability of the probiotics (*Bifidobacterium*, *Lactobacillus paracasei subsp. casei* and *Lactobacillus acidophilus*) in the yogurt was not significantly affected by enzymatic crosslinking ($p > 0.05$) during storage for nine weeks at 4°C. The populations of the probiotic cultures in both control and MTGase treated yogurt slowly decreased during storage, but the levels of all three cultures remained above 10^7 per gram through the end of the study. Results of this study indicate that enzymatic cross-linking may be an effective method to improve the consistency of probiotic goat milk yogurt.

Key Words: Goat milk, enzymatic crosslinking, probiotic yogurt

479 Comparison of bulk physical properties of angel food cakes containing egg white protein or whey protein isolate. P. Luck*, C. Pernel, E.A. Foegeding, and C. Daubert, ¹North Carolina State University.

Investigation of functional properties of proteins and factors that influence them is necessary for modeling food systems so that processes may be optimized or cost saving substitutions made. Angel food cake is an excellent model system for study of protein functionality because it contains few ingredients, relies on no chemical leavening and is very dependent on the functional properties of its protein constituents. Research concerning angel food cake lacks information about the bulk behavior of the initial foam and cake during baking which may yield insight into the functions of proteins within the cake. In this report, bulk behaviors during angel food cake baking are studied to distinguish differences in the performance of egg white protein (EWP) and whey protein isolate (WPI).

Cakes were made from foams containing EWP and WPI (2-20% protein), WPI with xanthan gum or heat treated WPI. Final cake volume and height during baking, foaming solution viscosity, thermal transitions and rheological properties during baking were measured.

Cakes made with 10% protein foams containing WPI had roughly half the final volume of cakes made with foams containing EWP. Correlation of cake height during baking and thermal transitions indicated the occurrence of 2 events: denaturation of proteins within the cake (75°C#WPI, 85°C-EWP) and starch gelatinization (95°C). Mild heat treatment of a 10% WPI solution prior to foaming yielded a cake with increased volume although not equal to that of EWP. An increased solution viscosity contributed to cake volume increase, but was not solely responsible for that increase. Rheological analysis indicated different protein mechanisms for EWP and WPI in angel food cake. Phase angle of WPI containing cake increased (more viscous) up to roughly 87°C and then decreased (more elastic) at the end of baking. The phase angle of cakes made with EWP continually decreased as temperature decreased ending at a low phase angle. Cake volume is highly dependent on protein specific interactions and protein interactions with starch that vary according to protein type.

Key Words: angel food cake, egg white protein, whey protein

480 Effect of potassium sorbate addition on the viscosity of aqueous solutions of locust bean gum during storage at 4 and 20 C. M.S. Gigante*, M. Almendra-Aliste², and P.S. Kindstedt², ¹State University of Campinas, Campinas, SP/Brazil, ²University of Vermont, Burlington, VT/USA.

Previous studies demonstrated that the viscosity of the serum phase of cultured cream cheese (made with locust bean gum (LBG) stabilizer), and the viscosity of aqueous solutions of LBG, decreased in temperature-dependent manner during storage. The objective of the present study was to evaluate whether viscosity losses may have been associated with

microbial growth. LBG solutions (.45%) with and without added potassium sorbate (.3%) were prepared in distilled water. The solutions were divided into three treatments and lactic acid was added to adjust the pH to 5.3, 4.8 and 4.3 (± 0.05). The acidified solutions were dispensed into sterile culture tubes and stored at 4 or 20°C for up to 56 d. Samples were randomly chosen after 1,7,14, 21, 28, 35, 42, and 56 d and analyzed for viscosity at 25°C and for yeast and mold and aerobic plate counts. The entire experiment was replicate three times. The effects of pH, storage time, and storage temperature on viscosity were evaluated by ANOVA according to a split-split plot design. The viscosity of LBG solutions with sorbate decreased significantly but only slightly (i.e. < 10% change) during 56 d of storage. No yeast, mold or aerobic bacteria were detected throughout storage. In contrast, the viscosity of LBG solutions without sorbate decreased dramatically in a temperature dependent manner. On average, viscosity decreased by ca. 65% and 91% during storage at 4 and 20°C, respectively. Furthermore, yeast and mold and aerobic plate counts increased rapidly in LBG solutions without sorbate due to random contamination of the solutions, with higher counts occurring at 20°C. In summary, LBG was stable in aqueous solution when microbiological growth was prevented. However, when microbiological growth occurred, LBG solutions quickly lost viscosity. The data support the view that microbiological activity may contribute to loss of viscosity in the serum phase of cream cheese during storage, and thus may contribute to the development of syneresis.

Key Words: Cream cheese, Locust bean gum, Syneresis

481 Water solubility and mechanical properties of heat cured whey protein isolate-based edible films: A comparison to commercial collagen and natural casings. S Amin^{*1}, A Booren¹, and Z Ustunol¹, *Michigan State University.*

Heat curing has been shown to improve the mechanical properties of protein-based films. The purpose of this study was to determine the effect of two different heat-curing conditions on mechanical properties and water solubility of whey protein isolate-based films with different plasticizer content as compared to collagen and natural casings.

Whey protein isolate (WPI; 5% w/v) films with three levels of glycerol (Gly; 3.5, 3.3, 2.7% w/v) and candelilla wax (CW; 0.8% w/v) were prepared and heat-cured using a vacuum oven at 80°C for 24h and 90°C for 12h. Tensile strength (TS), elongation at break (%E) and wet strength (WS) were determined using standard ASTM procedures and compared to collagen and natural casings. Water solubility (23°C, 24h) of WPI-based films, collagen and natural casings were also determined.

No differences in TS were observed between WPI-based films heat cured at 90°C and collagen; natural casings had lower ($p < 0.05$) TS than both. The WPI films heat cured at 80°C and natural casings had lower ($p < 0.05$) TS than collagen. However, WPI-based films heat cured at 80°C with 3.3 and 2.7% Gly had higher ($p < 0.05$) TS than natural casings. Heat cured WPI-based films had lower ($p < 0.05$) WS than collagen and natural casings. No differences in %E were observed among WPI-based films heat cured at 90°C, collagen and natural casing. The WPI-based films heat cured at 80°C with 3.5 and 3.3% Gly had higher ($p < 0.05$) %E than collagen and natural casings. All heat cured WPI-based films and collagen had higher ($p < 0.05$) solubility than natural casings. Heat curing temperature/time had no effect on the solubility of WPI-based films.

Our results indicate that WPI-based edible films with solubility and mechanical properties resembling to collagen and natural casings may be produced by heat curing of the films. Films with 2.7% Gly, heat cured at 90°C for 12h produced films with properties closest to collagen.

Key Words: Whey, Collagen, Casing

482 Role of polysaccharide stabilizers in the formation of yogurt structure. Rosalind McLeod and David W. Everett^{*}, *University of Otago, Dunedin, New Zealand.*

The mechanisms of interaction between casein micelles and polysaccharide stabilizers in yogurt were investigated by dynamic oscillatory rheometry. Fresh, unpasteurized skim milk was adjusted to 5% casein by addition of skim milk powder, heat-treated at 85°C for 30 min, cooled to 30°C, and inoculated with *S. thermophilus* and *Lb. bulgaricus* culture. One of five stabilizers was added after the heat-treatment step at 85°C at concentrations of 0.05% to 0.6% of the milk volume. The yogurt was set for 16 h at 30°C and stored at 4°C. pH was adjusted to 4.25 on day 1 after manufacture. Rheological measurements were

made at 10°C: 1) viscosity over a shear rate range of 1000 to 0 s⁻¹, 2) strain sweep from 0.001 to 1 at 1 Hz to determine the extent of the linear viscoelastic region, and 3) frequency sweep from 0.1 to 10 Hz at a strain of 0.003. Syneresis was quantified as the serum phase remaining after centrifugation at 200×g for 10 min at 4°C. All measurements were made in triplicate, 1, 21 and 42 d after manufacture. Stabilizers that adsorb onto the surface of casein micelles (λ -carrageenan and low-methoxy pectin) higher than a characteristic concentration of 0.3% and 0.4% respectively, decreased the viscosity at day 1 from 50±6 Pa.s to 15±3 Pa.s, along with an increase in syneresis and δ values from 15±3° to 50±7° for pectin and 16±1° to 181° for carrageenan. Higher values of δ indicate more liquid-like behavior. Non-adsorbing stabilizers (xanthan, guar, and locust bean gum) increased the viscosity at stabilizer concentrations higher than 0.6%, 0.5% and 0.5% respectively at day 1; xanthan 48±2 to 92±6 Pa.s, guar 0.6±0.1 to 157±13 Pa.s, and locust bean gum 0.5±0.1 to 5.4±2.7 Pa.s. A concomitant decrease in both δ and syneresis was observed for guar at day 1. A peak was observed for δ as a function of frequency. This peak shifted to lower frequencies as the stabilizer concentration increased and as the yogurt aged. As the level of adsorbing stabilizer increased, the casein micelles passed from a region of bridging flocculation to steric repulsion. For non-adsorbing stabilizers a transition occurred from depletion flocculation of micelles, to micelles suspended in a concentrated and viscous stabilizer gel.

Key Words: Yogurt, Casein, Rheology

483 Conjugated linoleic acid and docosahexaenoic acid enriched milk altered physical properties of milk fat and polymorphic structure of butter. CA Avramis^{*1}, JKG Kramer², AGM Marangoni¹, and AR Hill¹, ¹ *Department of Food Science, University of Guelph,* ² *Food Research Program, Agriculture and Agri-Food Canada.*

Inclusion of marine algae in dairy rations of Holstein cows produced milk enriched with docosahexaenoic acid (DHA), conjugated linoleic acid (CLA) and trans-octadecenoic acids. Significant milk fat depression resulted with an incorporation of marine algae in the dairy ration. Milk fat globule size and casein micelle size decreased in the treated milk which related to churning properties in butter-making. Butter made from enriched milk fat showed a decrease in hardness, dropping point and a lower solid fat content at 5°C. Differential scanning calorimetry was used to characterize both crystallization and melting behaviors of inherent and enriched butter oil. The microstructural network of DHA milk fat was significantly different from that of native milkfat. DHA milk fat crystallized directly to a β -2 polymorphic form at 5°C in contrast to native milk fat that crystallized initially in an polymorphic form. In an attempt to correlate the changes observed in the physical properties to lipid changes, an extensive identification and quantification of total fatty acid methyl esters (FAME) content ranging from C4 to C24 of both enriched milk and butter was conducted using gas chromatography (GC). Argention thin layer chromatography (Ag-TLC) combined with GC was used to identify, elucidate and quantify overlaps between positional /italicize cis and /italicize trans isomers in the 18:1 fraction. DHA-enriched milk fats had increased levels of short chain fatty acids (4:0 to 10:0), and 14:0 and 16:0, while 18:0 decreased. There were increased levels of n-3 polyunsaturated fatty acids (20:5n-3 and 22:6n-3), conjugated linoleic acid (CLA) and total /italicizetrans 18:1. A significant increase in 10/italicizetrans-18:1 was observed which is associated with milk fat depression.

Key Words: Fatty Acids, Gas Chromatography, Microstructure

484 Dairy fats enriched in n-3 PUFA and CLA by feeding fish meal. C Cruz-Hernandez^{*1}, JKG Kramer², and AR Hill¹, ¹ *University of Guelph,* ² *Agriculture and Agri-Food Canada.*

The present study was designed to evaluate changes in cheese lipids as a result of feeding cows partially protected fish meal i.e., DHA (docosahexaenoic acid), CLA (conjugated linoleic acid), *trans* 18:1, and short chain fatty acids. The control milk and cheese was obtained from cows fed a soy/corn diet. All samples were stored at -70°C until analyzed. Total milk fats were extracted using a chloroform/methanol/water system and fatty acid methyl esters (FAME) were prepared using sodium methoxide. The complete FA profile of milk and cheese lipids were obtained by gas chromatography (GC) equipped with a split/splitless injector, a flame ionization detector; and a 100 m CP-Sil 88 capillary column. Silver ion thin layer chromatography (Ag⁺-TLC) was used to separate

the geometric monoenoic FAME. Each fraction was analyzed by GC, as described above with the capillary column operated isothermally at 120°C. More than one hundred FAME from C4 to C26 were resolved in the GC analysis of total milk and cheese lipids. The qualitative separation and quantitative analysis of total FAME from cheese fat was greatly affected by the sample load applied onto the GC column. At least two and occasionally three different sample loads were required to separate and identify the minor and the major fatty acids in these samples. A combination of Ag⁺-TLC and GC was required to resolve and identify of the *trans* and *cis* isomers independently. Ten positional *cis* and *trans* 18:1 isomers were identified with 9c as the predominant isomer. The 10t-18:1 isomer, associated with milk fat depression, was the major *trans* isomer in DHA enriched milk and cheese, follow by the 11t-18:1. In addition, the n-3 FA of DHA cheese increased, i.e., DHA and EPA (eicosapentaenoic acid, 20:5n3). The CLA region showed that 9c,11t-18:2 was the major CLA isomer in these dairy fats on both diets, and the content was higher in the fish meal fed cows. The PUFA in cheddar cheese remained stable up to 18 months ripening at 8°C.

Key Words: docosahexaenoic acid (DHA), conjugated linoleic acid (CLA), gas chromatography

485 Milks from cloned cows: rennet coagulation properties of five clones over a single lactation cycle. J. A. Lucey^{*1}, S. Govindasamy-Lucey², J. E. Romero², M. M. Pace³, and M. D. Bishop³, ¹*Department of Food Science, University of Wisconsin, Madison, Wisconsin, USA*, ²*Center for Dairy Research, University of Wisconsin, Madison, Wisconsin, USA*, ³*Infigen Inc., Deforest, Wisconsin, USA*.

A group of 11 Holstein cows were derived from a single clonal line using somatic cell nuclear transfer technology. The coagulation properties of milks from five cows of this clonal group were determined using dynamic low amplitude oscillation on a Physica UDS 200 Rheometer. Milks were studied over one lactation cycle and each cow was sampled 6 times (apart from one cow which was sampled 4 times) at 2-month intervals. Coagulation was assessed at the natural pH of milk. Milks from each individual cow were obtained from the morning milking and collected separately, chilled with ice water to 4°C and tested that day. Control bulk milk samples (from a 200 cow herd of Holstein cows) were also tested at each sampling day. Milks from these cloned animals are not currently used for consumption. The large deformation properties of rennet-induced gels were determined using a low constant shear (0.01 s⁻¹) test of the pre-formed gel made in the rheometer. The stress required to fracture the gel and strain at fracture were determined from this shear test, which was performed 40 min after rennet addition. Coagulation time, storage modulus value at 40 min after rennet addition, and fracture stress were all significantly influenced by stage of lactation (*P* < 0.05) but not by

the individual clones. Only the values for fracture strain for individual clones were significantly different (*P* < 0.05). Neither the coagulation properties nor the milk composition of the clones were exactly identical; however, the values were similar to that expected for normal milk samples. There were significant (*r* > 0.7) positive correlations between clotting time and the parameters pH and fracture strain. Clotting time was negatively correlated (*r* > 0.7) with storage modulus and fracture stress. Detailed analysis of the composition of all the milks in this clonal line is currently underway. In conclusion, it appeared that, apart from the highly significant influence of the stage of lactation, there were no significant differences in the coagulation properties of this clonal group.

Key Words: Cloning, Rennet coagulation, Rheology

486 Stability of oil in water emulsions formed in presence of skim milk powder: effect of calcium salts and heat treatments. Deepa Mathew^{*} and Phillip S. Tong, *California Polytechnic State University*.

Stability of oil in water emulsions made with soy oil, water and skim milk powder fortified with calcium salts was studied. Four salts - calcium carbonate, calcium phosphate, calcium citrate and calcium lactate were studied separately. The amounts of skim milk powder and calcium salts were adjusted so that the protein content in the final emulsion was either 3.5% or 1.75% (w/w) and calcium content was either 0.24% (w/w) (2 times the amount naturally present in milk) or 0.36% (w/w) (3 times the amount naturally present in milk). Skim milk powder and calcium salt were blended together. The dry mixture was reconstituted in the required quantity of water and was kept at 5°C for 18 hrs for proper hydration of the powder. The temperature was then brought up to 25°C; soy oil was added (10% (w/v) and homogenized with a two stage homogenizer (first stage pressure of 13.8 MPa and second stage pressure of 3.45 MPa). The emulsions were subjected to either pasteurization (63°C for 30 minutes) or retorting (121°C for 16 minutes) and then were cooled to 25°C. Stability of emulsions was studied by measuring particle size distributions and fat analysis of the cream layer after centrifugation. Calcium phosphate caused immediate instability at both levels of calcium and protein. As a result, further studies were not pursued with calcium phosphate. It was observed that with the other three salts, instability of emulsions decreased as the protein content increased, for the same level of calcium. In all cases, retorted samples were more unstable compared to pasteurized samples. Emulsions containing calcium lactate and calcium citrate were more sensitive to heat treatments than emulsions containing calcium carbonate. The most stable emulsions were obtained when calcium carbonate was added (even more stability than control sample with no added calcium at 1.75% protein).

Key Words: Emulsion, Stability, Calcium

Extension Education

487 Pork processing inservice program for high school ag educators. K. Kephart^{*}, R. Mikesell, and W. Henning, *Penn State University*.

The purpose of this educational program was to provide agriculture educators with technical knowledge and classroom materials for teaching the fundamentals of meat processing to high school students. Teachers from the 160 school districts in Pennsylvania with ag science programs were invited to attend; 42 individuals from 29 school districts participated. The concepts taught included methods of meat preservation, function of processing ingredients (salt, sugar, phosphate and nitrate), food safety, and examples of processed products. Written materials, including lesson plans, quizzes, laboratory instructions and data sheets were provided along with a laboratory teaching kit with sufficient materials for 45 students. Each teaching kit included cooking bags, sanitary equipment, a 50-cc syringe with attached meat injection needle, meat thermometer, and premixed and pre-weighed ingredients to be dissolved in a standard volume of water. The laboratory was designed to enable each student to inject one of three solutions into a two-pound cut of boneless pork: 1) marinate (salt, sugar, phosphate); 2) nitrite (marinate + nitrite); 3) water. After injection, students refrigerated the pork for a minimum of 24-hours, cooked each cut to an internal temperature of 71°C, and recorded color, flavor and juiciness scores. Seventy-three percent of the participants felt the inservice program was well organized, 92% like the lesson plan format, 100% were pleased with the materials in

the teaching kit, and program has been successfully used in 97% of the school districts represented. We plan to build on the success of this program to offer similar programs in quality assurance, agriculture science projects, and environmental stewardship.

Key Words: Meat Processing, Secondary Education, Teacher Inservice

488 Third-party evaluation of proposed sites for swine operations and estimation of the risk of odor conflict. R. Mikesell^{*} and K. Kephart, *Penn State University*.

The purpose of this program is to assess the potential for odor related complaints arising from the operation of proposed swine facilities. We provide the swine industry with cost-free site evaluations to prevent odor complaints associated with poorly sited swine operations. Criteria for evaluation include: 1) Nature of odor problems (both physical and personal factors affect odor perception); 2) Neighbor location (those at greatest risk are within one-half mile east or south of the proposed site); 3) Topography and vegetation (hills and vegetation help enhance odor plume dilution); 4) Physical size and orientation (overall facility size dictates odor plume width); 5) Animal inventory (number of animals dictates physical facility size and manure production volume); 6) Type of manure storage (outdoor storages are subject to wind stripping

and absorption of solar radiation); 7) Manure application system (location and type of application system affects odor emission); 8) Personal factors (preconceived expectations affect neighbor attitudes); 9) Special technologies (e.g. biofiltration of exhausted air reduces odor emissions). Each assessment includes a detailed letter describing the site and surroundings along with suggestions for reducing odor risk. Of the 28 sites evaluated, the following recommendations were made (number of sites): manure injection or incorporation (18), re-orient or move the building on existing property (11), visit and notify neighbors (9), reduce animal inventory (5), consider using special technology (11), or abandon the project (2). Of the 28 sites evaluated, six are in operation (with no apparent conflict), 10 projects did not proceed, and 12 are in the permit process. Of those in operation or in the permit process, 100% of those asked heeded our recommendation to move the site, but only one in five agreed to reduce the size of the operation. We are encouraged with the level of cooperation thus far and continue to encourage all companies to take advantage of the service.

Key Words: Odor, Evaluation, Swine

489 Teaching environmental stewardship to commercial manure haulers through a certification program. R. Meinen*, K. Kephart, and L. Ressler, *Penn State University, University Park, PA.*

The purpose of this educational program is to strengthen environmental stewardship among commercial manure haulers. Participants who attend a classroom session and score an average of 80% on six exams, and attend a field demonstration qualify for certification. Participants are tested on the following: Pennsylvania's nutrient management laws, nitrogen management, phosphorus management, conservation practices, manure spreader calibration, and odor control. Other subjects taught, but not included in the exams include computerized record keeping, emergency preparedness, and equipment maintenance and appearance. Field demonstrations included hands-on exercises to teach manure calibration, utilization of GPS technology on manure application equipment, soil health and conservation concepts, compaction, and manure sampling. Since 2000, three classroom sessions, two commercial manure hauler field days, and four public field days have been held. Average scores (%) on each exam were: nutrient management laws (93.5), nitrogen management (85.3), phosphorus management (89.3), conservation practices (92.1), manure spreader calibration (92.9), and odor control (84.0). Fifty-three individuals have completed all certification requirements, 31 have completed the classroom phase only, 15 have completed the field day only, and four participated in both components, but have not scored high enough on the exams to earn certification. Over 60% of classroom participants listed themselves as commercial manure haulers or brokers. Approximately 150 people have attended the public field days, which were held to take advantage of the equipment and personnel available at each site. Public field day attendees consisted of local conservation district personnel, watershed specialists, interested public, farming community and agricultural business employees. We believe this voluntary approach helps improve environmental awareness and stewardship among individuals involved in commercial manure hauling.

Key Words: Nutrient Management, Manure, Environmental Stewardship

490 Using animal waste management plans on dairies to increase productivity and reduce environmental impacts. T.W. Downing*¹ and T.T. Leonnig², ¹*Oregon State University*, ²*Oregon Dairy Farmers Association.*

Animal waste management plans (AWMP) have been written for the dairy industry for years with limited adoption by the industry. Most plans use estimates for manure produced and yields removed to design the nutrient balance part of the waste plan. As concerns for water quality have increased, so has the need to demonstrate that the nutrients applied are equal to what is removed. A two year trial was conducted on a pasture based dairy in Oregon to determine if implementing the AWMP would improve productivity and/or reduce the dairy's environmental impacts. This challenge was especially complex because grazing animals are constantly harvesting forage and depositing manure. A traditional AWMP was written as a starting point for the project. Detailed records of grazing yields, manure applications, commercial fertilizer application, forage analysis, manure analysis and fall soil testing were maintained. Nitrogen was applied in each field at a level no higher than the documented nitrogen removal that year. Soil analyses were conducted on all

nineteen fields in the fall for nitrate and ammonium. At the end of year one, the AWMP was adjusted to account for the soil test results. The first year total nitrogen application per field ranged from 226 to 490 kg/ha averaging 382 ± 73 . Total dry matter yields ranged from 8761 to 20217 kg/ha averaging 15949 ± 2920 . Year 2 nitrogen applications per field ranged from 303 to 664 kg/ha averaging 531 ± 105 . Dry matter yields per hectare in year two ranged from 16623 to 25608 kg/ha averaging 21296 ± 2802 . Soil nitrate nitrogen measured in the first 30 cm averaged 111 ± 29.5 kg/ha, and ammonium nitrogen averaged 61.4 ± 19.3 kg/ha in year one. Nitrate nitrogen in year two averaged 59 ± 25.8 kg/ha and ammonium averaged 37 ± 11.1 kg/ha. Forage production increased in year two over twenty percent from the first year, and residue nitrogen left at the end of the growing season decreased by over 40 percent. Active nutrient management plans that are adjusted annually can have significant economic as well as environmental benefits.

Key Words: Waste management, Nutrient balance, Animal waste management plan

491 The development of an educational program to reduce the feeding of supplemental phosphorus on dairy farms in the Lake Champlain Basin. W. C. Emerich, K. W. Cotanch*, C. S. Ballard, E. D. Thomas, C. J. Sniffen, and P. Mandevbu, *W. H. Miner Agricultural Research Institute, Chazy, NY.*

The environmental threat of phosphorus (P) in the Lake Champlain Basin in Vermont and northeastern New York State has resulted in the development of a comprehensive management plan to reduce P inputs to Lake Champlain from dairy sources. Historically, P has been overfed in dairy rations due to the fact that dairy cattle only utilize a small proportion of the P they consume. Research has shown that lower levels of P may be fed to lactating cows without adversely affecting animal health and productivity. Although the feed industry is shifting toward lower P incorporation into dairy rations, educational efforts are needed for universal acceptance of the new P recommendations (NRC 2001: 0.32-0.38%). A survey of 11 dairy operations ranging from 80 to 2100 cows in the Lake Champlain basin was conducted to define current P feeding strategies in this region. The farms surveyed represented nine different feed companies. Seventy-three percent of the rations were formulated at levels higher than 0.38% P. In addition, analysis of TMRs mixed at the farms indicated that 81.8% had P levels higher than the nutritionist's formulation. Only 38% of the dairy producers surveyed believed reducing P levels in rations would result in reduced purchased feed cost. At Miner Institute, a comparison of milk yields and reproductive performance to P levels in the rations was made from 1997 to 2000. Over this time period, P was reduced from a high of 0.55% in 1997 to a low of 0.38% in 2000, while milk production increased from the 1997 rolling herd average of 22,189 on 92 cows to 2000 rolling herd average of 28,933 on 160 milking cows. Reproductive performance improved while ration P was reduced, indicating that 0.38% P was an acceptable level to maintain reproductive efficiency in the herd. By reducing ration P levels over this 4-year period, manure P levels were subsequently reduced from 0.79 to 0.59%. The economic as well as nutrient management benefits to reducing ration P in lactating and replacement rations should be emphasized to reduce the overfeeding of P in the dairy industry.

Key Words: Dairy cows, Phosphorus, Milk yield and reproductive performance

492 A decade of change in the U.S. dairy industry. K. E. Olson*¹, ¹*KEO Consulting.*

The tenth annual national survey of commercial dairy farms was completed in 2001. The survey includes farms that produce for fluid or manufacturing grade markets. It provides a tool for monitoring trends among producers. Substantial changes have occurred each year. Between July 2000 and July 2001 the number of dairy farms fell by 6,307, or 7.6%. It was the second largest percentage loss in the 10 years the survey has been conducted. Losses occurred in all regions, with the largest in the Midwest and Southeast with losses of 8.5% and 8.4%. The Northeast lost 6.2%, while the west was down 3.6%. A broad perspective of industry change over the ten years is provided in Table 1 where second quarter cow numbers, compiled by the National Agricultural Statistics Service (NASS) USDA are combined with herd data from the survey. Manufacturing grade herds declined dramatically over the ten years falling from 25,539 in 1992 to 9,614 in 2001, a drop of 62%. Grade A herds dropped 37% over the ten years. Rate of loss varied between regions with the largest in the Southeast and the least in the West.

Trends identified through this survey indicate the rapid rate of change that is occurring in the dairy industry. The changes impact not only producers, but also their communities, the industry infrastructure and business decisions that the support industry makes. While it is difficult to draw firm conclusions as to what has caused these trends, it is likely that they will continue to influence dairy policies in the future. Hopefully they will be helpful to the industry in developing sound policies and business strategies to meet the challenges of the future.

Table 1. Changes from 1992 to 2001

	1992			2001			Change (%)		
	Herds	Cows ¹ (x10 ³)	Cows/ Herd	Herds	Cows ¹ (x10 ³)	Cows/ Herd	Herds	Cows	Herd
South-east	14,165	1628	115	7485	1244	166	-47	-24	45
West	7450	2140	288	5218	2922	560	-30	37	95
North-east	29,785	1824	61	19,658	1650	84	-34	-10	37
Mid-west	80,135	4100	51	44,269	3308	75	-45	-19	46
US	131,535	9692	74	76,630	9124	119	-42	-6	62

¹Cow numbers from NASS Milk Production Reports

Key Words: Dairy Trends, Herds, Infrastructure

493 Results of a dairy herdsperson shortcourse conducted in the central valley of California. G. E. Higginbotham^{*1}, J. D. Robison², J. H. Kirk¹, J. W. Merriam¹, C. A. Collar¹, S. L. Berry¹, T. A. Shultz¹, and B. A. Reed¹, ¹*University of California Cooperative Extension*, ²*California State University-Fresno*.

University of California Cooperative Extension (UCCE) personnel partnered with faculty from California State University - Fresno (CSUF) to conduct an 18 hour training program for dairy farm employees. The shortcourse was developed in response to the desire of dairy owners to increase the skills of their employees. UCCE personnel consulted with dairy producers during planning meetings to identify training needs. The program consisted of classroom and on-farm teaching sessions at the CSUF dairy over three consecutive days. Session topics included raising replacement heifers, reproductive management, milking management, nutrition, hoof care, labor management, dairy facilities, herd health and DHIA records. Material was presented in English with Spanish interpreters present if needed. To provide adequate training, attendance was limited to 40 participants. A 10 question multiple choice test was given to participants at the beginning and conclusion of the shortcourse. The test covered various basic aspects of dairy management. Overall mean test score for the pre-test was 55.3% while the mean post-test score was 72.3%. Over 70% of the students improved their scores on the post-test. An evaluation completed by participants rated the shortcourse by course topic. All topic areas were rated as excellent to very good. Comments will be used to plan future offerings of the shortcourse. Additional short-courses are planned in the central valley of California due to the high level of interest among dairy owners and their employees.

Key Words: Dairy, Herdsperson, Training

494 The relationship between disease occurrence, feeding management and return over feed in Ontario dairy herds. C. J. McLaren^{*1}, K. D. Lissemore¹, K. E. Leslie¹, T. F. Duffield¹, D. F. Kelton¹, and B. Grexton², ¹*University of Guelph, Guelph, Canada*, ²*Ontario Dairy Herd Improvement Corporation*.

Dairy enterprises of most countries throughout the world are becoming increasingly concerned with global competition. Thus, it has become important to monitor the effect that management decisions have on profitability. The objective of this research is to examine the relationship between profitability as measured by Ontario Dairy Herd Corporation's (DHI) Return over Feed (ROF) index, and herd production characteristics (milk production, somatic cell count, and milk components), cow and herd-level disease occurrence (lameness, clinical ketosis, clinical mastitis, retained placenta, displaced abomasum and milk fever) and nutritional data (monensin use and forage particle size). Producers (n=104) were identified through the DHI ROF and Management Club groups. The ROF was calculated from the difference between milk revenue and feed cost each month. Percent dry matters were taken from provincial averages and individual cow dry matter intakes were calculated. These intakes were multiplied by fixed market prices to generate feed costs per cow per day. Revenue was calculated based on the Dairy Farmers of Ontario multiple component pricing formula for milk. There is a significant positive relationship between the Return

Over Feed values of the participants and their individual herd production levels (p<0.001). However, there are many factors such as disease and management that can affect the milk production of individual dairy cattle and the profitability of dairy herds. At the present, few studies have examined the complex interaction between management factors and profitability.

Study Quartiles and Averages	ROF/Cow (Dollars)	Herd Size	305Herd/ Cow (kg)
1st Quartile	11.43	47	9310
2nd Quartile	12.57	56	9509
3rd Quartile	13.46	48	9519
4th Quartile	15.24	52	10519
Study Average	12.77	62	9550
DHI Average	13.06a	54b	8300a

(a)-herd average for all(n=356) ROF and management club members
(b)-average for all DHI recorded herds (n=4329)

Key Words: Return Over Feed, Disease, Particle size

495 Evaluating 4-H dairy animals for a combination of type and genetic value for Net Merit dollars. A. J. Seykora^{*} and B. J. Heins, *University of Minnesota*.

The highlight of the year for many Minnesota 4-H dairy exhibitors is showing their animal at the State Fair at which time their animals are evaluated for show ring type and awarded a purple, blue, or red ribbon. It has long been recognized that the genetics for show ring type are not correlated with the genetics determining profitability for commercial milk production. In fact, many of the most popular A.I. bulls for siring show ring type are relatively poor for PTA Net Merit dollars. Genetic Values for Net Merit dollars (GV\$) were calculated by summing the sire and dam PTAs for Net Merit dollars for heifers and young cows without USDA PTAs. GV\$ for cows with published PTAs were calculated by multiplying their PTAs Net Merit dollar values by two. GV\$ were available on 141 of the 148 registered Holsteins shown. Their GV\$ averaged \$231 with a range of -\$728 to \$1228. GV\$ were available for 45 of the 160 grade Holsteins with an average of \$371 and a range of -\$220 to \$822. GV\$ were available for 27 of the 39 Jerseys shown with an average of -\$106 and a range of -\$958 to \$420. After the animals in a class were judged for type and awards presented, those with GV\$ values remained in the ring and were reevaluated considering functional type and GV\$. First through tenth place ribbons as well as champion ribbons and plaques were awarded. Primary purpose for the initiation of the Total Merit class was to encourage 4-H members to select higher PTA Net Merit dollar bulls when doing sire selection.

Key Words: Net merit dollars, 4-H, Show ring

496 Evaluation of back fat as a performance and carcass quality indicator among beef cattle sire breeds. T. A. Gardner^{*1}, E. M. Willard, A. L. Bryant, W. B. McKinley, and A. R. Williams, ¹*Mississippi State University*.

The objective of the Mississippi State University Farm to Feedlot program was to evaluate correlation between back fat thickness (BF) with performance and carcass quality characteristics of calves produced in the state of Mississippi. Steers (n=3040) were grouped by breed composition into American Breed (AB) (n = 625), European Breed (EB) (n = 1058), and British Breed (BB) (n = 1357). Previous analysis of this data determined that sire breed significantly influenced all carcass traits with the exception of hot carcass weight (HCWT). Initial results of the current study indicated an overall negative correlation (P<.0001) between BF in contrast with REA, weight per day of age (WDA), and Quality Grade (QG). BF was positively correlated (P<.0001) with Yield Grade (YG), Final Weight (FWT), Final Test Gain (FTG), Final Average Daily Gain (FADG), HCWT, and marbling score (MS). Analysis between breed groups indicated no significant differences (P<.1) among REA, WDA, QG, FWT, FTG, FADG, HCWT, and MS. However, AB and EB were significantly different (P<.1) with respect to BF and YG correlation. Mississippi State University Farm to Feedlot was a six-year study in which various statistical analyses of performance and carcass quality data were analyzed to promote the retained ownership program as a marketing alternative.

Key Words: Carcass, Beef Cattle, Feedlot

497 A web-based, economic selection index tool for terminal Charolais sires. W. O. Herring^{*1}, M. D. MacNeil², and R. E. Williams³, ¹University of Florida, North Florida Research and Education Center, Marianna, ²USDA-ARS, Fort Keogh Livestock and Range Laboratory, Miles City, MT, ³American-International Charolais Association, Kansas City, MO.

Beef breed associations compute EPD for production and carcass traits. However, there is a lack of guidance for identifying sires that produce the most profitable progeny in a specified production system. Therefore, a web-based tool that uses economic selection index theory combined with EPD was developed for the American-International Charolais Association. Potential users include commercial cattlemen contemplating using Charolais sires, Charolais seedstock producers, or animal science students. The user provides information describing their terminal beef system including costs, revenues and production variables. These variables are then passed to a modified version of SIMUMATE, a computer model used to estimate net returns for beef production systems. Rel-

ative economic values are defined as the marginal change in expected profit per progeny from increasing a particular trait by one unit. This derivation approximates the partial derivative of profit with respect to each parameter. The software estimates relative economic values for birth weight, weaning weight, post-weaning average daily gain, marbling score and yield grade. The EPD for birth weight, weaning weight, yearling weight, fat thickness, marbling score, ribeye area and carcass weight are currently computed for many Charolais sires. A linear transformation of the weaning and yearling weight EPD is used to calculate the EPD for post-weaning ADG. Another transformation is used to calculate a yield grade EPD from fat thickness, ribeye area and carcass weight EPD. Thereafter, the EPD and relative economic values are combined to rank Charolais sires based upon the economic selection index. This tool should provide valuable assistance to users of Charolais bulls attempting to maximize profit in their beef production system.

Key Words: beef, selection index, profit

International Animal Agriculture

498 Development of a sustainable sheep production system for the Mexican tropics. P. Fajersson^{*}, S. Hernandez, E. Santacruz, A. Alonso, and E. Ocaña, *Colegio de Postgraduados, Campus Veracruz.*

Mexico imports 54% of the mutton consumed. Interest exist in expanding sheep production in the tropics. The common extensive grazing systems without supplementation are neither competitive nor sustainable. Intensive and sustainable production systems have not been developed. The objective of this study is to improve tropical sheep production through management, genetic and nutritional strategies, minimizing the use of resources outside the ranch and without damage to the environment. Campus Veracruz is located in the humid tropics with 1200 mm annual rainfall (May-October) and a temperature of 27.8° C. 104 Tabasco ewes and 3 Tabasco and 3 Katahdin rams are managed on 7 ha of African Stargrass in a semi-confined system with 8 h grazing, cut Taiwan grass and minerals. Additional supplementation, from breeding through lactation, includes Gliricidia Sepium, Taiwan silage, corn sprouts and multi-nutritional blocks. A rotational grazing system with Leaders and Followers are being used. The ewes are subjected to 10 days flushing, synchronization using the male-effect and a 1 mo breeding period using controlled mounts. A comparison is made with 52 of the ewes bred to Tabasco rams and 52 bred to Katahdin rams to evaluate reproductive performance of the ewes and growth rate and carcass characteristics of purebred and crossbred lambs. Results of the first of three cycles were: 102 (97%) pregnant ewes gave birth to 149 lambs. Restricted suckling and supplementation were used until weaning at 3 mo of age. No differences ($P>0.05$) were observed between birth and weaning weights of the purebred lambs and those crossbred with Katahdin (3.0 and 3.1 Kg) and (14.5 and 14.6 Kg). Breed differences ($P<0.05$) were observed with regard to twin births, which were 28.8% for purebred and 57.7 % for crossbred lambs. Death of twin lambs caused the 8.1% mortality until weaning. At weaning, the lambs were sold for 25 cents/kg, a very good price, followed by slaughter at 5 mo of age and 35 kg. In conclusion, results from the first cycle indicate that the sheep production system developed is viable and feasible for producers and compares favorably to extensive systems currently common in the region.

Key Words: sheep, sustainable system, tropics

499 In vitro gas production and in situ degradability of four native species commonly consumed by grazing goats in North Mexico. M.A. Cerrillo^{*1}, O.O. Lopez¹, and R.A.S. Juarez¹, *Universidad Juarez del Estado de Durango. Durango, Dgo. Mexico.*

The objective of this study was to determine *in vitro* gas production and *in situ* degradability from huizache (*Acacia schaffnerii*), encino blanco (*Quercus grisea*), encino colorado (*Quercus eduardii*) and nopal (*Opuntia spp*). To measure *in vitro* gas production, 200 mg of samples were incubated in a mixed suspension of rumen contents obtained from three rumen cannulated goats; whereas *in situ* degradability was estimated in three rumen cannulated sheep. Both animal species were fed alfalfa hay. The gas volumes and *in situ* values were recorded at 0, 3, 6, 12, 24, 48, 72 and 96h after incubation. The *Opuntia* species produced more gas

and was degraded in a higher proportion than the other forages. The insoluble but fermentable fraction (b) of *Opuntia* was 51.7 ml of gas, the potential production (a + b) was of 67 ml and the fractional rate (c) was 11%/h. The degradability of b fraction of *Opuntia* was 35% and the a + b fraction was 91.5%; whereas the highest value for c was for the *Acacia* species (6.5%/h). The *Q. eduardii* was the forage with the lowest gas production (b = 27.1 ml and a + b = 32.5 ml). The *Acacia* was the forage that presented the lowest degradability (b = 14.4% and a + b = 36.9%). The high values of c in gas production and potential degradability of *Opuntia spp* may indicate the high energy content of this species and it could reflect an important nutritional role of the *Opuntia* species in the feeding of grazing goats, particularly during the dry season.

Key Words: Goats, *In vitro* gas production, *In situ* degradability

500 Release of urea from the mammary gland of lactating cows during a humid tropical summer. C. H. Lu¹, C. J. Chang^{*1}, P. N. Lee¹, C. P. Wu², and X. Zhao³, ¹National Chung Hsing University, Taichung, Taiwan, ²National Chia Yi University, Chia Yi, Taiwan, ³McGill University, Ste-Anne-de-Bellevue, Canada.

Lactation performance of 6 primiparous Holstein cows, average DIM 90 days, during a humid tropical summer was characterized with selected milk traits and arteriovenous concentration (A-V) differences of some metabolites across the mammary gland. In the 3-month duration, the afternoon humidex value ranged from 44.6 to 53.5. Meanwhile, the rectal temperature of cow varied ($P<0.05$) from the highest 40.02 °C in mid summer to 39.36 and 38.26 °C for the beginning and end of summer, respectively. Milk yield declined from 29.2 to 22.2 kg/d in the first month of summer but remained indifference thereafter. In the course of summer, lactose content decreased linearly ($P<0.05$) from 4.69 to 4.38 % and activity of milk N-acetylglucosaminidase (NAGase) increased linearly ($P<0.05$) for more than two folds, overall. A-V difference across the mammary gland indicated net uptake of glucose and net release of urea. The release of urea from mammary gland increased ($P<0.05$) with advancing summer from 1.54 to 7.76 mg/dl. It is suggested that experimental cows suffered from different extent of heat stress along the summer in the study area, as implied from rectal temperature. Decrease in lactose content and increase in NAGase activity indicate deterioration of mammary function. This deterioration is hypothesized to be initiated by elevated body temperature and become irreversible after mid summer. Increased urea release from mammary gland along the summer season implies accelerated amino acid turnover and decreased efficiency of protein utilization in the course of heat stress-induced malfunction of mammary gland. In perspective, increasing A-V difference of urea can be used for prognosis of suboptimal function of mammary gland.

Key Words: Heat stress, Urea, Mammary gland

501 Withdrawn. . .

502 Characterization of commercial feedlots in Nuevo León, México. H. Morales-Treviño, E. Gutierrez-Ornelas, H. Bernal-Barragan, J. Colin-Negrete, and R. Gonzalez-Gonzalez, *Universidad Autonoma de Nuevo Leon, Marín, Nuevo Leon, Mexico.*

Seven feedlots were enrolled in a descriptive survey during 1997 at Nuevo Leon, Mexico. The purpose of the survey was to get information about feeding practices, animal performance, type of animals, management and other factors may affect competitiveness. Feedlots had 73% of their full capacity (61000 animals) and the state of Nuevo Leon had facilities to feed 200000 animals. Feedlots fed 81% heifers, 11% bulls and 8% steers during an average feeding period of 120 d (90 # 165 d). Animals started at age of 16 months (8 to 26 months) with an initial body weight of 240 kg (160 to 320 kg). Slaughter weight was 400 to 420 kg for males and 360 to 380 kg for heifers. Most of the animals fed were crosses of Brahman X Brown Swiss. There were other animals crossed with European breeds and synthetic breeds such as Brangus and Beefmaster. Feedstuffs more frequently used were sorghum grain, cottonseed meal, whole cottonseed, protein supplement, molasses and sorghum or grass hay. Some feedlots included several byproducts such as poultry litter, poultry meal, rice grain polished, citrus pulp, bakery waste, sorghum straw and soybean hulls. Use of feed additives included sulfamethacin, chlorotetracyclin, oxitetracyclin, monensin, lasalocid, melengestrol acetate, sodium bicarbonate, vitamin E and as newly introduced product zilpaterol. One out of seven feedlots was using steam flaked grains, but for the remaining feedlots grinding was the current grain processing technique. None of the surveyed feedlots had an established feed quality control system. Total mixed rations were usually fed two to three times per day. Feeding systems involved 2 to 4 rations depending on the length of the feeding period. There was a great variability in the length (7 to 30 d) of feeding step up diets according with the initial weight of the animals and the feeding strategy of each operation. Finishing diets contained an amount of forage that went from 12 to 25%. Average daily gain, ADFI and ADG/ADFI were 1.3 kg, 9.5 kg and 0.13, respectively. There was not an established feeding system for the surveyed feedlots in Nuevo Leon since high variation existed in the number and type of diets, type of animals as well as source and quality of feedstuffs.

Key Words: Feeding System, Feedlot, Mexico

503 Perceptions and value of international education in the Animal Science curriculum. N. Forsberg^{*1}, J. Taur¹, and H. Chesbrough¹, ¹*Oregon State University.*

Goals were to determine the status of international (INT) education (ED) within Departments of Animal Science (AS) across Canada and the US, to survey perceptions of internationalization by leaders of departments, to identify barriers to INT ED and to evaluate relationships between INT ED and various criteria of student "success" (i.e., admission to veterinary and graduate schools and starting salaries). A survey was mailed to 124 department heads of AS and 78 of these were returned (63%). Sixty % offered INT opportunities to their students. The most common forms of INT ED included advising (56%), INT internships (34%), INT content in core AS classes (29%), scholarships for INT activities (20%) and internationalization of the mission statement (19%). Using a score of 1 (highly agree) through to 5 (strongly disagree), Heads agreed that "INT experiences enhance maturity and other personal attributes of students" (Score =1.57) and that "demand for graduates who understand INT issues was increasing" (Score = 1.80). Barriers to participation in INT programs were financial and lack of administrative and institutional support. In universities with enrollments over 15000, significant associations were detected between measures of internationalization and student outcomes. Significant associations existed between 1) the ratio of INT students/total students and 2) experience in INT study/research and % of seniors attending graduate school (R= .62 and .51, respectively). A significant association was also found between participation in INT study/research and starting salary (R=.51). It is worthwhile considering INT ED offerings within departments as means to broaden education and, possibly, to enhance student success.

Key Words: international, education, survey

504 Assessing the sustainability of animal traction among Maasai agro-pastoralists in Monduli District, Tanzania. A.B. Conroy^{*}, R.T. Eckert, and M.L. Becker, *University of New Hampshire, Durham, NH/USA.*

A case study using rapid rural appraisal (RRA) techniques was developed to assess the sustainability of draft oxen and donkey use in 10 villages and the corresponding 27 sub-villages in Southern Monduli District. Using semi-structured interviews, the heads of 130 agro-pastoral farmsteads were selected to represent the full range ecological and economic strata in the Kisongo section of Monduli district. The locations of each farmstead were documented using a hand held GPS. Interviewees described and displayed land use strategies, livestock and draft animal production systems, and their impact on the local economy and environment. This qualitative data was evaluated using a software program called NVivo, where the data were coded and organized around specific themes of sustainability. Traditionally pastoralists, the Maasai people have made a rapid transition to a more agropastoral lifestyle in the last 20 years. Livestock and crop growing has become more intensive, as farmsteads used the draft animals to grow and manage maize and beans on agricultural plots averaging 12 ha in size. Draft animals have generated great short term economic benefits, however the adoption of draft animals has had a profound affect on the environment and availability of common grazing lands for other livestock. The most sensitive indicators of sustainability developed in this study were the geography, the presence of livestock, especially cattle, the local perception and government policies toward animal traction, the prevalence of farming in marginal areas, the degree of soil erosion, adequate and improving crop yields, system of land tenure, availability of fertilizer, quality s

Key Words: Maasai, Animal Traction, Sustainability

505 A livestock based child nutrition project in Malawi. S. Patten^{*1}, A. Woldegebriel², G. Kanyama-Phiri³, B. Mtimuni³, H. Swartz², R. Savage², R. Phoya³, L. Kamwanja³, F. Chelera³, and W. Boylan⁴, ¹*Macalester College*, ²*Lincoln University*, ³*University of Malawi, Bunda College of Agriculture*, ⁴*University of Minnesota.*

The purpose of this study was to evaluate the potential benefits of goats milk and soybean flour as an effective component of the indigenous weaning food for children. The study group consisted of 200 children between the ages of 6 months-5 years from 4 villages in central Malawi. There was no control group instead; composite national data on the nutritional status of children was used for comparison. Women who met the selection criteria and volunteered to participate in the project received a doe, 5-10 kg of improved soybean seed, and legume seedlings. Participants were required to attend a series of demonstrations on goat management, health and husbandry, milking and milk utilization, food safety and food preparation. The women were also required to return the first-born kid and an equivalent of harvested soybean seeds to the project. Household baseline surveys indicated that 35.4% of the children under five were underweight for age and 57.7% were stunted. Weight and other growth parameters used to assess the effectiveness of the nutrition intervention project reflected the significant contribution of the project to the physical development of the children and to their reduced risk from life-threatening infectious diseases. The project also empowered women through formation of village-based committees that managed the day-to-day activities of the project. Almost 98% of the participants returned the kid and quantity of seed to the project. The introduction of the project into the villages, in conjunction with the training programs given to women, made the project locally sustainable and a highly valued approach to alleviating the problem of chronic child malnutrition. Presently NGOs working in Malawi and public-sector institutions that cater for malnourished children, had purchased animals from the villages in order to implement variations of the project in other settings. The cash returns from the sales had also improved the economic security of some families.

Key Words: Children, Malnutrition, Milk

Meat Science and Muscle Biology

Meat Quality

506 Environmental effects on pig performance, meat quality, and muscle characteristics. J. G. Gentry*, J. J. McGlone, M. F. Miller, and J. R. Blanton, Jr., *Texas Tech University, Lubbock, TX.*

The objective of this experiment was to determine the effect of diverse production systems that cause increased exercise on pig performance, muscle characteristics, and their relation to pork quality measures. Birth and rearing conditions were evaluated ($n = 48$ barrows). Pigs were farrowed either in indoor crates or outdoor huts. At weaning, indoor-born and outdoor-born pigs were randomly allotted to indoor (concrete-slatted flooring, $1.2 \text{ m}^2/\text{pig}$) or outdoor (alfalfa pasture, $212 \text{ m}^2/\text{pig}$) pens for finishing. Pigs were slaughtered using commercial practices. Muscle samples were removed within 1 h postmortem from the longissimus lumborum (LL) and the semimembranosus (SM) and stained histochemically to identify type I, IIA, and IIB/X muscle fiber types. Loins were collected from each carcass, aged for 14 d, and evaluated for color, sensory panel attributes, and Warner-Bratzler shear force (WBS). Pigs born outdoors had a greater ADG at d 28, 56, and 112 after weaning ($P < 0.05$) than pigs born indoors. Pigs reared outdoors had a higher ADG (2.2 vs $1.9 \pm 0.11 \text{ kg/d}$, $P = 0.01$), but also a higher Gain:Feed (0.41 vs 0.37 ± 0.04 ; $P = 0.01$) than pigs reared indoors. Pigs reared outdoors were fatter (2.4 vs $2.1 \pm 0.04 \text{ cm}$; $P = 0.01$) at the last rib and had loins with a higher (4.5 vs 3.4 ± 0.4 ; $P = 0.02$) a^* values than pigs reared indoors. No differences were detected in sensory traits or WBS values. Birth by rearing environment interactions were not significant for most measures. Pigs reared outdoors had a higher ($P < 0.01$) percentage of IIA fibers (LL: 16.4 vs $12.4 \pm 0.9\%$; SM: 23.6 vs $15.7 \pm 1.2\%$) and a lower ($P < 0.05$) percentage of IIB/X fibers (LL: 64.2 vs $68.3 \pm 1.2\%$; SM: 57.9 vs $67.3 \pm 0.9\%$) than pigs reared indoors. Pigs reared outdoors had a smaller cross sectional area for type I (3516 vs $4187 \pm 130 \mu\text{m}^2$; $P = 0.003$) and IIA (4237 vs $5159 \pm 271 \mu\text{m}^2$; $P = 0.02$) fibers in the SM than did pigs reared indoors. Production systems that include increased exercise levels or other features of an outdoor system may alter the size and type of individual muscle fibers which impact pork quality measures such as color.

Key Words: Pigs, Environment, Meat quality

507 Growth and meat quality of finishing hogs supplemented creatine monohydrate and a high glycemic carbohydrate 30 d pre-harvest. C. A. Stahl^{*1}, M. L. Linville¹, G. K. Rentfrow¹, G. L. Allee¹, and E. P. Berg¹, ¹*University of Missouri-Columbia.*

Crossbred market barrows ($n = 32$; 75 kg) were blocked by weight and randomly allotted to one of eight pens (4 replications per pen, 2 pens per treatment) within a self-ventilated finishing facility. A 7 d acclimation period was provided prior to the initiation of the 30 d feeding trial. All animals were provided *ad libitum* access to both water and feed via a water nipple and a single two-holed feeder, respectively. Test diets included of a control (basal diet), and three treatment groups consisting of creatine monohydrate (CMH; basal diet supplemented with 0.55% creatine monohydrate), dextrose (DEXT; basal diet supplemented with 2.1% dextrose), and CMH + DEXT (COMBO; basal diet supplemented with 0.55% CMH and 2.1% dextrose). Formulation of those supplements added to the basal diet were calculated estimating 20 g per pig per d CMH, 75g per pig per d dextrose, and the combination of both. Average daily gain on test (control=0.75, CMH=0.77, DEXT=0.73, and COMBO=0.74 kg/d), fat depth (control=2.3, CMH=2.6, DEXT=2.6, and COMBO=2.2 cm), and hot carcass weight (control=79.3, CMH=76.7, DEXT=77.4, and COMBO=78.6 kg) were not affected by dietary treatment. A strong linear trend ($P = 0.07$) was observed for loin muscle area (LMA) gain on test as determined via real-time ultrasound comparisons of d 0 and d 30 measurements at the 10th rib. COMBO pigs had a greater ($P < 0.05$) LMA increase during the 30 d feeding period (COMBO = 4.24 cm^2 vs Control = 1.0 cm^2 increase). No significant differences ($P > 0.05$) in pork quality were detected among treatment diets.

Key Words: Pork, Creatine, Carbohydrate

508 The effect of alpha lipoic acid on shelf life and Warner-Bratzler shear force values of fresh pork. T. B. Schmidt*, C. A. Stahl, D. L. McNamara, G. K. Rentfrow, and E. P. Berg, *University of Missouri.*

The objective of this trial was to determine the affects of supplemental alpha lipoic acid (ALA) to finishing swine from 95 to 117 kg BW on the shelf stability and palatability of fresh pork. Fifty-four commercial hybrid pigs were randomly allotted to one of three treatments: a control group compared to supplemental ALA at 8 (ALA8) or 16 (ALA16) mg per kg of final market weight (117 kg). Upon reaching 117 kg BW, pigs were delivered in two groups to a commercial packing plant that utilizes CO_2 stunning. All pigs were humanely harvested and carcasses were blast chilled for 15 minutes, then chilled for 20 h at 4°C . Hams and loins were collected on-line, wrapped, boxed, and delivered the same day to the University of Missouri Meats lab. Upon arrival, the semimembranosus (SM) was removed from the ham and a 2.54 cm thick steak was removed from both the SM and the longissimus (LD) for use in a 7 d simulated retail display. Chops were evaluated on day 0, 1, 4, and 7 for CIE L^* , a^* , and b^* values. An additional loin piece was weighed and stored for 20 days at 2°C to simulate domestic distribution. After 20 d storage, loin pieces were removed from their packaging, weighed, and chops cut, packaged and evaluated after 7 d of simulated retail display. Additional LD chops were evaluated for Warner-Bratzler shear force (WBS) and pH at 1 and 20 d postmortem. Treatment had no affect ($P > 0.05$) on WBS or pH. A linear decrease ($P = 0.03$) was detected for L^* values recorded on the posterior end of loins measured 1 d postmortem, suggesting that as ALA dose increased, L^* decreased, however, a linear trend ($P = 0.097$) observed at the blade end revealed L^* -values increased with ALA dose. There was a day affect for shelf life, however, treatment*day was not significant for L^* , a^* , b^* , chroma (color saturation), or hue angle (true red). SM purge loss increased with ALA dose in a linear trend ($P = 0.047$). The antioxidant affects of ALA fed at 8 or 16 mg per kg BW did not result in improved fresh pork quality.

Key Words: Shelf Life, Lipoic acid, Pork Quality

509 The affects of alpha-lipoic acid on beef longissimus bloom time. G. Rentfrow^{*1}, M.L. Linville¹, C.A. Stahl¹, K.C. Olson¹, and E.P. Berg¹, ¹*University of Missouri.*

The objective of this study was to evaluate the influence of the unique antioxidant alpha-lipoic acid (ALA) on strip loin steak bloom time. Thirty-six Simmental steers were supplemented with 0 (Con), 8 (1X), 16 (2X), or 24 (3X) mg/kg BW for 21 d prior to harvest. ALA was mixed with a paraffin carrier as a rumen protectant and top-dressed over a standard finishing diet. Steers were humanely harvested at the University of Missouri abattoir. After a 24 h chill (4°C), the right longissimus lumborum was removed from each carcass, one 2.54-cm thick steak was removed from the anterior portion, and color measurements (CIE L^* , a^* , b^*) were taken immediately with a Hunter Lab Miniscan XE Plus standardized to a black and white tile. Color measurements were taken every three minutes for a 93-minute period; hue angle (true red) and chroma (color saturation) were then calculated. The 3X treatment had the highest ($P < 0.0001$) L^* value (Con=30.5, 1X=30.4, 2X=30.9, 3X=34.5), while the 2X treatment had the lowest ($P < 0.0001$) hue angle (Con=41.1, 1X=41.3, 2X=40.8, 3X=41.5). However, ALA had no significant affect ($P > 0.05$) on a^* values, b^* values, or chroma. During bloom time the L^* values did not significantly change ($P > 0.05$) over the 93-minute period. The a^* values increased for six minutes, then leveled after nine minutes ($P < 0.0001$). A similar trend was followed for b^* values, hue angle, and chroma which increased for nine minutes, then leveled after twelve minutes ($P < 0.0001$). There was no significant treatment by bloom time interaction ($P > 0.05$).

Key Words: ALA, bloom time

510 Adaptations in muscle fiber characteristics and effects on meat quality traits induced by rearing conditions in pigs. G. Bee*, Swiss Federal Research Station for Animal Production.

The aim of this research was to determine whether outdoor free-range versus indoor confinement rearing affects meat quality and muscle fiber characteristics in pigs. This study used 12 gilts and 12 barrows from six Large White litters. Each litter was equally split between rearing indoors (I) in individual pens (2.56 m²) and rearing outdoors (O) from December to March on a fallow arable plot of land (9200 m²). Both groups had free access to the same grower-finisher diet that met Swiss nutrient requirement estimates. At slaughter, samples from the longissimus (LM), the light (STL) and dark (STD) parts of the semitendinosus and the rectus femoris (RF) were obtained from the right side of all pigs. Muscle fibers were stained and classified as SO, FOG, or FG. Fiber area and distribution were determined for each muscle. In addition to carcass characteristics, pH_i, pH_u, Minolta L*, a*, b* values, drip loss, glycolytic potential (GP), and i.m. fat of each muscle were assessed. The O-pigs had lower ADG (795 vs 938 g) and leaner carcasses (58.4 vs 56.2%; $P < 0.01$). Rearing conditions did not affect i.m. fat content of the ST, but i.m. fat was lower in the LM (19 vs 2.4%) and higher in the RF (1.6 vs 1.4%) of O-pigs ($P < 0.01$). The GP of all muscles was higher ($P < 0.07$) and pH_u of all muscles was lower ($P < 0.01$) in the O-pigs. In the LM of the O-pigs, but not in the other muscles, L* values (47.2 vs 48.8) were lower and drip losses (2.1 vs 1.8%) were higher ($P < 0.01$). The SO fibers of the LM (2430 vs 2936 μm^2) and STL (2703 vs 3558 μm^2) tended to be smaller ($P < 0.09$) in the O-pigs compared to I-pigs. Rearing conditions had little effect ($P > 0.05$) on STD and RF fiber area. In the O-pigs, LM and RF had more FOG (LM: 26.0 vs 20.8%; RF: 39.7 vs 32.0%) and fewer FG (LM: 62.3 vs 68.4%; RF: 56.2 vs 62.9%) fibers, while STL had fewer SO (3.3 vs 6.6%) fibers compared to I-pigs ($P < 0.05$). SO, FOG, and FG fiber distributions were correlated with L* (-0.29, -0.38, and 0.41), a* (0.37, 0.44, and -0.50), b* (0.17, 0.29, and -0.28), and GP (-0.36, -0.34, and 0.42). These results suggest rearing pigs outdoors increases aerobic capacity of glycolytic muscles, but has little concomitant influence on meat quality traits.

Key Words: Pigs, Muscle fibres, Meat quality

511 Effect of sex and slaughter weight on performance and carcass quality of pigs. J. Peinado¹, M. Cortes¹, A. Fuentetaja², R. Lázaro^{*3}, and P. Medel¹, ¹Imasde Agropecuaria, S.L., Madrid, Spain, ²Copese, S.A., Segovia, Spain, ³Universidad Politécnica de Madrid, Spain.

A total of 240 Pietrain*Large White x Landrace*Large White pigs, 60.5 \pm 6.2 kg of initial BW, were used to study the influence of slaughter weight and sex on productive performance and carcass quality. There were six treatments arranged factorially, with three sexes (castrated males, castrated females, and entire females) and two slaughter weight (114 and 122 kg). Males were castrated at birth and females at 35 kg BW. Each treatment was replicated four times and ten pigs housed together formed the experimental unit. All the animals received *ad libitum* access to a common feeding program of three diets based on barley, wheat, and soybean meal with 2,295 kcal NE/kg and 9.7 g/kg lysine from 60 to 75 kg, 2,415 kcal NE/kg and 7.1 g/kg lysine from 75 to 85 kg, and 2,415 kcal NE/kg and 6.7 g/kg lysine from 85 kg to slaughter weight. Castrated pigs ate more (2,484 vs 2,189 g/d; $P < 0.05$) and grew faster (746 vs 675 g/d; $P < 0.05$) than entire females, but no sex effect was found for feed conversion. Carcass dressed yield was not affected by treatment. Castrated pigs had more shoulder and less loin yield than entire females (15.2 vs 14.8% and 6.88 vs 7.26%, respectively; $P < 0.05$) but ham yield was not affected by sex. Castrated pigs had more P₂ and *gluteus medius* fat than entire females (24.54 vs 21.54 mm, and 21.14 vs 18.45 mm, respectively; $P < 0.05$). Fat thickness at the *gluteus medius* was greater in pigs slaughtered at 122 kg than in pigs slaughtered at 114 kg (20.9 vs 19.5 mm; $P < 0.05$). When slaughter weight increased from 114 to 122 kg the percentage of entire females showing a fat thickness greater than 20 mm at the *gluteus medius* increased from 24 to 46% ($P < 0.05$) but no differences were observed for castrated males or females. It was concluded that castrating females and increasing final weight improve carcass and meat quality of pigs destined to the industry for cured products.

Key Words: Fattening pigs, Performance, Carcass quality

512 Effect of breed, sex and final weight on performance and carcass quality of lambs. J. Peinado¹, P. De Miguel², G.G. Mateos^{*3}, and P. Medel¹, ¹Imasde Agropecuaria, S.L., Madrid, Spain, ²Grupo Carnico Magnus, S.A., Zamora, Spain, ³Universidad Politécnica de Madrid, Spain.

A total of 480 lambs, 16.2 \pm 0.6 kg of initial BW, were used to study the influence of breed, sex, and slaughter weight on productive performance and carcass quality under intensive feeding conditions. There were eight treatments arranged factorially with two breeds (Castellana vs Merino), two sexes (female vs male), and two slaughter weights (26 vs 31 kg). Each treatment was replicated six times and ten lambs housed together formed the experimental unit. All the animals received a common feeding program of two diets based on barley, wheat, and soybean meal with 1,703 kcal NE/kg and 18.3% CP for the first 10 d of trial, and 1,703 kcal NE/kg and 16.7% CP thereafter. Lambs were supplied *ad libitum* access to wheat straw. No significant differences were found between breeds for any of the productive parameters studied. Males ate more (1,018 vs 978 g/d; $P < 0.01$), grew faster (319 vs 264 g/d; $P < 0.01$), and had better feed conversion (3.20 vs 3.72 g/g; $P < 0.01$) than females. Lambs slaughtered at 31 kg ate more and grew faster than lambs slaughtered at 26 kg, but feed conversion was impaired (1,042 vs 953 g/d; 298 vs 285 g/d, and 3.53 vs 3.39 g/g for feed intake, daily gain, and feed conversion; $P < 0.05$). Carcass dressed yield was greater for Merino than for Castellano lambs (48.0 vs 46.7%; $P < 0.01$), for females than for males (47.7 vs 47.0%; $P < 0.01$), and for lambs slaughtered at 31 kg than for lambs slaughtered at 26 kg (47.5 vs 47.1%; $P = 0.05$). *Longissimus* depth at the thirteenth rib was greater for Merino than for Castellano lambs (1.39 vs 1.15 cm; $P < 0.01$) and for lambs slaughtered at 31 kg than for lambs slaughtered at 26 kg (1.32 vs 1.22 cm; $P < 0.05$). Fat thickness at the thirteenth rib was greater in females than in males (2.94 vs 2.31 mm; $P < 0.01$) and in 31 kg than in 26 kg BW lambs (3.04 vs 2.21 mm; $P < 0.01$). It was concluded that sex, breed, and final weight have to be considered when attention is given to carcass quality in fattening lambs under intensive feeding conditions.

Key Words: Lambs, Performance, Carcass quality

513 Relationship of live animal performance to meat color and carcass characteristics of milk-fed veal calves. D.A. Vermeire^{*1} and W.R. Henning², ¹Nouriche Nutrition Ltd., ²Pennsylvania State University.

Meat color and carcass muscling are important determinants of value of veal carcasses. The objective of this study was to determine the relationship between performance of veal calves and meat color and carcass characteristics in order to more effectively manage milk-fed veal calves. Male Holstein calves (n=164) were fed for 129 d, as milk-fed veal. Calves were weighed on d 1, 42, 89, and 129 at the farm, and blood samples collected during wk 1, 2, 4, 6, 8, 10, 12, 14, 16, and 18. Pearson correlations and linear regressions between variables were computed using linear models of Statistix version 7.0. Live weight \pm SE for d 1, 42, 89, and 129 were 43.15 \pm 0.30, 76.31 \pm 0.43, 145.58 \pm 0.98, and 212.77 \pm 1.47 kg, respectively. Gain:feed⁻¹ for d 1 to 42, 42 to 89, and 89 to 129 were 0.757, 0.629, and 0.548, respectively. Hot carcass weight averaged 128.41 \pm 0.97 kg with length of 96.33 \pm 0.20 cm. *Longissimus* area (REA) averaged 49.67 \pm 0.44 cm². Live weight on d 1 was poorly correlated with d 1 to 129 live weight gain (0.007, $P > 0.35$), REA (0.041, $P > 0.60$), yield (-0.040, $P > 0.60$), packer grade (-0.054, $P > 0.50$), or color of flank, breast, or *longissimus* (< 0.10 , $P > 0.30$). Live weight gain, d 1 to 129, was positively correlated with yield (0.345, $P < 0.001$), REA (0.515, $P < 0.001$), packer grade (-0.400, $P < 0.001$), and carcass color as measured by the Minolta chromameter for cold flank (a*, 0.191, $P < 0.02$, L*, -0.161, $P = 0.053$), *longissimus* (a*, 0.314, $P < 0.001$, b*, 0.367, $P < 0.001$). Correlation of live weight gain with cold flank b* and cold *longissimus* L* were not significant ($P > 0.05$). Hematocrit and hemoglobin were poorly correlated with live weight gain with the exception of blood samples collected during wk 10. REA was poorly correlated with blood chemistry variables measured. We conclude that carcass REA and yield are more closely related to live weight gain, rather than initial calf weight. Live weight and live weight gain were not highly correlated with carcass color. Blood variables related to iron status were not predictive of animal performance or carcass weight, length, or REA.

Key Words: Veal, Meat Color, Carcass Characteristics

514 Relationship of blood chemistry to meat color of milk-fed veal calves. D.A. Vermeire*¹ and W.R. Henning², ¹Nouriche Nutrition Ltd., ²Pennsylvania State University.

Color of veal meat is a major determinant of value received by veal packers. Standard veal industry practice in the U.S. is to collect blood samples from each calf during weeks 4, 6, or 8 to predict carcass color, then sample approximately 10 percent of groups every 2 to 4 weeks. The objective of this study was to determine the relationship between blood chemistry of veal calves during the starting, growing, and finishing periods and meat color of veal carcass in order to more effectively manage milk-fed veal calves. Male Holstein calves (n=164) were fed for 129 d as milk-fed veal. Calves arrived at veal facility when they were approximately 3-6 days old. Blood samples were collected during weeks 1, 2, 4, 6, 8, 10, 12, 14, 16, and 18 via jugular veinipuncture and analyzed for hematocrit (hct), hemoglobin (hgb), red blood cells (RBC), white blood cells (WBC), mean corpuscular volume (MCV), and platelets (plt) using Baker System 9110-Plus blood analyzer. At harvest, carcass color was determined by visual appraisal and by using Minolta chromameter on hot breast and flank, and on cold breast, flank, and longissimus (ribeye). Pearson correlations and linear regressions between variables were computed using linear models of Statistix version 7.0. Correlation between hot flank color, and cold ribeye color was 0.659 (P<0.001), 0.037 (P>0.65), and 0.266 (P<0.001) for Minolta a*, b*, and L*, respectively. The correlation between visible color scores for hot flank and cold ribeye was 0.327 (P<0.001). Blood chemistry (hct, hgb, MCV, and plt) from samples collected during weeks 10, 16, 18 were highly correlated to cold flank and ribeye color using Minolta a* and L* values. Although there was high degree of variation during week 1 (CV = 21%), hct (and also hgb, MCV, or plt) had moderate correlations to cold flank (0.210, P<0.01 for a*, -0.205, P=0.011 for L*) and ribeye color (0.195, P<0.02 for a*, -0.146, P<0.10 for L*). We conclude that blood samples taken during weeks 1, 10, 16, and 18 could more accurately predict meat color than the industry standard practice of collecting blood samples during weeks 4, 6, and 8.

Key Words: Veal, Meat Color, Blood Chemistry

515 The effects of steroidogenic growth promotants on steer performance, carcass quality, tenderness, and intramuscular lipid content. L.B. Smith*, C.A. Daley, C.L. Cooley, and A.M. Early, *College of Agriculture, California State University, Chico.*

Black Angus-crossed steers (n = 100; 362 kg) were used to study the effects of androgenic and estrogenic growth promotants on beef carcass quality, yield grade, tenderness, and conjugated linoleic acid (CLA) levels relative to intramuscular lipid deposition. The steers were randomized and allotted into one of four treatment groups to receive an implant as follows: (1) control, no implant. (2) Synovex-S (20 mg estradiol benzoate + 200 mg progesterone) (3) Compudose (17 β -estradiol) (4) Revalor-S (24 mg estradiol + 120 mg trenbolone acetate). Following the implanting, the steers were fed a high concentrate diet and were finished in a period of 135 days. The Revalor-S treated cattle had increased (P < 0.001) average daily gain in comparison to the control cattle. Longissimus area and carcass weight were not different among treatments (P > 0.05). Implants reduced (P < 0.05) the amount of intramuscular fat/gram of tissue as compared to the control. The reduction in fat was not dependant upon the type of implant used, both androgenic and estrogenic implants reduced intramuscular fat to approximately the same degree. The proportion of fatty acids, including CLA, was not different between treatments when evaluated per gram of fat extracted. However, a reduction (P < 0.05) in CLA was detected in implanted cattle when evaluated as 100 g tissue per gram of fat extracted. External fat was not different (P > 0.05) among treatments. No differences (P > 0.05) were found in Warner-Bratzler shear force values among implant treatments. Quality and yield grades were not affected (P > 0.05) by the treatments. Consumers will receive less intermuscular lipid and CLA/serving when they consume beef from cattle implanted with commercially available implants.

Key Words: Implants, Carcass-quality, CLA

516 In vivo inhibition of nitric oxide synthase increases post-slaughter lactate production and improves tenderness in ovine *Longissimus thoracis et lumborum*. J.J. Cottrell*^{1,2}, F.R. Dunshea², M.B. Mc Donagh², and R.D. Warner^{1,2}, ¹Victoria University, Werribee, Victoria, Australia., ²Natural Resources and Environment, Werribee, Victoria, Australia.

The aim of this experiment was to determine the effects of nitric oxide (NO) on post-slaughter muscle metabolism and meat tenderness. Nitric oxide synthase (NOS) was inhibited by a bolus i.v. injection of L-arginine methyl ester hydrochloride (L-NAME). Forty Border Leicester x Merino lambs (ca. 42 kg) were randomly assigned to a 2 x 2 factorial design with the respective factors being L-NAME injection (0 or 30 mg/kg at 135 min pre-slaughter) and exercise (0 or 15 min pre-slaughter). Exercise was conducted on individual lambs in a small paddock in the presence of a stock handler. Control lambs were moved from individual pens to abattoir (approx. 200 m) in a small flock. Plasma glucose immediately pre-slaughter was reduced by L-NAME, particularly in exercised lambs as indicated by the interaction. Plasma lactate increased with exercise, but was unchanged by L-NAME. *Longissimus et thoracis lumborum* (LTL) lactate at 5 min, but not 24 h post-slaughter, was increased in exercised animals, particularly in LTL from lambs injected with L-NAME. These data suggest that L-NAME did not change total LTL glycogen, but rather increased the rate of postmortem glycolysis. L-NAME decreased LTL Warner-Bratzler shear force (WBSF). In conclusion, LTL NOS activity increases with exercise and inhibition of NOS with L-NAME accelerates glycolysis and improves tenderness. Supported in part by Meat and Livestock Australia.

L-NAME, mg/kg (L)	0	0	30	30			P-value	
Exercise (E)	no	yes	no	yes	SED	L	E	LXE
Plasma								
Glucose, mM	3.4	8.1	3.2	6.1	0.74	0.06	<0.001	0.09
Lactate, mM	2.9	11.1	2.1	11.0	1.96	0.75	<0.001	0.80
LTL								
Lactate- 5 min, g/100g	1.3	1.6	1.0	1.9	0.19	0.75	<0.001	0.03
Lactate-24 h, g/100g	6.1	5.8	6.1	6.0	0.21	0.43	0.20	0.41
WBSF, kg/cm ²	8.2	9.2	6.6	8.1	0.89	0.04	0.07	0.68

Key Words: Nitric oxide, Muscle metabolism, Meat quality

517 Mutation in turkey alpha-RyR genomic DNA. W. Chiang*, J. Linz, M. Maile, and G. Strasburg, *Michigan State University.*

Pale, soft, exudative (PSE) meat has become a serious quality problem in the turkey processing industry in a manner reminiscent of the PSE problem in pork. There is general agreement that genetic and environmental factors contribute to the incidence of this problem. Pigs susceptible to porcine stress syndrome (PSS) or malignant hyperthermia (MH) are genetically predisposed to yield a higher incidence of PSE pork as a result of a mutation (R615C) in the ryanodine receptor (RyR1). This mutation is associated with higher calcium release rates that accelerate glycolysis, resulting in rapid, early-postmortem pH decline, protein denaturation, and loss of protein functionality. Likewise, there are at least twenty mutations in RyR1 associated with human MH; nine of these mutations are clustered between residues 35 and 615. Avian muscle comprises two RYR isoforms: α RyR and β RyR, which are homologous to mammalian RyR1 and RyR3, respectively. Based on the similarity in development of porcine and turkey PSE meat, we hypothesized a mutation exists in turkey α RyR which predisposes birds to the development of PSE meat. Analysis of the α RyR cDNA covering amino acids 376 to 614 (human sequence) revealed two cDNA variants. One is homologous to the mammalian RyR1 sequence in this region, whereas the other is characterized by the absence of 81 bp. The 81-bp deletion results in the loss of 27 amino acid residues corresponding to Ser-416 to Ser-443. Analysis of the turkey α RyR genomic DNA sequence suggests that there are two α RyR alleles which differ by the presence or absence of the 81 bp domain. These data suggest that the absence of the 81 bp in the α RyR cDNA sequence is the result of a mutation. Comparison of the genomic DNA sequences of human RyR1 and turkey α RyR over amino acid residues 376 to 479 also suggests that intron 12 of the human sequence is absent in the turkey α RyR gene. The significance of the deletion in α RyR function and its relationship to muscle food quality are under investigation.

Key Words: Ryanodine Receptor, PSE, Turkey

518 Phospholipids and plasmalogens as precursors of flavor in beef. S. Lorenz^{*1}, P. Schieberle², K. Ender¹, and K. Nuernberg¹, ¹Research Institute for the Biology of Farm Animals, ²Deutsche Forschungsanstalt fuer Lebensmittelchemie.

Fatty acids are known precursors of several characteristic flavor compounds of meat. (E,E)-2,4-decadienal, nonanal or 1-octen-3-one originating from different precursor fatty acids have been confirmed as character impact odorants of, e.g., stewed beef juice. But there is another important characteristic odorant detected in stewed beef juice. The branched aldehyde 12-methyltridecanal (12-MT), smelled tallow and beef-like, is bounded in plasmalogens. The major objective of this study was to develop a method for the determination of 12-MT in plasmalogens using high-performance liquid chromatography (HPLC). A second objective was to estimate the fatty acid composition of the phospholipids and plasmalogens using gas chromatography. The HPLC procedure for 12-MT based on the formation of 2,4-dinitrophenylhydrazones of carbonyl compounds. After purification the derivatives can be separated with an HPLC system with acetonitrile-water on RP-18 silica gel column. The

fatty acid composition was carried out on a 100 m CP Sil-88 column with hydrogen as carrier gas. Ten (group A: pasture, n = 6; group B: concentrate, n = 4) German Simmental cattle were used in the investigation. The phospholipids of the longissimus were separated into different classes using thin layer chromatography. The major classes of beef muscle were phosphatidylcholine (PC) and phosphatidylethanolamine (PE). The PC content was significantly ($P < 0.05$) higher in group B (245 mg) to 264 mg / 100 g muscle (group A). The amount of PE showed with 151 mg (group A) and 142 mg/100 g muscle (group B) no significant difference. The aldehyde composition of both PC and PE was estimated using HPLC. The major aldehydes are hexadecanal and octadecanal. The different feeding system led to significant ($P < 0.05$) changes of both aldehydes in the class of PE. Octadecanal, e.g., increased from 3.3 mg (group B) to 4.7 mg / 100 g muscle (group A). However, lower chain aldehydes (C10 # C14) could be identified, too. PC showed the highest amount of 12-MT with 17.1 μ g (group A) and 13.0 μ g / 100 g muscle (group B). There was no significant difference between the groups.

Key Words: phospholipid, beef, aldehyde

Nonruminant Nutrition Amino Acid and Protein Nutrition

519 Foundations for current knowledge of protein and amino acids for swine. W. Pond, *Cornell University, Ithaca, NY.*

The present knowledge of protein and amino acid (AA) requirements in swine is based on a continuum of research spanning nearly a century. Hanson (J. Anim. Sci. 17:1029-1057, 1958) reviewed 50 years of progress in the early understanding of protein and AAs in swine nutrition. McCollum and Steenbock in 1912 and Osborne and Mendel in 1914 set the stage for the concept of essential AAs when they reported that zein (the major protein of corn) supported rat survival, but not growth, and that the addition of missing AAs promoted growth. In the 1930s, W.C. Rose reported the AAs required for rat growth; this formed the basis for the flood of research in the 1950s which established that the growing pig requires the same 10 AAs as the growing rat. Early methods to establish AA requirements of swine were focused mainly on measurements of growth and N-balance. The concepts of AA imbalance and of interactions among AAs and between AAs and other nutrients emerged during the 1950s and 1960s. More recent studies refined estimated AA requirements for growth, gestation and lactation. Other refinements, such as ileal digestibility and the concept of ideal protein, based on optimum ratios of AAs, were also made possible by the efforts of earlier investigators. The advent of inexpensive crystalline AAs for addition to feeds marked yet another major advance in efficient protein utilization. The future of AA and protein research and its application promises even more exciting discoveries.

Key Words: Amino acids, Protein, Swine

520 Whole body and hindlimb protein breakdown is differentially altered by feeding in piglets. M.C. Thivierge^{*1&2}, H.V. Nguyen¹, J.A. Bush¹, A. Suryana¹, R. Orellana¹, C.W. Liu¹, D.G. Burrin¹, F. Jahoor¹, and T.A. Davis¹, ¹USDA/ARS Children's Nutr. Res. Ctr., Dept. Pediatr. Baylor Coll. Med., Houston, Texas, ²FSAA, Universit Laval, QC, Canada.

The neonatal period is characterized by a high rate of muscle protein accretion, which is due, at least in part, to an elevated rate of skeletal muscle protein synthesis in response to feeding. However, little is known about the regulation of protein breakdown by feeding during the neonatal period. To determine the feeding-induced response of protein breakdown at the whole body level and across the hindlimb, overnight-fasted 28-day-old pigs (n=6) were infused for 7 h with [1-¹³C]phenylalanine and [ring-D₄]tyrosine during an initial 4 h fasting period and a 3 h refeeding period. Refeeding was achieved by continuous intraduodenal infusion of an elemental diet. Plasma samples were obtained simultaneously from the carotid artery and the vena cava; blood flow of the caudal aorta was recorded using ultrasonic flow probes. The results indicate that refeeding increased whole body phenylalanine flux (+92%), phenylalanine oxidation (+300%), and whole body protein synthesis (+81%). Refeeding decreased whole body protein breakdown (-45%); protein breakdown represented 28% of whole body flux in the refeed state. Phenylalanine

hydroxylation to tyrosine increased with refeeding (+7-fold). In the hindlimb, refeeding increased the utilization of phenylalanine for proteins synthesis (+233%) and this was associated with an increase in blood flow (+20%). However, refeeding did not alter protein breakdown in the hindlimb. The ratio of hindlimb protein breakdown over hindlimb phenylalanine flux indicates that muscle protein is mobilized during the fasting period but that protein degradation accounts for only 30% of hindlimb flux during the refeeding. Thus, the results show that proteolysis is more sensitive to feeding at the whole body level than in the hindlimb in 28-day-old piglets. Furthermore, the protein anabolic response to feeding in the hindlimb is driven primarily by a stimulation of protein synthesis.

Key Words: Proteolysis, Hindlimb, Piglets

521 Low protein diets can be fed to gestating sows without adverse effects. S. Möhn^{*}, D. J. McMillan, and R. O. Ball, ¹University of Alberta, Edmonton.

Reducing dietary protein content can reduce the N excretion of pigs. Performance should not be affected if low protein diets are supplemented adequately with free amino acids. We tested the effect of supplemented low protein diets on the performance of 80 sows during their second and third parity. Sows were offered isoenergetic barley-based diets containing either 14.8 % crude protein (CP, group HP) or 12.0% CP with added lysine and threonine (LP). At allocation, breeding body weight (BW) and back fat (BF) were similar for HP and LP. Litter size and weight in the first parity were similar for LP and HP. At similar daily feed intake (LP: 2.23 0.03 kg, HP: 2.25 0.02 kg), weight gains during pregnancy were similar in LP (55.9 1.1 kg) and in HP (55.4 1.2 kg). BF when 40 d or 95 d pregnant were similar in LP (19.7 0.5 mm and 19.6 0.4 mm, respectively) and HP (19.3 0.5 mm and 19.2 0.3 mm, respectively). At breeding for the third parity, BW in LP was lower (180.3 2.2 kg) than in HP (186.8 2.5 kg, $P = 0.05$), but BF was similar (LP: 17.0 0.4 mm, HP: 17.0 0.4 mm). By day 40 of the third parity, BW was similar in LP (202.4 1.7 kg) and HP (205.0 2.2 kg). At similar daily feed intake (LP: 2.47 0.03 kg, HP: 2.51 0.03 kg), weight gains during the third pregnancy were slightly greater ($P = 0.098$) in LP (66.4 1.4 kg) than in HP (62.7 1.6 kg). BF when 40 d or 95 d pregnant were similar in LP (17.8 0.4 mm and 18.5 0.3 mm, respectively) and HP (17.7 0.4 mm and 18.5 0.3 mm, respectively). Parity had no effect on N excretion determined in 6 animals per group. Urinary N to creatinine ratio showed that N excretion in LP was lower ($P = 0.04$) by 28.7% compared to HP during early pregnancy. During late pregnancy, N excretion was similar for HP and LP. Overall, N excretion tended to be lower ($P = 0.08$) by 19.4% in LP compared to HP. Our results indicate that low protein diets can be used successfully for pregnant sows because they promote the same growth rate as conventional diets while reducing N excretion. Funding was provided by Alberta Pork, AARI and Degussa AG.

Key Words: Sows, Gestation, Protein intake

522 Low protein diet for sows reduce carbon dioxide and heat production. J.K.A. Atakora*, D.J. McMillan, S. Möhn, and R.O. Ball, *University of Alberta*.

Carbohydrates are used more efficiently than protein in intermediary energy metabolism. Low protein diets supplemented with amino acids have a greater content of carbohydrates and lower excess of protein than conventional diets. Therefore we hypothesized that low protein diets would reduce the production of CO₂ and heat by sows during gestation and lactation. Twenty-two sows were fed either conventional diets (HP) or amino acid supplemented, low-protein diets (LP) during gestation and lactation of the second and third parities. Oxygen consumption and CO₂ production were measured using an open-circuit respiration system. Heat production was calculated based on gas exchange. During gestation, average production of CO₂ was lower in LP ($P = 0.04$; 3029 317 g/d) than in HP (3183 386 g/d). Allowing for the covariates feed intake, sow weight and parity ($P < 0.01$), CO₂ production in LP was reduced by 4.8% relative to HP ($P = 0.03$). Mean heat production during gestation was lower in LP ($P = 0.01$; 37.9 4.2 MJ/d) than in HP (40.1 4.3 MJ/d). Heat production during gestation was also affected by sow weight, feed intake and ambient temperature ($P < 0.05$). During lactation, average CO₂ production was about 7% less for LP ($P = 0.01$; 6508 842 g/d) than HP (7016 824 g/d). Parity, feed intake and piglet weight also affected CO₂ production during lactation ($P < 0.05$). Mean lactation heat production was lower in LP ($P = 0.01$; 51.8 9.3 MJ/d) than in HP (57.2 8.9 MJ/d). Regression analysis showed that heat production decreased with protein intake (LP, $P = 0.001$) and increased with feed intake and litter weight ($P = 0.001$). Feeding low protein diets to sows in commercial operations will significantly reduce carbon dioxide production, thus contributing to a reduction of greenhouse gas production. The reduced heat production indicates an improved nutrient utilization in low protein diets.

Key Words: Sows, Protein intake, Heat production

523 Effect of litter size and day of lactation on amino acid uptake by the porcine mammary glands. T.T. Nielsen¹, N.L. Trottier*², H.H. Stein¹, C. Bellaver¹, and R.A. Easter¹, ¹University of Illinois, Urbana-Champaign, Illinois, USA, ²Michigan State University, East Lansing, Michigan, USA.

Twelve multiparous sows were used to investigate the relationship between litter size and day of lactation, and plasma amino acid (AA) arteriovenous differences (A-VD), AA uptake, and plasma flow across the mammary glands. Sows were assigned randomly to one of the following litter sizes: 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, or 14 pigs per litter by cross fostering on d 2 postpartum. All sows were surgically fitted with catheters in the carotid artery and the main mammary vein. Matched arterio-venous blood samples were obtained on d 9, 12, 15, 18, 21, and 24 postpartum. Daily mammary uptake of AA was based on the product of plasma A-VD and daily mammary plasma flow (MPF). Daily MPF was estimated using the Fick method based on lysine conservation across the gland, and daily milk production. For the majority of AA, as litter size increased, A-VD did not increase, except for alanine ($P < 0.05$, linear and quadratic) and valine ($P < 0.1$, linear and quadratic). As day of lactation increased, A-VD for the majority of AA increased ($P < 0.05$, linear and quadratic) except for arginine, lysine and phenylalanine. As litter size increased, net daily mammary AA uptake increased for all indispensable AA ($P = 0.001$ to $P < 0.05$, linear and quadratic), excepting arginine. Milk production increased with increasing litter size ($P < 0.001$, linear) and with increasing day of lactation ($P < 0.05$, quadratic). Daily MPF increased ($P < 0.05$, linear) with increasing litter size, but did not change during the period measured from d 9 to 24. In conclusion, litter size appears to be a major determinant of net mammary AA uptake with daily MPF a driving variable, whereas AA A-VD is a function of day of lactation and a major variable in determining net AA uptake with advancement of lactation.

Key Words: Lactating sow, Amino acid, Mammary gland

524 Supplemental arginine in diets of lactating sows: effect on plasma nitric oxide and milk amino acid concentration. J. Perez Laspiur*, A. Zanella, P. K. Ku, and N. L. Trottier, *Michigan State University*.

Our previous work has shown that heat stress (HS) in lactating sows decreases milk production and average daily gain of nursing pigs. We

hypothesized that the decrease in milk production is caused in part by a decrease in plasma nitric oxide and milk amino acid concentration. The objectives of this study were to determine 1) if HS decreased nitric oxide (NO) and arginine (arg) concentration in plasma, and amino acid (AA) concentration in milk and 2) if dietary arg supplementation increased plasma NO and milk AA concentrations. Sows ($n=42$) were exposed to a thermoneutral (TN=20°C) or hot (HT=29.4°C) environment and allocated to one of three dietary treatments in a 2 × 3 factorial design. Diets contained 0.96%, 1.34%, and 1.73% arg for control (C), medium (M), and high (H), respectively. Blood samples were collected on day 21 of lactation. On day 7, 14, and 21 of lactation, milk samples were obtained ($n=18$) manually from the first two anterior mammary glands. Differences in responses to HS and arg supplementation were determined by analysis of variance. Statistical analysis was performed using the MIXED procedure of SAS. Compared to TN sows, HT sows had lower ($P<0.05$) plasma concentrations of isoleucine, phenylalanine and threonine, and milk concentrations of arg, leucine, lysine, phenylalanine and valine. Plasma NO concentration was not different between TN or HT sows. Arginine supplementation increased arg and threonine concentrations in plasma ($P<0.05$) and increased proline concentration in milk ($P<0.05$) in HT sows. Arginine supplementation did not increase plasma NO concentration in either TN or HT sows. In conclusion, HS did not decrease the concentration of arg in plasma, but decreased the concentration of arg, lysine, and large neutral AA in milk. Supplemental arg did not increase NO concentration in plasma in either TN or HT sows, but increased proline concentration in HT sows. These results suggest that the decrease in milk production observed in sows exposed to HS may result from a decreased uptake of AA by the mammary glands.

Key Words: Lactating sow, Arginine, Milk production

525 Effect of crude protein reduction and dietary fiber on nitrogen retention and excretion in the growing pig. J. Perez-Laspiur*, C. Wickens, L. Recker, J. Moore, P.K. Ku, and N.L. Trottier, *Michigan State University, East Lansing, Michigan, USA*.

Forty-eight 50-kg barrows were used to determine if dietary crude protein (CP) reduction and dietary fiber inclusion decreases nitrogen (N) excretion (E) without reducing N retention (R). Pigs were allocated to one of six dietary treatments in a randomized block design. Diets were 15.5% CP, 12.5% CP, and 9.5% CP, 12.5% CP containing 10% wheat middlings (WM), 12.5% CP containing 10% sunflower hulls (SH), and 12.5% CP containing 10% corn distillers grains (CDG). Synthetic amino acids were added to the 12.5%, 9.5%, WM, SH, and CDG diets. Feed was either restricted (FR) or provided ad lib (FA). Each block consisted of a 14-day adaptation period to diets followed by a 6-day fecal and urine collection period. Feces were collected via bags directly attached on the skin surrounding the anus. The FR and FA were fed at 3.5 and 5% of BW, respectively. Reducing CP from 15.5 to 12.5% did not reduce NR for either FR or FA group and reduced ($P < 0.05$) total daily N and urinary N. Reducing CP from 15.5 to 9.5% reduced ($P < 0.05$) total daily N and urinary N, but decreased ($P < 0.05$) NR in both FR and FA groups. When compared to the 12.5% CP diet, WM, SH, or CDG diets yielded similar NR and urinary N excretion. In conclusion, reducing CP from 15.5 to 12.5% reduced daily urinary excretion and did not compromised NR. Feeding a diet containing 9.5% CP dramatically reduced daily N excretion but also decreased NR. Addition of fiber sources such as WM, SH, or CDG at 10% of the diet to a 12.5% CP diet did not reduce urinary N excretion compared to that in pigs fed a 12.5% CP diet.

Key Words: Pig, Nitrogen excretion, Dietary protein

526 Effect of crude protein reduction and dietary fiber on fecal urease and urinary nitrogen form in the growing pig. J. Perez-Laspiur, C. Wickens*, L. Recker, J. Moore, P.K. Ku, and N.L. Trottier, *Michigan State University, East Lansing, MI, USA*.

Forty-eight 50-kg barrows were used to determine 1) if dietary crude protein (CP) reduction decreases fecal urease (FUase) concentration (conc.) and urinary pH, and increases urinary (U) ammonia (NH₄) relative to urea conc.; 2) if dietary CP reduction with dietary fiber inclusion increases FUase conc. and decreases U pH and urea conc. Pigs were allocated to one of six dietary treatments in a randomized block design. Diets were 15.5% CP (15.5 CP), 12.5% CP (12.5 CP), 9.5% CP (9.5 CP),

and 12.5% CP containing 10% wheat middlings (WM), or sunflower hulls (SH), or corn distillers grains (CDG). Each block consisted of a 14-day adaptation period to diets and a 7-day fecal and urine collection period. Urinary pH was lower ($P < 0.05$) in 9.5 CP diet compared to 15.5 CP but not different between 12.5 and 15.5 CP. Daily production and conc. of FUase was lower ($P < 0.05$) for 9.5 and 12.5 CP compared to 15.5 CP. Urinary urea conc. was lower ($P < 0.01$) for 9.5 compared to 12.5 and 15.5 CP, and not different between 12.5 and 15.5 CP. Daily U urea production was lower for 9.5 ($P < 0.01$) and 12.5 CP ($P < 0.05$) compared to 15.5 CP. Urinary NH₄ conc. and daily production was higher ($P < 0.05$) in the 9.5 compared to 12.5 and 15.5 CP, and not different between 12.5 and 15.5 CP. Urinary pH for WM, SH, and CDG diets was similar to 12.5 CP and lower ($P < .05$) for SH and CDG compared to 15.5 CP. Fecal urease conc. for WM, SH, and CDG was similar to 12.5 CP and lower ($P < .05$) for WM and CDG compared to 15.5 CP. Urinary urea conc. and production was not different for WM, SH, and CDG compared to 12.5, but production was lower compared to 15.5 CP. Compared to 12.5 and 15.5 CP, urinary NH₄ conc. and production was not different for WM and SH, and was higher ($P < 0.05$) for CDG. In conclusion, reducing CP reduces FUase conc., U urea conc. and U pH, and increases U ammonia conc. Fiber inclusion in reduced CP diets does not increase FUase conc., and does not reduce U pH, urea and NH₄ conc. or production.

Key Words: Pig, Fecal urease, Nitrogen excretion

527 Optimal true ileal digestible (TID) lysine dietary level in growing hybrid pigs. N. Warnants¹, M.J. Van Oeckel¹, M. De Paepe¹, L. Le Bellego^{*2}, and C. Relandeau², ¹CLO-Ghent, Melle, Belgium, ²Ajinomoto Eurolysine, Paris, France.

Two trials were performed with Pietrain x Seghers Hybrid pigs of 4-10 weeks (trial 1) and 10-15 weeks of age (trial 2). In trial 1, 5 diets with rising TID lysine levels from 1.01 to 1.29% were fed to 66 pigs per treatment. Each pen was composed of 3 barrows and 3 gilts. In trial 2, 6 diets with levels of TID lysine increasing from 0.69 to 1.07% were fed to 45 barrows and 45 gilts per treatment. The sexes were housed separately in pens of 5. In both trials, diets were based on cereals and soybean meal and were balanced in threonine, methionine + cystine and tryptophan relatively to lysine, according to the ideal protein. Lysine:crude protein was 0.07 and NE contents were 9.62 (trial 1) and 9.41 MJ/kg feed (trial 2). In both trials DFI, ADG and FCR increased with dietary TID Lysine level ($P = 0.001$ for linear contrast). In trial 1, ADG (348 g/d) and FCR (1.59) were the highest with 1.22% TID lysine treatment, with a DFI of 554 g/d. Using a broken line model, the optimal requirement for ADG was 6.96 g/d or 1.22% TID lysine. FCR was described as a quadratic function of TID lysine intake and resulted in the same requirement (7.00 g/d). In trial 2, ADG and FCR were respectively highest and lowest for both barrows and gilts at 1.07% TID lysine with a DFI of 1403 (barrows) and 1260 (gilts) g/d. However, analysis of data using exponential and quadratic models suggest that the optima for ADG and FCR were above the investigated lysine range. Based on ADG and using an exponential model, the requirement for barrows could be estimated at 17.24 g/d or 1.23%. For gilts, it was not possible to determine the optimum as the relation between ADG and TID lysine intake was linear. For FCR, using a quadratic model, the requirement was 16.44 and 13.46 g/d or 1.17 and 1.07% TID lysine for barrows and gilts, respectively. These results demonstrate that lean modern genotypes have a daily TID lysine requirement close to traditional genotypes but require a higher TID Lysine concentration in the feed due to their limited feed intake capacity.

Key Words: TID lysine, Hybrid pig

528 Tryptophan:lysine ratios that optimize performance in 6 to 23-kg pigs. R.W. Fent^{*1}, R.D. Boyd², G.L. Allee¹, D.R. Cook³, and M.M. Ward³, ¹University of Missouri-Columbia, ²PIC USA, Inc., Franklin, KY, ³Akey, Lewisburg, OH.

Two experiments were conducted to determine minimum dietary tryptophan:lysine ratio (T:L) for optimum response in 6.3 to 22.7-kg nursery pigs. In Exp. 1, 880 pigs (440 barrows, 440 gilts) were allotted to five dietary treatments in a randomized complete block design for phase 2 (6.3-12.7 kg). Test diets involved a lysine:ME ratio below the requirement for maximum response. Treatments (1.30% Lysine) included a positive control (PC) consisting of typical nursery ingredients and four diets containing high quality porcine-derived gelatin (8.75%) and corn

starch (9.89-10.0%) with added levels of crystalline tryptophan. Analyzed total T:L for the five diets were 0.16 (PC), 0.10, 0.13, 0.14, and 0.18, respectively. Quadratic improvements ($P < 0.01$) in ADG, ADFI, and G:F occurred for both sexes, but maximal response was observed at 0.14 T:L for gilts and 0.18 T:L for barrows. Upon reaching an average BW of 12.7 kg, pigs on the lowest T:L treatment were removed from test and the remainder were reallotted for evaluation during phase 3 (12.7-22.7 kg). Phase 3 treatments (1.20% Lysine) resulted in analyzed T:L of 0.16 (PC), 0.11, 0.14, 0.15, and 0.17. Quadratic improvements ($P < 0.01$) were observed for ADG, ADFI, and G:F, but means were similar for the 0.14, 0.15, and 0.17 T:L diets. In Exp. 2, 880 pigs were utilized from 11.2 to 23.1 kg BW to determine the effect of true ileal digestible tryptophan:lysine ratio (TID T:L) using practical corn-soybean meal diets. Pigs were allotted to treatments consisting of four TID T:L levels (0.158, 0.178, 0.198, and 0.218) and one diet containing 8.75% gelatin formulated to 0.158 TID T:L. Analyzed values were very similar to calculated values. Increases in TID T:L did not result in improvements in average daily gain, average daily feed intake, or feed efficiency. These results suggest that, with corn-soybean meal-based diets and corn-soybean meal-gelatin diets, a TID tryptophan:lysine ratio of 0.158 is adequate for phase 2 (6-13 kg) and phase 3 (13-23 kg) nursery diets.

Key Words: Pigs, Amino acids, Tryptophan

529 Evaluation of the lysine requirement for 11 to 20 kg pigs. D. C. Kendall^{*1}, G. L. Allee¹, J. L. Usry², M. M. Ward³, and D. R. Cook³, ¹University of Missouri-Columbia, ²Ajinomoto Heartland Inc., ³Akey.

We have previously demonstrated (Kendall et al., 2002) that under experimental conditions, the lysine requirement of 11-25 kg pigs is 1.33% TID lys. A 16d experiment was conducted to determine the lysine requirement for 11 to 20 kg pigs ($n=812$, TR-4 x PIC C-22) under commercial conditions. Pigs were co-mingled from five sow farms and upon arrival were allotted by weight and sex in a randomized complete block design with 4 replicate pens per sex and housed at 22 pigs/pen (.25 m²/pig). Pigs were fed nutritionally adequate diets prior to reaching a target weight of 11 kg. Pigs were then fed one of 5 dietary treatments. TID lysine levels of the corn-soybean meal diets were 1.05, 1.14, 1.23, 1.32, 1.41% TID lys with all diets containing the same inclusion of soybean meal (34.2%). Dietary lysine content was increased by adding Lys-HCl (0, .115, .230, .344, and .459% Lys-HCl, respectively). All diets were pelleted and formulated to be equal on a ME basis (3.42 Mcal ME/kg) with additional synthetic amino acids supplied as necessary to meet minimum amino acid ratio requirements. Pigs were given ad libitum access to feed and water. There was a linear improvement in ADG (482, 489, 518, 526, and 530 g/d, respectively; $P < .01$) and G:F (.697, .716, .759, .766, and .784, respectively; $P < .001$) with increasing lysine level. There were no differences in ADFI for the period. This experiment demonstrates that the lysine requirement for pigs from 11 to 20 kg under commercial conditions may be as high as 1.41% TID lys.

Key Words: Pigs, Lysine, Nursery

530 Evaluation of the tryptophan:lysine ratio for late finishing barrows. D. C. Kendall^{*}, J. W. Frank, A. M. Gaines, and G. L. Allee, University of Missouri-Columbia.

A 28d experiment was conducted to determine the TID tryptophan:lysine (Trp:Lys) ratio for 90 to 115 kg barrows ($n=82$, Dekalb EB x Newsham). Pigs were allotted in a randomized complete block design and were fed one of 7 dietary treatments with 6 replicates (5 replicates for the control) and housed at 2 pigs/pen. A six point titration was constructed with a basal diet (96.1% corn, .55% TID lys, 8.68% CP) formulated to contain .06% TID trp with additional amino acids supplied from synthetic sources to meet minimum ratios (.109 Trp:Lys). The next five treatments contained increasing levels of TID trp by adding L-Tryptophan at the expense of corn (.145, .182, .218, .254, and .290 Trp:Lys, respectively). A positive control corn-soybean meal diet was formulated to contain .55% TID lys, 13.6% CP and .14% TID trp (.290 Trp:Lys). All diets were formulated to be equal on a ME basis (3.40 Mcal ME/kg). Pigs were weighed bi-weekly to determine average daily gain, average daily feed intake and feed efficiency and ultrasonically scanned for tenth rib backfat and loin eye area at d0 and d28. For the overall period, there was a trend for a quadratic improvement in ADG (718, 945, 926, 925, 807, and 905 g/d, respectively; $P < .07$) and G:F (.227, .260,

.259, .258, .254, and .254, respectively; $P < .08$) with increasing tryptophan level, characterized by an improvement in performance from the basal diet to the .145 Trp:Lys diet and a plateau thereafter. The pigs fed the positive control diet had similar ADG ($P > .10$), but tended to be more efficient (.286 vs. .253; $P < .07$), have less accretion of BF (1.17 vs. 4.09 mm; $P < .02$), and greater accretion of LEA (5.15 vs. 2.36 cm²; $P < .06$) than pigs fed the corn-synthetic amino acid diet at .290 Trp:Lys. This experiment demonstrates that the TID tryptophan:lysine ratio for pigs from 90 to 115 kg may be as low as .145 Trp:Lys, and that very low protein diets with high levels of synthetic amino acids may compromise feed efficiency and carcass characteristics in late finishing barrows.

Key Words: Pigs, Tryptophan, Late finishing

531 Effect of dietary protein content and phase feeding on performance and plasma urea nitrogen patterns of growing pigs. N.T. Rodgers^{1,2} and R.T. Zijlstra¹, ¹*Prairie Swine Centre Inc.*, ²*University of Saskatchewan, Saskatoon, Canada.*

Successful N management is important for sustainable pork production. Plasma urea nitrogen (PUN) concentration is related to excess dietary AA and urinary N excretion. Either a reduction in dietary protein or phase feeding (more diets with gradually reduced AA content fed within a period) should reduce PUN, indicating reduced urinary N excretion. Two levels of dietary protein (high, avg. 19%; low, avg. 17%; 3,400 kcal DE/kg; ideal AA profile) and 3 separate phase feeding programs (2 diets each 3 wk, 3.0 and 2.2 g dig. Lys/Mcal DE; 3 diets each 2 wk, 3.0, 2.6, 2.2 g dig. Lys/Mcal DE; 6 diets each 1 wk, 3.0 down to 2.0 g dig. Lys/Mcal DE) were used as 6 treatments in a 2 x 3 factorial arrangement in 6-wk studies with 25-kg barrows. In the performance study, 180 pigs were housed 5 pigs/pen with free access to feed, for 6 pens per treatment. In the metabolism study, 36 pigs were housed in individual pens pair-fed to performance pigs, for 6 pigs per treatment. Once per wk, pig weight and feed intake were measured, blood was collected from pigs in both studies, and PUN was analyzed. Overall ADG ranged from 905 to 957 g/d in the performance study and from 790 to 889 g/d in the metabolism study, without treatment differences ($P > 0.10$). Overall ADFI ranged from 1.89 to 1.96 kg/d in the performance study ($P > 0.10$), and was 1.88 for high and 1.86 kg/d for low protein in the metabolism study ($P < 0.10$). Overall, PUN differed between dietary protein levels ($P < 0.01$) but not among phase feeding programs ($P > 0.10$) for both studies. Specifically, for the performance study for high versus low protein, PUN was 19% higher in wk 1 and 12% in wk 2 ($P < 0.01$), not different in wk 3 and 4, and 11% higher in wk 5 and 6 ($P < 0.10$), with similar trends for the metabolism study. In summary, dietary protein content or phase feeding did not alter performance. Results indicate that PUN may predict expected reductions in urinary N excretion for reduced dietary protein, but not for phase feeding.

Key Words: Plasma urea nitrogen, Dietary protein, Pig

532 N-acetylcysteine is a highly bioavailable precursor of cysteine for protein accretion in piglets. A. K. Shoveller¹, J. A. Brunton¹, P. B. Pencharz^{1,2}, and R. O. Ball^{1,2}, ¹*Department of Agricultural, Food and Nutritional Science, University of Alberta, Canada*, ²*Departments of Nutritional Science and Paediatrics, University of Toronto, Canada.*

During the neonatal period, cysteine may be an indispensable amino acid for protein accretion. In addition to its role in protein synthesis, cysteine is also a precursor for the de novo synthesized antioxidant, glutathione. Antioxidant supplementation in grower-finisher pigs has been shown to improve the physical appearance of meat. However, cysteine is relatively unstable; therefore, there are advantages to supplying alternative forms. N-acetylcysteine (NAC) may be an effective means of

supplying cysteine. NAC has been shown to increase the synthesis of glutathione. The bioavailability of cysteine from N-acetylcysteine was determined in intravenously fed piglets randomized to one of four diet treatments with equal intakes of methionine (0.3 g/kg/day) and 0.2 cysteine (CON), 0 NAC (zeroNAC), 0.13 NAC (lowNAC) or 0.27 g/kg/d NAC (highNAC). Piglets (2-4 days old; 1.8 kg, n=16) were surgically implanted with femoral venous catheters for blood sampling and jugular catheters for diet and isotope infusion. All piglets recovered on complete diets for 2 days. On day 3, the test diets were initiated and continued until day 8. Blood was sampled 6h before test diet initiation and at time 0, 6, 12, 18, 24, 36, 48, 60, 72, 84, 96, 108, and 120 h. Urine was collected on ice in 24-h periods. On day 8, 3H-phenylalanine (1 mCi/kg) and a flooding dose of cold phenylalanine (150 mmol/L, 9mL/kg) were used to measure the fractional rate of protein synthesis. Total mean weight gain was highest in highNAC and CON, lower in lowNAC and lowest in the zeroNAC group; however, these differences did not reach significance. NAC retention was not different between lowNAC and highNAC, and was 85.2% and 80.3%, respectively (pooled SD=2.19, n=8). Preliminary data indicate that the zeroNAC group had significantly lower nitrogen retention (%) than the highNAC and CON groups, and the lowNAC groups were not different from either zeroNAC or highNAC and CON. Further analysis will confirm the availability of cysteine from NAC for protein synthesis. These data suggest that NAC is a highly available precursor for cysteine when used in an intravenous solution and administered to neonatal piglets.

Key Words: N-acetylcysteine, Protein synthesis, Piglet

533 The effect of dietary protein to energy ratio on carcass composition and fillet yields of rainbow trout and Atlantic salmon. P.A. Azevedo^{*}, S. Leeson, and D.P. Bureau, *University of Guelph, Guelph, Ontario.*

Salmonid fish species have different protein and lipid deposition patterns between various body compartments. Yield of marketable products may be different for different species and these may respond differently to changes in diet composition. This study examined the effect of dietary digestible protein to digestible energy ratio (DP/DE) on dressed carcass and fillet yield and composition of market size Atlantic salmon and rainbow trout. Four isoenergetic diets (DE = 20 MJ/kg), with different DP/DE (18, 20, 22 and 24 g/MJ) were hand-fed to near-satiety to triplicate groups of 55 rainbow trout (initial body weight, IBW = 270 g/fish) and 55 Atlantic salmon (IBW = 460 g) reared at 8.5°C over 24 weeks. Dressed carcass and fillet yields were determined and samples were collected for proximate analysis. Dressed carcass yield (DCY) was significantly higher ($P < 0.0001$) for salmon compared to trout. Diet had no effect on DCY of trout (mean 87%), but DCY of salmon showed a linear decrease (from 91 to 88 %) with decreasing DP/DE ($P < 0.05$). Fillet yield (%) was not affected by species or diet and averaged 62% of carcass weight. Moisture and crude protein (CP) contents of dressed carcass were significantly higher and lipid content was lower ($P < 0.05$) in salmon compared to trout, but this was not affected by diet. Fillet moisture and lipid contents were significantly affected by species and diet ($P < 0.05$). Salmon fillets had significant higher moisture and lower lipid contents than those of trout and both contents were affected by diet ($P < 0.05$). There was a linear decrease ($P < 0.05$) of water in salmon fillet and a linear increase of lipid content ($P < 0.05$) in trout fillet with decreasing DP/DE ratios. CP was not affected by diet but it was higher in salmon fillet than in trout fillet ($P < 0.05$). The results show that isoenergetic diets with different protein contents have significant effects on carcass yield of salmon and on chemical composition of salmon and trout carcasses.

Key Words: Salmonids, Carcass composition, Diet

Physiology Estrus Synchronization II

534 Administration of gonadotropin-releasing hormone (GnRH) on d 5 or 6 of the estrous cycle alters follicle dynamics and increases pregnancy rates in beef cattle. A. M. Arnett^{*}, J. D. Rhinehart, J. D. Bailey, R. B. Hightshoe, and L. H. Anderson, *University of Kentucky.*

Follicle ablation prior to maternal recognition of pregnancy (d 16 - 17) can improve pregnancy rates. Two experiments were conducted to de-

termine if administration of GnRH on d 5 or d 6 (d 0 = first observed estrus) would alter follicular growth in heifers and improve pregnancy rates. The objective of the first experiment was to characterize ovarian follicular dynamics of heifers after administration of GnRH on d 5 or d 6 of the estrous cycle. Mature crossbred heifers (n = 15) were administered

a single injection of prostaglandin F₂ α (i.m.; 25 mg; Prostamate) and were observed for estrous behavior. Heifers were administered GnRH (i.m.; 100 μ g; Cystorelin) on either d 5 (n = 4) or d 6 (n = 5). Transrectal ultrasonography was used on alternating days from d 6 - 18 to determine the diameter (mm) of follicles and to map follicle growth and regression. Treatment with GnRH on d 5 and d 6 induced ovulation of first-wave follicles and formation of accessory corpora lutea in all heifers. Atresia and subsequent recruitment of the third follicle wave by d 17 occurred in all four and in three of five heifers administered GnRH on d 5 or d 6, respectively. Experiment two was designed to determine if pregnancy rate could be altered by administration of GnRH on d 5 or d 6 with embryo transfer on d 7. Recipient females (n = 58) from two locations were randomly allocated to either receive GnRH (n = 30; 100 μ g) or to serve as untreated controls (n = 28). Recipient females were administered GnRH on d 5 (n = 8) at one location and d 6 (n = 22) at another location. Frozen embryos were transplanted on d 7 by experienced technicians. Pregnancy rate was determined on d 30 by transrectal ultrasound. A higher proportion ($P < 0.01$) of females administered GnRH on d 5 (75 %) or d 6 (77 %) became pregnant than females that received no treatment (29 %). This study concludes that administration of GnRH on d 5 or 6 alters follicular dynamics and may increase pregnancy rates in embryo transfer.

Key Words: GnRH, Follicle waves, Embryos

535 Synchronizing ovarian follicular development with melengestrol acetate (MGA) and a CIDR in beef cattle. M.L. Mussard¹, C.R. Burke¹, C.L. Gasser¹, and M.L. Day¹, ¹ *The Ohio State University.*

Artificial breeding programs in beef cattle that involve timed AI require the presence of a healthy and responsive dominant follicle (DF) on the ovaries at the time of AI. This study evaluated the potential of feeding MGA to promote a persistent DF followed by a short period of progesterone (P4) treatment to induce development of a new DF. Each of 34 heifers and 25 postpartum cows was fed MGA (.5 mg/hd per d) for 14 d, followed by an intravaginal P4 insert (CIDR) for 4 d (d 0 = CIDR insertion). Ovarian structures were monitored by transrectal ultrasonography from d -17 until ovulation. Blood samples were collected on d 0 and 1 for analysis of P4 concentration. At the time of CIDR insertion, animals were classified as having a persistent DF (PF) or not (NPF), with persistence being defined by the presence of a DF that developed during MGA feeding and was present for > 4 d in the absence of 1 ng/ml P4 on d 0. Persistent follicles developed in 13/34 heifers and 11/25 cows. In both heifers and cows, size of the DF at CIDR insertion was greater in the PF than NPF groups ($P < .01$). Emergence of a new DF occurred after CIDR insertion in 12/13 heifers and 10/11 cows in the PF groups compared to 10/21 heifers and 7/15 cows in the NPF groups. In heifers, emergence of the ovulatory DF occurred on d $1.9 \pm .9$ in the PF and d $.4 \pm .6$ in the NPF group and in cows, on d 1.7 ± 1.7 in the PF and d -3.1 ± 1.2 in the NPF group ($P < .05$). Size of the DF on d 7 did not differ between heifer groups ($12.2 \pm .3$ mm), but in cows, the NPF group had a larger ($P < .05$) DF on d 7 than the PF group ($16.3 \pm .9$ and 12.6 ± 1.0 mm, respectively). The d of ovulation did not differ between the PF and NPF groups in either heifers ($8.8 \pm .3$ d) or cows ($8.9 \pm .2$ d). Turnover of persistent follicles was induced in 92% of females with a CIDR. In females without persistent follicles on d 0, the treatment evaluated in this experiment appeared to allow normal follicular dynamics in heifers, but cows developed ovulatory follicles of extended lifespan.

Key Words: Persistent follicle, Beef cattle, Ovaries

536 Follicular development and reproductive maturation are precociously activated in heifers by early weaning and feeding a high concentrate diet. C. L. Gasser*, C. R. Burke, M. L. Mussard, E. J. Behlke, D. E. Grum, J. E. Kinder, and M. L. Day, *The Ohio State University, Columbus, OH.*

Wave-like patterns of follicular growth begin early in the life of heifers and dynamic maturational changes occur between 3 and 6 mo of age. Precocious puberty can be induced in >85% of heifers weaned at 2.5 mo of age and fed a high concentrate diet. We hypothesized that this precocious induction of puberty was the result of an acceleration of ovarian maturation in heifers. Crossbred Angus heifer calves were weaned at 104 ± 1.5 (n = 19; early weaned, EW) or 208 ± 2.5 d of age (n = 10; normal, NW). The EW heifers were fed a high concentrate (60%

corn; EWH, n = 10) or control diet (30% corn; EWC, n = 9). The NW heifers were fed the C diet after weaning. Heifers were weighed every two weeks after weaning. Daily trans-rectal ultrasonography was performed to determine number and size of follicles present through one complete follicular wave beginning at 18, 23, 28, 32, 36, and 44 (EW) or 32, 36, and 44 (NW) wk of age or until puberty. Blood samples were collected weekly starting at 22 (EW) or 31 (NW) wk of age. Heifers in the EWH treatment were heavier ($P < 0.01$) than EWC from 175 d of age through the end of the study (trt x age; $P < 0.05$). Body weights did not differ between EWC and NW. Maximum diameter of the dominant follicle (MaxDF) was affected by treatment ($P < 0.01$). At 28 wk of age, MaxDF was greater ($P < 0.01$) in EWH (12.9 ± 0.5 mm) than EWC (10.8 ± 0.4 mm). This difference continued through 32 wk of age. At 32 wk of age, MaxDF was greater ($P < 0.05$) in EWC than NW, but similar by 36 wk of age. All EWH, 5 of 9 EWC, and 5 of 10 NW attained puberty at less than 300 d of age. Mean age at puberty for EWH heifers was 252 ± 9.6 d. Heifers attaining puberty during the experiment continued with subsequent luteal phases as evidenced by cyclic patterns of progesterone concentrations. Ovarian maturation was accelerated in heifers that were weaned early and fed a high concentrate diet, resulting in precocious onset of puberty.

Key Words: Puberty, Follicle, Heifer

537 Effects of varying intervals from dominant follicle emergence to progestin removal on follicular dynamics and estrus synchronization. M.D. Utt*, F.D. Jousan, and W.E. Beal, *Virginia Polytechnic Institute and State University.*

The objective of the experiment was to determine if varying the interval from emergence of a new follicle to the end of an estrus synchronization treatment affected the synchrony of estrus. On Day 6 to 8 of the estrous cycle non-lactating beef cows were fitted with a progesterone-releasing intravaginal device (CIDR; n=49). At CIDR insertion each cow received an i.m. injection containing either 1 mg estradiol-17 β and 100 mg progesterone (EP) or 100 μ g of GnRH. CIDRs remained in place for 7 or 9 d. In addition, one half of the animals in each subgroup were treated with 37.5 mg PG at CIDR insertion to regress the corpus luteum (CL). All cows received 25 mg PG 24 h prior to CIDR removal. HeatWatch was used to monitor estrus. Ovarian follicular development was monitored by ultrasonography. Data was analyzed as a 2x2x2 factorial with: EP or GnRH; 7- or 9-d CIDR; and CL regressed or present as main effects. Interval from follicle emergence to CIDR removal was greater following GnRH treatment or in animals fitted with a CIDR for 9 d. Longer interval from follicle emergence to CIDR removal increased dominant follicle (DF) size at CIDR removal. Cows with larger DF at CIDR removal tended to exhibit estrus earlier, but no difference in the synchrony of estrus was detected. Cows with the CL regressed at CIDR insertion had a larger DF at CIDR removal and exhibited estrus earlier, however, synchrony of estrus was not affected. Treatments altered the interval from follicle emergence to progestin withdrawal and affected follicular dynamics, but did not improve the synchrony of estrus.

	EP	GnRH	CIDR 7	CIDR 9	CL present	CL regress	SE
Emergence to CIDR removal (d)	4.7 ^a	6.6 ^b	4.8 ^a	6.5 ^b	5.5	5.8	0.2
DF at CIDR removal (mm)	11.3 ^a	13.4 ^b	11.8 ^a	13.0 ^b	11.5 ^a	13.2 ^b	0.4
CIDR removal to estrus (h)	55.3	49.8	56.4	48.8	58.3 ^a	46.8 ^b	3.4

Least-square means within each row and main effect with uncommon superscripts differ ($P < 0.07$).

Key Words: Estrus synchronization, Follicle emergence, Progestin

538 Comparison of the efficiency of estradiol 17 β , estradiol benzoate, and estradiol cypionate in stimulating atresia of dominant follicles in beef heifers. J. D. Rhinehart*, A. M. Arnett, R. B. Hightshoe, and L. H. Anderson, *University of Kentucky*.

The objective of this experiment was to compare the efficacy of estradiol 17 β , estradiol benzoate and estradiol cypionate to induce regression of the dominant follicle and stimulate new wave recruitment in beef heifers. Fifteen crossbred heifers (BW = 431 kg, Age = 14.3 months), at random stages of the estrous cycle, were randomly assigned to one of three treatment groups. Heifers received a 1 mg i.m. injection of either estradiol 17 β (E17), estradiol benzoate (EB) or estradiol cypionate (ECP, Pharmacia & Upjohn, Kalamazoo, MI) on D 0. Follicle diameter was assessed via transrectal ultrasonography on D -3, D -1, D 3, D 4, and D 5. Pretreatment ultrasonography (D -3 and D -1) was used to determine the status of the dominant follicle at treatment. Dominant follicles were classified as growing, regressing or static. No difference ($p > .10$) was observed in the proportion of heifers in which regression of the dominant follicle was induced by E17 (80%), EB (100%) or ECP (60%) on D 3. Size of the dominant follicle tended to be smaller in the E17 (10.2 mm .82) and EB (10.2 mm .46) groups than in the ECP (12 mm .78) group at time of treatment (D 0; $p = 0.11$). The frequency of follicles classified as regressing tended ($p = 0.14$) to be greater in the ECP (3/5) treated group than in the E17 (1/5) or EB (1/5) groups. The number of days to new wave emergence (day at which multiple 5 mm follicles were observed) tended ($p = 0.13$) to be earlier in heifers treated with E17 (3.2 .22 days) and EB (3.2 .2 days) than that for heifers treated with ECP (4.0 days). Among treatment groups, the size of the dominant follicle on D5 was similar ($p = 0.434$) and averaged 9.27 1.7 mm (range = 3 - 18mm). We conclude that estradiol 17 β , estradiol benzoate and estradiol cypionate are equally effective in stimulating follicular atresia but that the recruitment of a new follicle wave after regression may be delayed in beef heifers administered estradiol cypionate.

Key Words: Estradiol, Follicle development

539 Effects of abomasal casein or essential amino acid infusions on splanchnic hormone metabolism in lactating dairy cows. C. K. Reynolds*, J. A. Benson¹, and A. Faulkner², ¹The University of Reading, Reading, UK, ²The Hannah Research Institute, Ayr, UK.

The objective was to determine the effects of increased postprandial supply of amino acids (AA) and the form of AA delivery on splanchnic metabolism of insulin and glucose-dependent insulinotropic polypeptide (GIP) in 6 multiparous, catheterized, rumen cannulated, early-lactation Holstein X Friesian cows (653 kg BW) fed alfalfa, grass silage and concentrates (33, 17 and 50 % of DM, respectively) hourly at 97 % of ad libitum DMI. Treatments were 4-d abomasal infusions (18 L/d) of water followed by either casein (CAA) or free essential AA (EAA) equal to 800 g milk protein/d for 6 d in a single-reversal experiment with a 5 wk interval. Plasma concentration (pg/ml) and splanchnic (portal-drained viscera [PDV] and liver) net hormone flux ($\mu\text{g/h}$) was measured hourly on the last day of infusions. Daily DMI and milk yield averaged 23.3 and 36.8 kg, respectively. There were no interactions ($P > 0.10$) between AA infusion and the form of delivery (CAA vs. EAA). Treatment infusions increased ($P < 0.01$) net PDV release (234 vs. 302) and liver removal (-97 vs. -155) of insulin, such that total splanchnic release (136 vs. 147) and arterial concentration (464 vs. 489) were not affected. Infusions had no effect ($P > 0.10$) on arterial concentration (406 \pm 12) or net PDV release (36 \pm 36), liver removal (-35 \pm 16), or total splanchnic release (2 \pm 36) of GIP. In conclusion, chronic increases in abomasal CAA or EAA supply did not increase net PDV release or arterial concentration of GIP in lactating dairy cows. This suggests that increased net PDV insulin release in response to abomasal AA infusion is not attributable to measurable changes in GIP metabolism.

Key Words: Splanchnic, Insulin, GIP

540 Efficacy of synthetic GnRH analogs for estrous synchronization. M. A. Cline*, J. B. Hall, and W. D. Whittier, *Virginia Polytechnic Institute and State University, Blacksburg, VA*.

Commercial analogs of GnRH appear equally effective for estrous synchronization; however, few studies have compared analogs. To test the hypothesis that there is no difference among GnRH analogs, two experiments were conducted to determine the effect of GnRH analogs, Cystorelin[®] (CYS, gonadorelin diacetate tetrahydrate, Merial Ltd, Iselin, NJ) and Factrel[®] (FAC, gonadorelin hydrochloride, Fort Dodge, Fort Dodge, IA), on pregnancy rate to synchronized AI, LH surge characteristics and ovarian follicular dynamics. In Experiment one, 496 beef cows from 7 herds, blocked by body condition and d postpartum, were randomly assigned to CYS or FAC treatment as part of the Ovsynch protocol (100 μg GnRH d 0, 25 mg Lutalyse d 7, 100 μg GnRH d 9). There was a tendency ($P = .09$) for more FAC cows to be pregnant at d 45 compared to CYS cows. However, only in one herd ($n = 32$) did FAC cows have greater pregnancy rate at d 45 than CYS cows. In Experiment two, 18 cycling luteal phase beef cows were assigned to receive either CYS or FAC as part of the Ovsynch protocol. On d 0 and 9, blood samples were collected every 15 min from -30 to 525 min post GnRH injection to characterize the LH surge. Ultrasound examination of ovarian structures was conducted daily from d -1 to d 11. Follicular phase CYS cows had a shorter time to maximum LH concentration than did FAC or luteal phase CYS cows (treatment X phase interaction, $P = .03$). The duration of the LH surge was shorter for follicular and luteal phase CYS cows than follicular or luteal phase FAC cows (treatment X phase interaction $P = .02$). Maximum LH concentration and area beneath the LH curve did not differ ($P > .05$) between treatments. Cows treated with CYS had more ($P = .02$) non-dominant follicles. GnRH analog did not affect ($P > .05$) the day of new follicular wave emergence, rate of dominant follicle growth, peak follicle size or dominant follicle size at second GnRH injection. We conclude that either product may be used in beef cows as part of timed AI protocols without compromising fertility.

Key Words: Beef Cattle, GnRH, Synchronization

541 Time of ovulation, serum LH and progesterone concentrations in estrous synchronized Brahman cows. S.R. Tatman¹, D.A. Neuendorff¹, A.W. Lewis¹, T.W. Wilson¹, C.R. Looney², G.L. Williams³, and R.D. Randel*¹, ¹Texas Agricultural Experiment Station, Overton, TX, ²Ovagenix, LP, Bryan, TX, ³Texas Agricultural Experiment Station, Beeville, TX.

The effect of PGF₂ α (PG; 25 mg Lutalyse[®], Upjohn) injection or an intravaginal progesterone releasing device (CIDR) combined with PG on ovulation time and hormone secretion was studied in dry, nonlactating, multiparous, Brahman cows. Normal estrous cycling cows were assigned to control (CO; $n=9$), PG ($n=11$), or CIDR + PG (CP; $n=11$). PG cows received PG on d 14 of the estrous cycle. CIDRs were removed after 7 d and PG was injected. Estrus (E) was detected using sterile bulls and continuous observation. Ovulation time was determined using ultrasonography at 2-hr intervals from E through ovulation, and serum samples were collected at the same times. One CO and PG cow had silent E, while six CP cows failed to respond to treatment ($P \leq 0.05$). Interval from E to ovulation (26.02 \pm 1.75 hrs, 25.78 \pm 2.35 hrs, and 27.45 \pm 1.66 hrs for CON, CP, and PG treatments respectively) and LH concentrations from hr 0 (E) to hr 22 were similar ($P \geq 0.30$). Although there was a time effect for LH ($P \leq 0.001$), there was no time by treatment interaction ($P \geq 0.70$). Cows that had an LH surge following E (4 of 9 CO, 1 of 5 CP, 5 of 10 PG cows; $P \geq 0.10$) were evaluated for intervals from peak LH to ovulation, E to ovulation, and E to peak LH, and data were pooled as no differences ($P \geq 0.10$) were detected among treatments for these parameters (26.15 \pm 3.14 hr, 30.99 \pm 2.71 hr, 4.80 \pm 1.88 hr) nor for peak LH (28.74 \pm 9.07 ng/ml; respectively). Progesterone on days 6, 7, 8, 12, 13, and 14 differed ($P \leq 0.001$) by day but there was no treatment or day by treatment interaction ($P \geq 0.10$). Synchronization treatment did not appear to alter LH and progesterone profiles in Brahman cows that showed E during the synchronization period. The CP treatment resulted in fewer cows showing E within the 120 hr period. Neither time of ovulation relative to E or the LH peak, nor interval from E to LH peak appeared to be affected by treatment.

Key Words: Brahman female, ovulation, LH

542 In vitro fertilization of cumulus-intact and cumulus-free bovine oocytes in medium supplemented with heparin and different concentrations of calf serum. Parviz Tajik^{*1}, ¹*Faculty of Veterinary Medicine, University of Tehran.*

Bovine follicular oocytes were isolated from ovaries recovered from a local slaughter house within 2h. Oocyte-cumulus complexes were washed 4 times with TCM-199 (with Earle's salts) and supplemented with 10% (v/v) heat inactivated fetal calf serum (FCS), 100 IU/ml penicillin G and 0.1 mg/ml streptomycin. Every ten oocytes with compact cumulus cells were transferred into a 0.1-ml drop of the culture medium. Covered with paraffin oil which had been previously kept about 2h in a CO₂ incubator before the oocytes were added. After culture of oocytes for 22-24h, they were randomly divided into 2 groups. One left intact and the other freed from cumulus and corona cells by treatment with PBS containing 0.1% hyaluronidase for 10-20min and by repeat passage through a fine pipette. Oocytes were then washed twice with BO (Brackett and Oliphant, 1975) medium containing heparin and different concentrations of calf serum (CS) into a 50-μl drop of the same medium. The transferred oocyte dishes were kept in a CO₂ incubator for about 30min until the spermatozoa were added for fertilization. Semen preparations and insemination were according to Tajik et al, 1993. Table shows the effect of different concentrations of CS on penetration in vitro of cumulus-intact and cumulus-free bovine oocytes in a medium containing heparin.

Cumulus	CS concen- trations	No oocytes examined	oocytes) penetrated (%)
+	0	31	15(48)
+	5%	31	23(74)
+	10%	31	23(74)
+	20%	30	13(43)
-	0	40	0
-	5%	41	41(100)
-	10%	43	36(83)
-	20%	46	10(22)

In the present situation it can be concluded that, there is no penetration of cumulus-free oocytes in the BO medium lacking protein supplement (in the present study CS). However, 48% of cumulus-intact oocytes were penetrated. High concentration (20%) of CS is not recommended for in vitro fertilization of bovine oocytes.

1.Brackett BG., and Oliphant G. (1975) Biol. Reprod. 12:260-274.
2.Tajik P., Niwa K. and Murase T. (1993) Theriogenology 40:949-958.

Key Words: In vitro fertilization, Bovine oocytes, Calf serum

543 The effect of small doses of Naloxone on the onset and duration of the first oestrus after weaning in the sow. V. Fuentes^{*}, R. Orozco, and A. Hernández, ¹*Centro Universitario de los Altos Universidad de Guadalajara, México.*

This work was carried out with the objective of observing the effect of small doses of naloxone on the onset and duration of the first Oestrus post weaning in the sow. For this purpose 32 multiparous sows were chosen and allocated at random in two groups of 16 animals each. Group 1 was treated with 2 mg of naloxone im administered every 12 hrs. Treatment was initiated since 3 days before the day of weaning and continued for three days after. Group 2 received similar treatment as group 2, and injected with 2 ml of saline solution. It was observed that in sows treated with naloxone oestrus was evident at 85.8 ± 5.2 hr after weaning. In the control group treated with saline injections oestrus was detected at 108.37 ± 5.2 hr after weaning (P<0.05). Further more it was also observed that the duration of oestrus was of 89.6 ± 3.9 hr, and 49.6 ± hr for naloxone and saline treated sows respectively(P<0.05) It was concluded that naloxone treatment gives further support to endogenous opioids as modulators of reproduction.

Key Words: naloxone, sow, oestrus

544 Evaluating the benefit of melengestrol acetate (MGA) in synchronizing dairy heifers. R. L. Saltman^{*1}, A. P. Belschner¹, J. F. Boucher¹, C. E. Gardner², and A. J. Wormuth², ¹*Pharmacia Animal Health, Kalamazoo, MI,* ²*Agway Feed & Nutrition, Shippensburg, PA.*

The purpose of this study was to evaluate the effect of melengestrol acetate (MGA) on heat detection and conception rate in breeding age dairy heifers. The study was a generalized block design with blocking based on week of assignment. Heifers were randomly assigned to either the control group or the MGA group. On the day of assignment, the MGA treatment group began receiving 0.5 mg MGA/head/day in their feed which continued for 14 consecutive days. The control group did not receive MGA. Nineteen days after withdrawing the MGA, all heifers (both MGA and controls) received a 5 mL injection of LUTALYSE® Sterile Solution (prostaglandin F2α). All heifers were observed for estrus for the 7 days following the Lutalyse injection. All heifers seen in estrus during this period were inseminated. All heifers not seen in estrus in the 7 days following the Lutalyse injection received a second Lutalyse injection 14 days after the first injection. All heifers were observed for estrus for the 7 days following the second Lutalyse injection. All heifers seen in estrus during this period were inseminated. After the seven day period following the second injection, heifers not seen in estrus or returning to estrus were maintained on study and were bred at signs of estrus. Pregnancy was determined by rectal palpation at least 40 days post-insemination. Significant differences were seen in percent of heifers inseminated after first Lutalyse injection (71.6 in controls vs. 91.8 in the MGA treatment group), pregnancy rate of all heifers 15 days after the first Lutalyse injection (52.7 vs. 71.2), days from the first Lutalyse injection to first breeding (8.8 vs. 5.0), variance in days from the first Lutalyse injection to first breeding for heifers in heat after the first Lutalyse injection (0.9487 vs. 0.5096), and days from the first Lutalyse injection to 90% pregnancy in the treatment group (23.0 vs. 13.5).

Key Words: Reproduction, Dairy heifers, Melengestrol acetate

545 Effects of progesterone (P4) with an estradiol-17beta (E2β) 7day controlled internal drug releasing (CIDR) insert on fertility to timed insemination in beef females. J.A. Meyer^{*1}, C.R. Looney², R.S. Walker¹, C.R. Long², M.L. Day³, and D.W. Forrest¹, ¹*Texas A&M University, College Station, TX,* ²*Ovagenix LLC, College Station, TX,* ³*The Ohio State University, Columbus, Ohio.*

This study compared pregnancy rates (PR) to Timed AI (TAI) between cows that did or did not receive P4 (50 mg, IM) in a CIDR-based TAI program. Cows in the control group (n = 379) received E2β (2.5 mg, IM) upon CIDR insertion (d 0), prostaglandin F2α (25 mg, IM) at CIDR removal (d 7) and E2β (1 mg, IM) 24 h post-CIDR removal (d 8). The treatment group (n = 383) received the same protocol with the addition of P4 (50 mg, IM) upon CIDR insertion. All cows were TAI 30 h post-final E2β injection. Females were located in 5 breeding herds of multiparous Angus or Charolais in Texas and were TAI by the same technician (tech) in two herds, by a different tech in one herd and by two or more techs in two herds. Tech code was not recorded by TAI of each female. TAI-PR was defined as cows (n) pregnant to TAI divided by cows (n) in each treatment group. Bulls were joined with cows for 60 d after the TAI for determination of final PR. Logistical regression analyses identified affect of breed (P< 0.3), parity (P< 0.6) and age (P< 0.4) on TAI-PR. TAI-PR was 43.7±0.24% for control and 41.5±0.34% for P4-treated cows (P< 0.5). Location of trial affected (P< 0.01) TAI-PR. TAI-PR was greater (P< 0.03) for Herds 2, 3, and 4, when compared to Herd 1. Herd 5 had the lowest (P< 0.01) TAI-PR when compared to contemporary herds. Final PR were 82.8±0.13% for control and 79.4±0.12% for P4-treated cows (P< 0.22). It was concluded that an injection of P4 at time of CIDR insertion did not influence pregnancy rates to TAI.

Trait	Herd 1	Herd 2	Herd 3	Herd 4	Herd 5
n	34	20	191	45	472
TAI-PR	52.9 ±0.34 ^{bc}	64.9 ±0.46 ^{ac}	57.5 ±0.14 ^{ac}	60.0 ±0.30 ^{ac}	33.1 ±0.09 ^d
Final PR	97.1 ±0.16 ^c	90.0 ±0.74 ^d	71.7 ±0.16 ^f	97.7 ±0.13 ^c	81.8 ±0.12 ^e

a,b P < 0.03. c,d,e,f P < 0.01.

Key Words: CIDR, Estradiol, Timed AI

546 Development of standard methods to estimate manure production and nutrient characteristics from dairy cattle. D. Meyer^{*1}, J. Harrison², R. Kincaid², R. Koelsch³, D. Mertens⁴, W. Powers⁵, W. Weiss⁵, and P. Wright⁷, ¹*University of California, Davis*, ²*Washington State University*, ³*University of Nebraska*, ⁴*Agricultural Research Service, Madison, WI*, ⁵*Iowa State University*.

Standard tables published by the American Society of Agricultural Engineers identify production and nutrient characteristics of manure from livestock and poultry. The column used to represent dairy animals has been modified once since 1969. The modification merged two columns: heifers and mature animals. This combined column is being used beyond its original intent with the onset of comprehensive nutrient management plans. The table values were not intended to be used to estimate nutrients available for land application. Emphasis of current regulatory trends makes it imperative to have a more precise method to estimate nutrient excretion. The objectives of the current evaluation were to expand columns in the existing table to account for variation in growth and production levels and provide reasonable estimates of manure volume and nutrient excretion. Additionally, equations were developed to provide more precise estimates of nutrient excretion on a site-specific basis. Data from published and non-published experiments were reviewed to estimate manure and nutrient excretion based on dietary parameters. Columns representing a reasonable range in milk production quantities were developed at specific dry matter intake and nutrient composition. Rows accounted for daily excretion of feces, urine, TKN, P, K, Ca, Na, Cl, S, and some micro-elements. Equations were developed for the same parameters for use by dairies where land available for nutrient application is limited or environmental considerations require more precise estimates of nutrients excreted.

Key Words: Dairy, Manure Production, Nutrient Excretion

547 Evaluation of manure production and nutrient characteristics from dairy goats. D. Meyer^{*1}, E. Tooman, M. Hyman, and M. Lie, ¹*University of California, Davis CA*.

Standard tables published by the American Society of Agricultural Engineers identify production and nutrient characteristics of manure from livestock and poultry. The column used to represent goats does not differentiate between dairy and meat animals. The column assumes a linear relationship between body size and manure production or nutrient excretion. Table values are 4.1, 0.045, 0.011, and 0.031 percent of body weight for daily manure production, N, P and K excretion. Four lactating and three non-lactating, non-bred yearling does underwent total collections for seven days. A standardized pelleted goat ration was fed. Animals were fitted with indwelling urinary catheters. Feed, water, Orts, milk, feces, and urine were measured daily and analyzed for DM, N, P, K, Ca, Na, Mg, Cl and urea. Dietary N concentration was 2.87%. Regression analyses resulted in equations: manure production (kg/d) = $1.97 \times \text{DMI (kg/d)}$; N excretion (g/d) = $19.4 + .35 \times \text{N intake (g/d)}$. These data do not support the existing table assumption of a linear relationship between body weight and manure production or N excretion.

Key Words: Dairy Goats, Manure Production, Nutrient Excretion

548 Horse manure production and composition. Jose Bicudo^{*1}, Laurie Lawrence¹, and Eileen Wheeler², ¹*University of Kentucky*, ²*Pennsylvania State University*.

The amount, composition, and consistency of horse manure influence management and facility design. Physical and chemical properties of manure are mostly affected by the ration and environment. Physiological state (work, lactation, etc) of horses affects manure characteristics through ration composition and feed conversion efficiency under a given environment. Currently, most horse manure composition and production values do not account for differences in physiological state. The purpose of this study was to summarize available information on horse manure from as many sources as possible. Values for amounts and characteristics of fresh manure (feces and urine, as excreted), stable manure (with bedding), and as composted manure, were obtained from existing standards and databases. Public standards included those published by

ASAE, MWPS and NRCS. In addition, published nutrition study values for nitrogen (N), phosphorus (P) and potassium (K) excretion were summarized. Values for N were relatively consistent among published sources, but there were larger variations for P and K that appear related to diet composition. When possible, data were classified by physiological state of the horse. There was reasonable agreement on average fresh manure production (23 kg). Most available stable manure values were associated with straw bedding. The second most common horse bedding was wood (shavings, chips or sawdust). There was wide variation in the amount of bedding incorporated into stable manure, which affects composition and amount. Using the limited values provided by commercial composting facilities, it appeared that nutrient characteristics of composted manure were similar to stable manure. Very little information was available on the organic matter, as measured by the biological or chemical oxygen demand, and micronutrient content of fresh, stable and composted horse manure. These data are needed to evaluate potential environmental impacts and degree of stabilization of stockpiled and composted manure.

Key Words: Manure, Environment, Composting

549 Development of standard methods to estimate manure production and nutrient characteristics from livestock operations: Beef cattle. G. Erickson^{*1}, B. Auverman², R. Eigenberg³, W. Greene², T. Klopfenstein¹, and R. Koelsch¹, ¹*University of Nebraska-Lincoln*, ²*Texas A&M University*, ³*USDA Meat Animal Research Center*.

Standards set forth by the American Society of Agricultural Engineers for beef cattle manure characteristics are being updated. Only confined beef feedlot cattle will be evaluated for nutrient excretion. Manure is not collected from grazing livestock and accurate estimation of excretion across production systems for grazing livestock is difficult. Feedlot cattle will be separated into two categories: Calf-feds and Yearling cattle. Calf-feds are calves weaned and fed for >180 d in feedlots whereas yearlings would be defined as cattle that are >18 months of age at slaughter and fed for <120 d. These distinct types of cattle excrete quite different amounts of nutrients per d and encompass most finishing cattle. All other cattle types (Ex: short yearlings) can be extrapolated from these data. A feed intake and retention based model will be utilized for estimating nutrient excretion for given production situations. Model inputs will require DMI, initial and final body weights, and duration. A sensitivity analysis will be conducted to determine which inputs are vital for model use and accuracy. Estimating retained nutrients will be based on retained energy and retained protein equations developed by the NRC (1996). All other nutrients with available data will be calculated from retained protein. Nutrient excretion will be calculated as nutrient input minus nutrient retained. Model outputs will estimate DM, organic matter, N, P, K, Na, and selected trace element excretion similar to current table values. Recent survey data of feedlot nutritionists' formulation practices will allow for determination of appropriate average excretion values for N and P. The model may not accurately predict nutrient excretion for all diet scenarios utilized in the industry but this simplified approach will provide good estimates for the majority of feedlot cattle fed today.

Key Words: Nutrient excretion, Feedlot cattle, Standards

550 Estimation of manure nutrient excretion from swine based upon diet composition and feed intake. S. Carter^{*}, P. Westerman, T. van Kempen, G. Cromwell, G. Hill, G. Shurson, B. Richert, and K. Casey, *FASS-ASAE Manure Standards Review Committee*.

Accurate estimation of manure and nutrient excretion is an essential component of environmental planning for new and existing swine production systems. Estimates of excretion generally are based on values published by the American Society of Agricultural Engineers (ASAE), Natural Resources Conservation Service (NRCS), and Midwest Plan Service (MWSP). However, these current estimates are average values and do not directly allow for modifying excretion based on changes in diet and feed intake. The increasing variety of feed ingredient options, changes in nutritional programs to match improving genetic potential,

and feeding strategies designed to reduce nutrient excretion impact the amount and composition of nutrient excretion. Standard methods for estimating nutrient excretion must adapt to these changes and provide methodologies reflective of the specific nutritional programs used in swine production. The ASAE, Federation of Animal Science Societies (FASS), and NRCS have initiated a joint effort to review existing standards and develop new, feed program-based models for estimating manure and nutrient excretion. The basic approach is a mass balance that calculates nutrient excretion as the difference in nutrient intake (diet and feed intake) and nutrient retention (production level, lean growth potential, etc). Published and recent unpublished studies that measured excretion will be reviewed for verifying this approach. Estimates will be provided for various classes of swine (e.g., gestating and lactating sows, finishing pigs) and for stage of growth or weight within class when appropriate. Nutrients anticipated for inclusion are N, P, K, Cu and Zn. If possible, volume and weight of manure excretion will be estimated based on dry matter intake and digestibility, with assumptions for water intake and feed wastage included. The outcome of the proposed work is to accurately estimate manure and nutrient excretion based upon diet composition and feed intake for various classes of swine.

Key Words: Swine, Nutrient excretion, Modeling

551 Opportunities for the animal scientist in the CNMP process and the EPA CAFO rule. A. L. Sutton*¹, ¹Purdue University.

The US. Environmental Protection Agency (EPA) is scheduled to adopt a new rule in December 2002 affecting confined animal feeding operations (CAFO) and potentially affecting animal feeding operations (AFO). The final decision has not been made designating the specific criteria for CAFO and AFO, however, in a unified strategy published jointly with USDA in 1999 and in the proposed EPA rule, EPA strongly recommended livestock and poultry operations to implement a comprehensive nutrient management plan (CNMP) to comply with the new regulations. If 1000 animal units remain as the level above which EPA designates CAFO, then over 11,000 livestock and poultry operations will need to create CNMP for their operations. If AFO are required to obtain CNMP (currently considered as voluntary) at the level of 300 AU or more, then over 45,000 operations will need the CNMP. One component of the CNMP is feed management that can affect the nutrient flow and balance of nutrients on the livestock and poultry operation. In many cases, feed ingredients are a major source of nutrients imported onto the operation. Research has shown that new diet manipulation technology and feed management practices can potentially reduce nutrient excretions from 10 to 60%. However, much of this technology has not been implemented in livestock and poultry operations. With the advent of new regulations being enacted, implementation of new technologies that are economically sound and environmentally sustainable is encouraged. Animal nutritionists and management specialists potentially have a key role in implementing scientifically sound and timely information to the animal industries. This can be accomplished by partnering with CNMP planners, becoming certified to conduct the CNMP process and/or assisting producers with diet formulations and feeding management practices. Technical service providers, nutrition consultants, extension specialists are in a position to assist in the CNMP process to maximize the potential to control the nutrient flow and balance within the livestock and poultry operations. The list of agencies and their role in the development and implementation of the CNMP will be discussed.

Key Words: Regulations, Feed Management, Diet Manipulation

552 National standards for estimating manure nutrient excretion based upon animal feed program. W. Powers*¹ and R. Koelsch², ¹Iowa State University, ²University of Nebraska.

Environmental planning in animal production systems often requires an estimate of nutrient excretion. Standard values published by the Natural Resources Conservation Service (NRCS), American Society of Agricultural Engineers (ASAE) and Midwest Plan Service (MWSP) commonly have been used for this purpose. However, these current procedures do not reflect the impact of animal dietary decisions by producers on nutrient excretion. The increasing variety of feed ingredient options, changes in nutritional programs to match improving genetic potential, and feeding strategies designed to reduce nutrient excretion impact amount and

composition of nutrient excretion. Standard methods for estimating nutrient excretion must adapt to these changes and provide methodologies reflective of the specific nutritional programs used in animal production. The ASAE, Federation of Animal Science Societies (FASS), and NRCS have initiated a joint effort to review existing standards and develop new, feed program-based models for estimating manure and nutrient excretion. Seven work groups have been established to recommend standards for the following three topics: 1. As Excreted - Feed Intake Summary: Characteristics of excreted manure will be defined based upon a mass balance approach using estimates of feed intake and animal retention and calculation of excretion by difference or other appropriate relationships. Work groups for five species (dairy, beef, poultry, swine, and equine) are established. 2. As Excreted - Average Summary: A review and modification of the existing ASAE D384.1 tables would define average characteristics of excreted manure for typical feed programs. 3. As Removed - Average Summary: An update or modification of MWPS-18 (Section 1) on Manure Characteristics would summarize typical manure characteristics as removed from typical animal housing and manure storage systems.

Key Words: Nutrient Excretion, Manure, Environment

553 Estimating nutrients and characteristics of manure for land application following storage. W.J. Powers*¹, J.C. Lorimor¹, and A. Sutton², ¹Iowa State University, ²Purdue University.

Estimates of manure nutrients and characteristics are necessary for nutrient utilization planning purposes. Estimates of excreted nutrients can be obtained following a nutritional approach whereby mass balances of nutrients are established. Losses during storage that are specific to manure handling practices can be estimated and nutrients remaining, calculated. While calculations using site-specific data are most desirable for planning nutrient use of an individual site, table values are helpful in serving as a reference tool to provide values for non-specific scenarios. As part of a joint effort between the American Society of Agricultural Engineers (ASAE), the Natural Resources Conservation Service (NRCS), and the Federation of Animal Science Societies (FASS) currently available tables are under revision. The revised tables will reflect modern manure management, animal management, and feed management practices. Data will be solicited and included for animal production stages that reflect current operational practices. Specific tasks addressed by committee are to 1) define the species and management systems to be included in table, 2) define the appropriate physical, chemical, and biological characteristics to be included in table, 3) identify for each species/management system where credible data is available, 4) recommend average characteristics for manure as removed from animal housing or manure storage system, and 5) determine the value and/or need for reporting a range or standard deviation for characteristics. Characteristics to be included in the table include nitrogen, phosphorus, moisture content, and mass. Additional nutrients will be included where data are available. Production groups for each species will consider feed and water system contributions to nutrients stored in addition to manure characteristics influenced by manure handling practices. While estimates, only, will be provided in the new tables, the tables will serve as a starting point for predicting nutrients available following storage.

Key Words: manure, storage, nutrients

554 A phosphorus management survey on Northeast and Mid-Atlantic dairy farms in the US. J. D. Toth*¹, Z. Dou¹, J. D. Ferguson¹, R. J. Munson¹, L. E. Chase², K. F. Knowlton³, R. A. Kohn⁴, J. T. Sims⁵, and Z. Wu⁶, ¹University of Pennsylvania, ²Cornell University, ³Virginia Polytechnic Institute, ⁴University of Maryland, ⁵University of Delaware, ⁶Penn State University.

On many farms rations formulated for lactating dairy cows exceed National Research Council recommendations for phosphorus (P). Ration P in excess of that required for body maintenance, milk production and reproduction will be excreted in manure, mostly in chemical forms potentially subject to loss in the environment. As the initial phase of a four-year, six-institution collaborative research project designed to develop optimal P management technologies in the Mid-Atlantic and Northeast region, we surveyed dairy farmers in New York (NY), Pennsylvania (PA), Delaware (DE), Maryland (MD) and Virginia (VA) on production and herd management parameters and producer opinions on issues related to dietary P levels. Questionnaires were mailed in January

2002 to a randomly selected subsample of 2500 out of the approximately 18000 dairy farms in the region. Rate of response exceeded 25%. Responses from the small number of dairy operations in DE were grouped with PA. Holstein (91% of responses) was the predominant dairy breed across all states. Lactating herd size averaged 97 for MD, NY and VA and 64 for PA. Mean daily milk production was 28 kg and similar for all states. Routine forage testing was reported by 80% of MD respondents and 82% from VA compared to 73% in NY and 72% in PA. In NY and PA, 18% of respondents reported they were aware of their ration P content compared to 28% in MD and 30% in VA. The majority of respondents replied they were aware of nutrient management regulations and issues, 98% in MD, 92% in VA, 87% in PA and 79% in NY. When asked if they had reduced diet P for their lactating herd, 28% of MD respondents replied affirmative, 21% of NY, 14% of PA and 29% of VA respondents. Questionnaire responses will aid us in identifying producers for project participation and in designing cooperative extension programs for improved P management in the region.

Key Words: Phosphorus, Dairy Rations, Dairy Producer Survey

555 The effect of improved crop yields on whole-farm mass nutrient balance. G.L. Albrecht¹, D.G. Fox¹, G.J. Birdsall¹, H.G. Nafziger¹, L.E. Chase¹, and J.H. Cherney², ¹*Cornell University Department of Animal Science*, ²*Cornell University Department of Crop and Soil Sciences*.

Prior research efforts have quantified that approximately two-thirds of nutrients imported onto a dairy remain on the farm, with purchased feeds comprising two-thirds of the imported nutrients. Replacing purchased feeds with farm-raised forages and grains can reduce the contribution of imported nutrients to nutrient balances on farms while maintaining or improving animal performance. Furthermore, reducing the mass balance of nutrients on farms has the potential to curb nutrient losses from agricultural production. A study was conducted to evaluate the changes in mass nutrient balance resulting from improvements in crop management and, subsequently, yield on a 400-cow dairy farm in Central New York State. Baseline crop production was documented during the 1999-growing season and a mass nutrient balance was determined for the following 12-month feeding period (FP1). The average 1999-growing season yields were similar to average yields from the 1996, 1997, and 1998-growing seasons; thus, such yields were assumed to represent the historical performance of the cropping program. Crop management was evaluated and a plan for improvement was developed and implemented during the 2000-growing season. The primary area for improvement centered on forage yield, because forage quality was consistently adequate at the case study farm. A second mass nutrient balance was performed for the subsequent 12-month feeding period (FP2). Through improvements in crop rotations, agronomic nutrient management, corn hybrid and maturity selection, weed control, and human resource management, corn silage, alfalfa hay crop silage, and grass hay crop silage yields were increased by 2.3, 1.8, and 1.4 tonnes of dry matter/ha, respectively, relative to past performance. The increase in farm-raised forage inventories allowed for reductions in purchased hay, corn silage, and protein concentrates and increases in overall forage content in the diets, relative to FP1. The rolling herd average remained at similar levels (11,540 kg for FP1 and 11,549 kg for FP2). The changes resulted in a 1.8, 1.7, and 6.8 tonne/yr decrease in whole-farm mass nutrient balance of nitrogen, phosphorus, and potassium, respectively.

Key Words: nutrient management, forage management, mass nutrient balance

556 Flows of N through a dairy herd. J. D. Ferguson^{*1}, Z. Dou¹, B. Vecchiarelli¹, S. Lees¹, J. Beach¹, and C. F. Ramberg, Jr.¹, ¹*University of Pennsylvania, School of Veterinary Medicine*.

The Marshak Dairy, a 200 free stall, green house facility was used to monitor N flow from feeding to waste collection. Animal housing and management was as follows: cows were housed in groups of 10 to 40 cows; stall surfaces were mattresses bedded with sawdust or wood shavings, alley ways were grooved concrete, feeds were offered as a TMR once a day to 10% refusal, and milking occurred twice a day. Rations were formulated for three or four groups based on production and stage of lactation using the CPM Dairy ration program. Alley ways, parlor, and holding area were cleaned twice a day by flushing with recirculated waste water. Solids were separated by conveyor with liquids and fine

particles collected by gravity to a holding pond. Liquid from the first pond was collected into a second pond for recirculation for flushing. One week per month was chosen for data collection. During the sampling week, 3 of 5 days were selected to collect samples of TMR, Orts, feces, urine, blood, flush liquid, and solids from the separator pile. Daily samples of feed, feces, Orts, and separator pile were composited and analyzed for DM, N, lignin, and mineral composition. Urine and blood were analyzed for ammonia, urea, and creatinine concentration. In addition urine was analyzed for P and K content. Feces and flush liquid were analyzed for ammonia, urea, P and K content. Daily records during the sampling week were collected for milk volume. Milk samples from Tuesday evening and Wednesday morning milkings were composited for for analysis of fat, true protein, milk urea, and somatic cell content by PA-DHIA milk laboratory. A total of 11 months were sampled from Nov., 2000 through Oct., 2001. Across all months, 146.4 animals were housed in the facility. Mean daily feed offered contained 80,125 g of N. Milk true N was 20,907 g (26.1% of intake); fecal N was 36,827 g (46.0% of intake); and urinary N was 22,801 g (28.5% of intake). Excreted urine was calculated to contain 21,835 g of urea N, of which only 1269 g of urea N was collected in the flush liquid at the separator. Ammonia N content of the flush liquid increased by 461 g after cleaning the facility. It was estimated that 25.1% of intake N was lost through ammonia volatilization from the dairy. Further volatile losses occur during storage of waste liquid.

Key Words: N flow, Dairy cattle, Atmospheric losses

557 Excretion of urine, feces, and nitrogen by lactating Holstein cows. L. M. Johnson^{*1}, J. H. Harrison¹, D. Davidson¹, and R. Kincaid², ¹*Washington State University, Puyallup, WA*, ²*Washington State University, Pullman, WA*.

Data from 12 total collection metabolism studies conducted at Washington State University were combined and analyzed for excretion of urine, feces, and nitrogen. The objective was to evaluate differences in the amount of feces and urine excreted at varying levels of milk production. Urine and fecal output (wet basis), nitrogen intake, and nitrogen excreted in the urine, feces, and milk were measured for cows producing milk at the following levels; 1) ≤ 20 , 2) between 20 and 30, 3) between 30 and 40, and 4) ≥ 40 kg per day. These data indicates that fecal output for a Holstein cow producing between 20 and 30 kg of milk per day will be similar to ASAE standards. Cows producing milk in excess of 30 kg per day excrete approximately 10 to 25 kg per day of wet feces in excess of ASAE standards. Predicted nitrogen excreted in the feces, urine, and milk was lower for the ASAE standards compared to data summarized in this study. These results suggest that the ASAE tables need to be revised to account for fecal and nitrogen output in high producing dairy cattle.

Item	ASAE standard for dairy cows		$\geq 20 - \leq 20$ kg		$\geq 30 - \leq 30$ kg		≤ 40 kg		≥ 40 kg	
	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
(kg/d)										
Milk			14.7	5.5	25.0	3.1	34.4	3.0	50.6	12.9
(kg/d per 1000 kg of BW)										
Feces	60		44.1	19.0	61.0	14.3	70.6	15.9	86.2	23.1
Urine			36.3	13.2	41.8	14.0	39.6	12.9	44.1	12.7
Intake N			0.820	0.23	0.994	0.20	0.960	0.14	1.009	0.20
Excrete N	0.45	0.096	0.811	0.15	0.988	0.18	1.049	0.15	1.265	0.30
Fecal N			0.271	0.09	0.345	0.08	0.366	0.08	0.464	0.14
Urine N			0.360	0.10	0.405	0.11	0.370	0.10	0.354	0.09
Milk N			0.160	0.04	0.238	0.05	0.313	0.06	0.446	0.14

Key Words: feces, nitrogen

558 Manure management, odor and diseases control. A. Itkin^{*}, *A.I. Engineering Services, Ontario, Canada*.

Livestock producers are receiving much criticism for creating pollution and disease problems. Concurrently, farmers are experiencing production problems (costly manure removal, energy consumption, medicine cost and most importantly, barns are not safe working places). One of the long-standing and costly problems of handling manure has been the

absence of a simple, reliable, accurate and long-lasting system of manure handling were used in the industry, which assumed that manure would be held for some time in the barn. The Enterprise tendency to lager livestock production, with a concern for the quality of food in an efficient environment, requires a number of radical changes and development of new methods for proper and efficient manure management. I have devoted years to research, development, design and construction of livestock production (manure handling) in Russia and would like to share my approach to manure management. The barn environment has a major impact on animals and the objective is to provide an environment in the barn, which will allow achievement of optimal utilization of feed and highest production. In order to provide the livestock industry with adequate manure handling systems, which will be both technically and economically competitive. It is necessary to apply plumbing technology principles by excluding manure storage from being in close proximity to animals in the barn. This technology requires a manure reception structure with a flushing system in the pen and piping system for transportation of liquid manure. The plumbing technology approach offers

proper sanitation and facilitates the barn being kept clean. My proven technology solves many existing problems:

1. Improved barn design eliminates odor in and around the barn. This will eliminate the odor nuisance with much less ventilation. I also allows for the ability to design a multi-level barn for wean-to-finish production.
2. Significantly improved environment increases productivity (pigs have higher rates of growth). Since the new system excludes retention of manure in the pen, it results in pigs being dry and clean.
3. Prevents spreading of diseases. Pigs will not have contact between pens through manure. This will allow for reduction in medicine consumption.
4. Rational use of water reduces the volume of liquid manure by 4-5 times and brings the moisture to 92-95% selection of proper treatment and utilization technologies.
5. The technology reduces capital and maintenance cost and does not require special expertise to operate. The system requires a lesser degree of farmer's attention and can be incorporated into a computerized plant system. A completely new engineering design approach is a superior alternative in the design for livestock production. New and existing livestock producers will highly benefit from implementation of this technology.

Ruminant Nutrition
Fat

559 Use of the CPM-Dairy fat sub-model to predict absorption of total and individual LCFA from different fat supplements. P.J. Moate*, R.C. Boston, and W. Chalupa, *University of Pennsylvania, Kennett Square, PA.*

There is growing interest in the non-caloric effects of feeding fat to dairy cows. Improved fertility is associated with increased absorption of linoleic acid (C18:2) and low milk fat syndrome is associated with increased absorption of vaccenic acid (C18:1trans). Until now, no ration formulation programs have predicted the absorption of the major LCFA in dairy cows. CPM-Dairy has a new fat sub-model that describes intake, ruminal lipolysis, ruminal biohydrogenation, de novo synthesis of LCFA in the rumen and intestinal absorption of C12:0, C14:0, C16:0, C16:1, C18:0, C18:1trans, C18:2 and C18:3 acids. In this simulated comparison, a 650 kg cow was fed 25 kg of a basal diet (26% alfalfa silage, 26% corn silage, 22% steam-flaked corn, 14% soybean, 2% blood meal and 10% mineral mix/LCFA supplement). The basal diet provided 500 g of LCFA. In addition, supplemental LCFA (400 g) were provided in the mineral mix in the form of Megalac (M), Megalac R (MR), Energy Booster (EB), Tallow (T), Roasted Soybeans (RSB) or Whole Cotton Seed (WCS). Intestinal digestibilities of M and MR were predicted to be higher than the basal diet because rumen non-lipolysed fatty acids in the form of calcium salts have higher intestinal digestibilities than rumen non-lipolysed fatty acids in the form of glycerides. To increase amounts of C18:2 absorbed, C18:2 must either be in a form that protects it from ruminal lipolysis (MR) or the feed ingredient must contain high amounts of C18:2 (RSB). However, with RSB, there is also an increase in absorbed C18:1trans which might lower milk fat test.

Parameter	Basal	M	MR	EB	T	RSB	WCS
LCFA †							
Intake (g/d)	500	400	400	400	400	400	400
Rumen Escape (g/d)	15	54	54	0	2	16	1
Duodenum (g/d)	659	400	400	400	400	404	404
Absorbed (g/d)	479	327	337	291	293	298	300
Intest. Digestion (%)	73	82	84	73	73	74	74
C18:1 trans †							
Intake (g/d)	0.1	0.0	0.0	1.6	5.2	0.0	0.0
Duodenum (g/d)	37.0	2.3	11.0	1.9	5.6	39.7	30.3
Absorbed (g/d)	29.0	1.8	9.1	1.5	4.4	31.2	23.8
C18:2 †							
Intake (g/d)	225	28	127	7.2	18.8	230	157
Duodenum (g/d)	58	17	77	0.7	2.2	54	12
Absorbed (g/d)	48	17	76	0.6	1.8	43	10

† from basal diet or supplement

Key Words: Cattle, Fatty Acids, Digestion Model

560 Effects of feeding raw and micronized flaxseed on yield and composition of milk from Holstein cows. Arif Mustafa*¹, Yvan Chouinard², and David Christensen³, ¹*McGill University*, ²*Universit Laval*, ³*University of Saskatchewan*.

Nine multiparous Holstein cows were used in three 3 x 3 Latin squares to investigate the effects of feeding raw and micronized flaxseed on milk yield and milk fatty acid composition. Three diets were formulated to meet nutrient requirement of dairy cows in early lactation: A control diet with no added flaxseed (C); a raw flaxseed diet (RFS); and a micronized flaxseed diet (MFS). The level of flaxseed in RFS and MFS was 7% of the diet DM. Feeding flaxseed to dairy cows had no effect on DMI or milk yield. However, energy- corrected milk was higher for cows fed MFS than for those fed RFS or C. Supplemental flaxseed reduced milk fat percentage without affecting the concentration of milk protein or milk lactose. However, yield of milk components was not affected by feeding flaxseed. Concentrations of short- and medium-chain fatty acids were decreased while the concentrations of long-chain fatty acids were increased in milk of cows fed RFS and MFS compared with cows fed C. Feeding flaxseed to dairy cows can alter milk fatty acid composition, but only minor effects on milk fatty acid composition can be expected by feeding micronized versus raw flaxseed.

Key Words: Flaxseed, Micronization, Milk fatty acids

561 Influence of barley grain variety on fatty acid synthesis and the expression of fat metabolism genes in bovine adipose tissue. E. Okine*, E. Norberg, D.R. Glimm, G.R. Khorasani, and J.J. Kennelly, *Department of AFNS, University of Alberta, Edmonton, Alberta, Canada.*

Our hypothesis was that ruminal rate of DM and starch degradation of grain varieties influence expression and protein abundance for genes encoding fatty acid synthase (FAS) and acetyl-CoA carboxylase (ACC) in subcutaneous bovine adipose tissue. Hulled (Falcon), hulless (Oxbow) barley varieties and corn were used in this experiment. Fifteen lactating Holstein cows were blocked into 5 groups according to parity, calving date, and milk yield. Cows in each group were randomly assigned to 3 dietary treatments following a 2-wk covariate period and were fed the test diets for 8 wks. Diets contained 55% concentrate and 45% forage (DM basis) and were fed once daily as a TMR. Milk yield and milk composition were not affected ($P > 0.05$) by grain type, but DMI (19.3 vs. 22.9 kg/d, $P < 0.05$) and DMI as percentage of BW (3.0 vs. 3.5%, $P < 0.05$) were lower for animals fed barley compared to corn-based diets. Levels of C18:0, C18:1 in adipose tissue were similar ($P > 0.05$) for hulled barley and corn but different ($P < 0.05$) for hulless barley fed cattle. There were no differences ($P > 0.05$) in mRNA expression of ACC and FAS in cows fed different diets. FAS protein abundance in adipose tissue was 1.9 and 1.7x lower ($P < 0.05$) for cows fed the hulled than for cows fed the hulless variety or corn. ACC protein abundance was 2.1 and 2.6x lower ($P < 0.05$) in adipose tissue of animals fed hulless compared to hulled and corn fed cows. However, activities of these enzymes were not

affected by any of the dietary treatments. It was concluded that de novo synthesis and uptake of dietary fatty acids may be affected by the rate of ruminal degradation of grain fed to lactating cows. However, lack of kinetic differences precludes any conclusions about effects of ACC and FAS on fatty acid composition in subcutaneous adipose tissue of cows fed different grain types.

Key Words: Barley variety, Dairy cow, Adipose tissue, Fatty acids synthesis

562 Effect of feeding calcium salts of soybean or palm oils on milk yield and composition, and on selected reproductive parameters by high producing dairy cows. P. Mandebvu*¹, C. S. Ballard¹, C. J. Sniffen¹, M. P. Carter¹, H. M. Wolford¹, T. Sato^{1,2}, Y. Yabuuchi², E. Block³, and D. L. Palmquist⁴, ¹W. H. Miner Agricultural Research Institute, Chazy, NY, ²Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan, ³Church & Dwight Co. Inc., NJ, ⁴Ohio State University, Wooster, OH.

Calcium salts of soybean oil (Ca-Soy) or palm oil fatty acid distillate (Megalac[®]) were compared. Forty high producing Holstein cows housed in a free-stall barn were blocked and assigned to one of two TMR containing 1.7% Megalac[®] or Ca-Soy (DM basis) and group-fed for ad libitum intake. Fatty acid profiles of Megalac[®] and Ca-Soy, respectively, were C16:0: 48.1, 12.1; C18:1: 35.7, 23.9; and C18:2: 8.9, 51.2. The TMR (DM basis) were 50:50 forage to concentrate ratio for both the fresh group (FG; wk 1 to 6 postpartum) and high producing group (HG; wk 7 to 10 postpartum) cows and contained 28% NDF and 18% CP (DM basis). Results are shown in table. There were no treatment differences in milk yield and components and no treatment effect was realized for the reproductive parameters measured. Cows fed Ca salts of soybean oil produced milk containing a higher content of C18:1t and C18:2.

Item ¹	Megalac [®]	Ca-Soy	SE	P
Milk, kg	43.3	43.4	2.87	1.000
Fat, %	4.24	4.22	0.121	0.909
Lactose, %	4.83	4.86	0.04	0.630
CP, %	2.81	2.88	0.05	0.332
MUN, mg/dL	12.7	11.5	0.5	0.078
SCC x 1000	266.9	191.6	80.3	0.512
BCS	3.26	3.25	0.11	0.948
DMI FG, kg/d	20.3	20.9		
HG, kg/d	26.4	27.6		
Milk FA-FG ²				
C14:0	6.79	7.27	0.339	0.297
C16:0	26.7	25.4	0.38	0.004
C18:0	14.0	15.4	0.36	0.008
C18:1	0.79	0.73	0.034	0.351
C18:1t	2.78	3.00	0.157	0.178
C18:2	2.89	2.93	0.108	0.682
CLA9c11t	0.55	0.59	0.028	0.273
Milk FA-HG ³				
C14:0	9.00	9.32	0.280	0.347
C16:0	29.6	26.8	0.45	<0.001
C18:0	12.7	14.1	0.37	0.014
C18:1	22.7	21.8	0.66	0.366
C18:1t	2.72	3.27	0.07	<0.001
C18:2	2.91	3.32	0.08	0.001
CLA9c11t	0.59	0.64	0.02	0.057

¹Measurements were taken from FG and HG cows from wk 1 to 10 postpartum unless specified otherwise; ²Milk fatty acids for FG cows reported as a % total fatty acids; ³Milk fatty acids for HG cows reported as a % total fatty acids.

Key Words: Dairy cow, Ca salts, Milk yield and composition

563 Effects of long chain fatty acids on lipid metabolism in monolayer cultures of bovine hepatocytes. D. G. Mashek* and R. R. Grummer, *University of Wisconsin, Madison.*

Previous studies in our laboratory showed that different long chain fatty acids influence hepatic lipid metabolism in short term (3 h) cultures. To test the long-term effects of specific long chain fatty acids, we used monolayer cultures of bovine hepatocytes from 7-14 d old Holstein bull calves. From 16 to 64 h after plating, hepatocytes were exposed to the

following treatments: 1 mM palmitic acid (1mM16), 2 mM palmitic acid (2mM16), or 1 mM palmitic acid plus 1 mM stearic (18:0), oleic (18:1), linoleic (18:2), linolenic (18:3), eicosapentaenoic (20:5), docosahexaenoic (22:6), or .5 mM each of eicosapentaenoic and docosahexaenoic acids (20:5/22:6). Metabolism of [1-¹⁴C] palmitic acid to cellular triglycerides, phospholipids, fatty acids, cholesterol, and cholesterol esters or acid-soluble products was measured. The effect of increasing palmitic acid concentration from 1 to 2 mM was analyzed and Fisher's LSD was used to compare all treatments containing 1 mM palmitic acid. Increasing palmitic acid concentration from 1 to 2 mM increased total incorporation into all metabolic products measured ($P < 0.05$). Specifically, palmitic acid metabolism to acid-soluble products and triglycerides increased from 8.76 to 27.32 and from 18.79 to 45.54 μ moles/ μ g DNA/48 h for the 1 and 2mM palmitic acid controls, respectively. Addition of 18:0 resulted in a nearly 2-fold increase in palmitic acid oxidation to acid-soluble products compared to the other treatments, which were not significantly different from each other. Incorporation of palmitic acid into cellular triglycerides was increased by 90% over 1mM16 for treatment 22:6, whereas 18:2 yielded the lowest rates of palmitic acid incorporation into cellular triglycerides (21% increase over 1mM16). The 22:6 and 20:5/22:6 treatments increased palmitic acid metabolism to phospholipids (97% and 88% above 1mM16), and to cholesterol (234% and 222% above 1mM16), respectively, while the other treatments were similar to 1mM16. Overall, the effects of fatty acids on lipid metabolism by monolayer cultures of bovine hepatocytes differed among the fatty acids tested.

Key Words: long chain fatty acids, liver metabolism, bovine

564 Effects of conjugated linoleic acid on lipid metabolism in monolayer cultures of bovine hepatocytes. D. G. Mashek* and R. R. Grummer, *University of Wisconsin, Madison.*

To determine the effects of unconjugated and conjugated linoleic acid isomers on hepatic lipid metabolism, we isolated and cultured hepatocytes from 7-14 d old Holstein bull calves. The monolayer cultures were exposed to treatments from 16-64 h after plating. The treatments included 1.0 mM palmitic acid plus either 0.1 or 1.0 mM of cis-9,cis-12 (c9,t12), cis-9,trans-11 (c9,t11), or trans-10,cis-12 (t10,c12) linoleic acid. Metabolism of [1-¹⁴C] palmitic acid to cellular triglycerides, phospholipids, fatty acids, cholesterol, and cholesterol esters or acid-soluble products was measured. Reported values are pooled across concentrations of linoleic acid unless otherwise noted. Metabolism of palmitic acid to cellular triglycerides was decreased ($P < 0.05$) from 23.51 to 20.98 μ moles/ μ g DNA/48 h when the media contained c9,t11 compared with t10,c12. The conjugated isomers of linoleic acid (c9,t11 and t10,c12) at a concentration of 1.0 mM increased palmitic acid incorporation into phospholipids compared to c9,t12 (6.37 and 5.93 vs. 3.54 μ moles/ μ g DNA/48 h; $P < 0.0001$). Similarly, c9,t11 and t10,c12 increased palmitic acid metabolism to cholesterol, especially at the 1 mM concentration when compared with c9,t12 (1.68 and 1.64 vs. 0.51 μ moles/ μ g DNA/48 h; $P < 0.0001$). Palmitic acid incorporation into cellular triglycerides was increased for t10,c12 compared with c9,t11 (23.51 vs. 20.98 μ moles/ μ g DNA/48 h; $P < 0.05$). Increasing the concentration of the treatment fatty acids from 0.1 to 1.0 mM decreased oxidation of palmitic acid to acid soluble products (8.69 vs. 6.80 μ moles/ μ g DNA/48 h), but no effects of fatty acids were observed. There were no differences among the linoleic acid isomers on palmitic acid incorporation into the cellular fatty acid pool or to cholesterol esters. Overall, the conjugated linoleic acid isomers elicited changes in palmitic acid metabolism to cellular triglycerides, phospholipids and cholesterol, but had little or no effect on other metabolic fates of palmitic acid.

Key Words: conjugated linoleic acid, liver metabolism, bovine

565 Saturation effects of rumen-inert fat sources on feed intake, milk production, and feeding behavior in lactating cows varying in milk yield. K. J. Harvatine* and M. S. Allen, *Michigan State University, East Lansing.*

Effects of saturated (SAT) and unsaturated (UNSAT) rumen-inert fat sources were evaluated using 31 multiparous Holstein cows (144 \pm 70 DIM, 2.35 \pm 0.38 BCS) in a crossover design experiment with 14 d periods. Milk yield of cows averaged 43.7 kg/d (range 34.0-57.5 kg/d) for 14 d immediately prior to initiation of the experiment when they were offered a diet intermediate in composition to the treatment diets. Treatments were 2.5% added fatty acids (FA) from rumen-inert fat sources

varying in saturation of FA; SAT (prilled FA#s, Energy Booster 100[®]) or UNSAT (calcium soaps of palm oil, Megalac[®]). Diets were formulated to 18.5% crude protein and 27.8% NDF and contained 5% FA from forage, grains and whole cottonseeds. UNSAT reduced DMI by 0.72 kg/d compared to SAT treatment ($P < 0.01$). No treatment effect was observed for 3.5% FCM, SCM or milk energy output although UNSAT tended ($P = 0.09$) to increase milk yield by 0.62 kg/d. SAT increased milk protein (3.07 vs. 3.02%; $P=0.02$) and lactose (4.80 vs. 4.75%; $P < 0.01$) concentrations. Response in milk protein concentration for SAT compared to UNSAT was positively correlated with pretrial FCM yield and pretrial milk fat yield ($r^2 = 0.46$, $P < 0.05$ and $r^2 = 0.52$, $P < 0.01$, respectively). Treatment response for milk, FCM, DMI and ruminating were not significantly related to pretrial FCM, milk fat yield or DMI. Yield of milk components were not affected by treatment. Efficiency calculated as the sum of milk and retained tissue energy per kg DMI was not affected by treatment. UNSAT reduced time spent ruminating by 25 min/d ($P < 0.01$) and increased time spent idle by 25 min/d ($P < 0.01$) but did not effect time spent eating. Decreased DMI and rumination time for UNSAT are consistent with reports of duodenally infused unsaturated fat increasing satiety and decreasing gut motility.

Key Words: Rumen-inert fat, Saturation, Hypophagic effects

566 Metabolic clearance rate of progesterone and estradiol-17 β is decreased by fat. S. Sangsritavong, D.G. Mashek, A. Gümen, J.M. Haughian, R.R. Grummer, and M.C. Wiltbank*, *Department of Dairy Science University of Wisconsin-Madison.*

The circulating concentrations of progesterone (P_4) and estradiol-17 β (E_2) regulate a variety of reproductive processes and depend upon both synthesis and metabolism of these steroids. Previous studies have shown that feeding fat can alter follicular growth, progesterone metabolism, and reproductive efficiency in dairy cattle. We hypothesized that fatty acids can decrease metabolism of steroids by direct effects on liver cells. Exp.1 was designed to test this hypothesis by incubating bovine liver slices with P_4 or E_2 in the presence or absence of various fatty acids in the media ($n = 6$ different liver preparations with each treatment evaluated in triplicate with each preparation). Linoleic acid increased the half-life of both progesterone (31.7 ± 3.3 vs. 50.7 ± 2.7 min; $P \leq 0.001$) and estradiol-17 β (25.9 ± 1.9 vs. 37.3 ± 5.8 min; $P \leq 0.05$). Exp.2 tested the effects of fat on steroid metabolism *in vivo*. Non-lactating Holstein cows ($n=6$) were continuously infused for 6 h with P_4 and E_2 in the presence or absence of a soybean oil emulsion using a crossover experimental design. Blood samples were taken every 15 min for the first 120 min and every h for another 4 h. Soybean oil dramatically increased serum concentrations of both P_4 (2.42 ± 0.24 vs. 3.83 ± 0.24 ng/ml; $P = 0.002$) and E_2 (287 ± 28 vs. 379 ± 28 pg/ml; $P = 0.005$) even though the infusion rate of steroids was identical in both groups. Thus, fatty acid and/or triglyceride can increase circulating P_4 and E_2 concentrations by directly inhibiting liver cell metabolism of these steroids. This may be an important functional link between fat feeding and reproductive function.

Key Words: liver, fat, steroid metabolism

567 Influence of diet on conjugated linoleic acid content of milk, cheese and blood serum. R. C. Khanal¹, T. R. Dhiman¹, D. J. McMahon², and R. L. Boman¹, ¹*Department of Animal, Dairy and Veterinary Sciences,* ²*Department of Nutrition and Food Sciences.*

An experiment was conducted to study the influence of diet on conjugated linoleic acid (CLA) content in milk, cheese and blood serum. Eighteen dairy cows with an initial average milk yield of 33 ± 7 kg and 184 ± 37 days in milk were blocked according to initial milk yield and assigned to one of three treatments. Cows were either fed a total mixed rations containing 50:50 conserved forage to grain ratio (TMR), or grazed on predominantly rye grass pasture (PS) and pasture supplemented with 2.5 kg/day of full-fat extruded soybeans (ES). Experiment was conducted for a period of six weeks. Measurements were made on dry matter intake (DMI), milk yield and composition and fatty acid profile including CLA in milk, cheese, and blood serum during the last 3 weeks of the experiment. Cows in PS treatment had lower DMI and milk yield ($P < 0.01$) compared with cows in ES and TMR treatments. Milk fat, protein, and lactose content did not differ among treatments. The milk CLA contents were 5.0^b , 17.0^a , and 15.0^a mg/g of fat in TMR, PS, and

ES cows, respectively. The cheese CLA contents were 4.7^b , 14.7^a , and 14.6^a mg/g of fat in TMR, PS, and ES cows, respectively. Cows in PS and ES treatments had 300% more CLA in milk and cheese compared with milk and cheese from cows in TMR. Supplementation of full-fat extruded soybeans to cows grazing on pasture had no influence on CLA content of milk and cheese ($P>0.05$). The CLA contents of blood serum were 0.95^c , 2.14^a , and 1.82^b mg/g of fatty acids in TMR, PS, and ES treatments ($P<0.05$), respectively. The results suggest that diet can influence the CLA content of blood serum and its contribution to milk. Supplementing feeds rich in linoleic acid such as full-fat extruded soybeans to cows grazing on pasture did not increase the CLA content of milk and cheese but decreased blood serum ($P<0.05$) CLA content in the present study.

Key Words: Conjugated linoleic acid, milk, pasture

568 Effect of fat source on microbial fermentation in continuous culture of rumen contents. G.I. Crawford^{*1}, M.D. Stern¹, R.L.K. Hulbert¹, K.A. Caperton¹, and B.L. Miller², ¹*University of Minnesota,* ²*Land O'Lakes Farmland Feed.*

Eight dual flow continuous culture fermenters were used to study the effects of fat source on fermentation by rumen microbes. Four dietary treatments were formulated to meet the requirements of a lactating dairy cow. The four dietary treatments were: 1) a control with no supplemental fat (C), 2) free fat supplemented as choice white grease (WG), 3) bypass fat supplemented as Megalac[®] (M), 4) bypass fat supplemented as a porcine fat-bloodmeal combination (PBM). The control was formulated to contain 3.4% fat, while the diets with supplemental fat were formulated to contain approximately 5.0% fat. The experiment consisted of two 10-d experimental periods, including a 7-d stabilization phase followed by 3 d of sampling for each period. Fermenter dilution rates were set at .10 and .055/hr for liquid and solids, respectively. Each dietary treatment contained approximately 17.5% CP, which supplied 2.1 g N/d. The treatments were fed at a rate of 75 g DM/d throughout the experimental periods. Fermenter pH was maintained from 6.0 to 6.5 throughout the experiment. Average pH for all treatments was 6.11, and did not differ ($P > 0.05$) among treatments. Concentrations of ammonia N were not affected ($P > 0.05$) by treatment, averaging 16.4, 13.8, 11.3, and 17.7 mg/100 mL for the C, WG, M, and PBM treatments, respectively. Non-ammonia N and bacterial N flow averaged 1.62 and 0.39 g/d, respectively, and were not affected ($P > 0.05$) by treatment. Efficiency of bacterial synthesis (g of N/kg OM truly digested) and CP degradation (%) did not differ among treatments ($P > 0.05$), averaging 12.1 and 41.4, respectively, for all treatments. Digestion of OM, NDF, and ADF averaged 47.4, 33.6, and 50.0%, respectively, and were not affected ($P > 0.05$) by treatment. Results from this experiment indicate that supplemental fat source had no effect on microbial fermentation.

Key Words: Fat, Digestion, Continuous Culture

569 Effects of esterification, degree of saturation, and amount of fatty acids infused into the rumen or abomasum in lactating dairy cows. N.B. Litherland^{*1}, A.D. Beaulieu¹, and J.K. Drackley¹, ¹*University of Illinois, Urbana.*

Our previous experiments showed that abomasal infusion of soy free fatty acids (FFA) decreased DMI and milk yield more than did soy triglycerides (TG); saturated FA infused abomasally did not suppress DMI or milk yield. Our hypothesis was that increasing amounts of unsaturated FFA infused postruminally would more potentially inhibit DMI than equivalent amounts of unsaturated TG or saturated FA infused ruminally or postruminally. Six multiparous Holstein cows with ruminal cannulas were used in a 6 \times 6 Latin square with 21-d periods. During d 1-14, 250 g/d of FA and during d 15-21 500 g/d of FA were infused continuously into the rumen or abomasum. Treatments were infusions of 1) control; 200 g/d of meat solubles plus 12 g/d of Tween 80 in 10 L of water; 2) control plus mostly saturated FA abomasally (SFAA); 3) control plus mostly saturated FA ruminally (SFAR); 4) control plus soy FFA abomasally (UFAA); 5) control plus soy TG abomasally (TGA); and 6) control plus soy TG ruminally (TGR). Cows were fed a TMR (17.5% CP, 21.3% ADF) of (DM) 20% alfalfa silage, 30% corn silage, 27% ground corn, and 16% soybean meal. DMI was decreased more by increasing UFAA than by TGA (esterification \times level, $P<0.001$). Both SFAR and TGR decreased DMI. Milk production followed a similar trend to DMI. Interactions of site of SFA \times level ($P<0.01$) and site of

TG×level ($P<0.03$) showed that SFAR and TGA decreased milk production at the higher infusion amount. Milk fat yield was decreased by UFAA ($P<0.01$). Unsaturated FA decreased milk fat yield to a greater extent than did saturated FA ($P<0.03$). All FA treatments decreased short and medium chain FA in milk, with greatest decreases for UFAA. Both UFAA and TGA increased C18:2 in milk. Milk CLA 9,11 was increased by TGA and TGR ($P<0.001$). Plasma NEFA were higher for UFAA than for TGA ($P<0.03$). Unsaturated FFA infused abomasally potentially decreased DMI in a dose dependent manner. Unsaturated TG and saturated FA depressed DMI to a lesser extent; TG infused abomasally decreased DMI more than saturated FA infused ruminally or abomasally.

Key Words: dry matter intake, fatty acids, triglycerides

570 Fish oil inhibits the biohydrogenation of fatty acids in the rumen causing an increase in milk trans-octadecenoic and conjugated linoleic acid content. K. J. Shingfield^{*1}, S. Ahvenjärvi², V. Toivonen², A. Ärölä², P. Huhtanen², and J. M. Griinari³, ¹*The University of Reading, School of Food Biosciences*, ²*MTT Agrifood Research Finland, Animal Production Research*, ³*The University of Helsinki, Department of Animal Genetics*.

Evidence from animal model and human intervention studies suggest that consumption of milk and dairy products enriched with conjugated linoleic acid (CLA) has the potential to confer significant benefits to human health. Milk fat CLA content can be enhanced through feeding vegetable oil supplements but greater increases have been attained using fish oil (FO). The current study was conducted to identify the mechanisms underlying FO stimulated increases in milk CLA content. Five lactating cows fitted with rumen cannula were used in a continuous-design with two 14 d experimental periods. Cows were offered 18 kg DM/d of a basal (B) diet formulated from grass silage and a cereal based-concentrate (60:40; forage:concentrate ratio, on a DM basis) followed by the same diet supplemented with 250 g FO/d. The flow of fatty acids leaving the rumen was assessed using the omasal sampling technique and the triple indigestible marker method. FO decreased ($P=0.06$) DM intake (17.7 and 15.7 kg/d for B and FO, respectively) and milk yield ($P<0.01$; 18.6 and 14.1 kg/d), but had no effect ($P>0.05$) on milk fat content (46.0 and 42.8 g/kg). Milk fat trans-11 C18:1 (vaccenic acid), total trans-C18:1, cis-9 trans-11 CLA and total CLA content increased in response to FO from 1.80, 4.51, 0.39 and 0.56 to 9.39, 14.39, 1.66 and 1.85 g/100g total fatty acids, respectively. Furthermore, FO caused a shift ($P<0.05$) in rumen fermentation towards propionate and butyrate, at the expense of acetate, decreased ($P<0.001$) the amount of C18:0 entering the omasal canal (283 and 47 g/d for B and FO, respectively), increased ($P=0.001$) total trans-C18:1 fatty acid flow (38 and 182 g/d), but had no effect ($P>0.05$) on ruminal CLA synthesis (4.36 and 3.50 g/d). Flows of trans-C18:1 acids with double bonds in positions from 4 to 16 entering the omasal canal were all enhanced, but the effects of FO were primarily associated with an increase in the flow of vaccenic acid leaving the rumen (17.1 and 121.1 g/d for B and FO, respectively). FO supplements enhance milk fat cis-9, trans-11 CLA content due to increased trans-vaccenic acid production in the rumen.

Key Words: Fish Oil, Conjugated Linoleic Acid, Trans Fatty Acids

571 Biohydrogenation shift and milk fat depression in lactating dairy cows fed increasing levels of fish oil. A. Ärölä¹, K. J. Shingfield², A. Vanhatalo¹, V. Toivonen¹, P. Huhtanen¹, and J. M. Griinari^{*3}, ¹*MTT, Agrifood Research Finland*, ²*University of Reading, UK*, ³*University of Helsinki, Finland*.

Previous studies have demonstrated that milk fat conjugated linoleic acid (CLA) content can be increased with fish oil supplements (FO).

Feeding diets to enrich milk CLA concentrations often result in milk fat depression (MFD) and a shift in the ratio of trans-10 to trans-11 C18:1 concentration in milk fat, both of which limit mammary CLA secretion. A 4x4 Latin Square study with four cows was conducted to examine the effects of increasing levels of FO (0, 75, 150, and 300 g/d) on milk fat synthesis and fatty acid (FA) composition, and the threshold for the trans C18:1 isomer shift and MFD. Basal diet consisted of grass silage and a cereal based-concentrate (forage:concentrate ratio 58:42 on a DM basis). Increases in FO dose resulted in linear decreases ($P<0.01$) in DM intake (19.7, 19.6, 18.8 and 16.4 kg/d, for 0, 75, 150 and 300 g FO/d, respectively), milk fat concentration (39.5, 40.5, 33.1 and 28.8 g/kg) and milk fat yield (960, 987, 848 and 593 g/d). Concentration of total trans-C18:1 fatty acids in milk fat was increased ($P<0.001$) through dietary FO (4.1, 6.3, 11.4 and 14.3 g/100 g total FA). Both the concentration of trans-10 and trans-11 C18:1 increased ($P<0.001$) linearly in response to FO (0.29, 0.46, 1.11 and 4.15 and 1.46, 2.52, 5.51 and 6.11 g/100g total FA, respectively). The ratio of trans-10 to trans-11 increased at the highest level of FO (0.20, 0.19, 0.21 and 0.78; quadratic effect $P=0.001$). Consistent with this, concentration of CLA in milk fat increased linearly only up to the 150 g/d dose level (0.77, 1.26, 2.63 and 2.61; cubic effect $P<0.05$). Cis-9, trans-11 isomer accounted for proportionately 0.79, 0.84, 0.90 and 0.90 of total CLA. Milk FA responses suggest that the highest level of FO resulted in a shift in rumen biohydrogenation of long-chain FA towards the trans-10 C18:1 pathway. Therefore, in this study 150 g/d of FO was the optimal dose for CLA enrichment of milk.

Key Words: CLA, Fish Oil, Milk Fat

572 Effect of milk urea nitrogen level on probability of conception of dairy cows. K. Guo^{*}, R. Kohn, E. Russek-Cohen, and M. Varner, *University of Maryland, College Park*.

The objective of this study was to evaluate the association between milk urea nitrogen (MUN) and the probability of conception of dairy cows. The data were retrieved from Lancaster DHIA. Cows that were first bred between June 1, 2000 and May 31, 2001 were included in the study (total of 182 dairy herds and 4200 dairy cows). Over all, the mean days from calving to first breeding was 91 days, the mean interval between first and second service was 55 days. Nominal Logistic Regression was used to determine the effects of different MUN levels, test-day milk production, and breeding season on the probability of conception for several services. MUN and milk production data were used from 60 to 90 days post partum for effect on probability of pregnancy at first service, and data from 120 to 150 days post partum were used for probability of conception at second service. Milk production level, seasonal effects, and season by MUN interaction affected ($P<0.05$) the probability of conception at first service. MUN recorded 90 to 120 days post partum did not affect probability of conception at first service when used as the MUN input. In the regression model for the second and third service, only milk production and seasonal effects remained significant ($P<0.05$). Probability of conception averaged 27.2, 30.4 and 31.8% at first, second and third service respectively. For all the seasons except spring, cows that had higher MUN were less likely to conceive at the first service. However, in spring, cows that had higher MUN were more likely to conceive at first service.

	HH	HL	LH	LL		HH	HL	LH	LL
Winter	0.28	0.30	0.31	0.33	Summer	0.29	0.32	0.32	0.35
Spring	0.45	0.41	0.48	0.45	Fall	0.15	0.20	0.17	0.23

HH: High Milk Production (45kg/d) and High MUN (16mg/dl), HL: High milk production (45kg/d) and Low MUN (16mg/dl), LH: Low milk production (31kg/d) and High MUN (16mg/dl), LL: Low milk production (31kg/d) and Low MUN (16mg/dl)

Key Words: milk urea nitrogen, probability of conception, reproduction

Contemporary and Emerging Issues Critical Perspective of Animal Agriculture

573 Livestock, ethics and quality of life. J Hodges^{*}, *European Association for Animal Production*.

Livestock played a key role in development of human societies. This role goes beyond lifting the physical conditions of human life; livestock have also shaped values with the concept of Community of Life. Consequently in pre-modern societies the normal and acceptable standards for caring

for livestock were extended to many areas of life and linked with sustainability. In agricultural societies, the derivation of values and ethical behavior emphasizes the common interests of various sectors of society and decision-making processes generally enhance the overall quality of life. In the modern era changes in Western agriculture and in the food chain have been prime factors in reshaping society from a rural to an

urban base. The plentiful supply of food and animal products brought about by the rise of science, the economic success of market economy capitalism and adoption of democracy have also dramatically affected values and ethical standards applied to the food chain. Today Western society sees livestock as a disposable resource, science has joined forces with business, decision making is based solely on economic criteria and the farmer/livestock producer has little influence in shaping the food chain. Thus a new plausibility structure has been accepted by Western society leading to a redefinition of what is normal and acceptable behavior with livestock and animal products. A radical shift in both power and vulnerability in the food chain is occurring which affects livestock, small farmers, the environment, life science companies, rural society, consumers, rich and poor, perceptions of risk, health and safety, etc. Newer and fewer centers of decision making now control the quantity and quality of animal products. The role and nature of agriculture is being redefined, resulting in an unplanned consequence—a lost sense of the Community of Life. Consequently society has a deepening concern about values and ethics in animal science and livestock production. Into this matrix biotechnology has recently been inserted as the major research interest of life scientists and is impacting the food chain in ways not yet fully understood. The paper examines these emerging issues in the context of how contemporary Western society forms its values, views social justice and defines ethical expectations.

Key Words: ethics, issues, sustainable agriculture

574 Value-added Agriculture: Inclusion of Race and Gender in the Professional Formula. M.M. Beck*¹ and J.C. Swanson², ¹Univ of Nebraska, Lincoln, Nebraska, ²Kansas State Univ, Manhattan, Kansas.

The Morrill Act establishing the land grant university system required that admission to the state universities be available to both women and racial minorities. Today women are close to 50% of the undergraduate population in a number of animal science departments but racial minorities lag far behind, in part because the schools created under the 1890 legislation provided a diversion away from the state universities. In the faculties of the animal science departments, both women and minorities are seriously underrepresented; causative factors underlying this phenomenon are similar. Although historical adherence to role stereotypes and divisions of labor explain some of the underrepresentation,

these assumptions do not hold across all economic classes. Other factors contributing to the scarcity of women and faculty of color in animal science include assumptions and mechanisms of scientific research itself; the very neutrality and disinterestedness of researchers, inherent in the scientific method, prevent recognition that values and personal biases affect decisions of hiring selections and mentoring effectiveness. We will explore the cultural factors that underlie these values and biases that are common not only to agriculture but also to science more broadly.

Key Words: Race and agriculture, Gender and agriculture, Role stereotypes

575 Rethinking relationships in wretched contexts: the power of privilege. C. Cuomo*, University of Cincinnati, Cincinnati, Ohio, USA.

Even a minimal ethical commitment to the interests of animals provides what appears to be a devastating critique of common human/nonhuman relations, including many forms of domestication. If we accept ethical critiques of basic social institutions, but those institutions and practices apparently cannot be simply "abolished," is our participation in them inevitably collusion with oppression?

In agreement with some of the best work in science, feminist and post-colonial ethics begin with the recognition that the boundaries between individuals, and between species, are not as ontologically absolute or morally defensible as anthropocentric and liberal traditions take them to be. Instead, relationships are ontologically and ethically fundamental. For example, right relations provide moral models and make evident the role of empathy, connection, and care in ethical life.

How can these models provide insight regarding participation in institutions that seem to cause so much suffering? Is it possible to be true to our good relationships with nonhuman animals in the context of animal science?

In this paper I will explore what it means to take right relationships to be the starting place for agriculture and animal science. I will emphasize the positive tools at our disposal, and how even institutional practices can be informed by the wisdom generated in cross species relationships guided by empathy and other forms of connection

Key Words: ethics, feminism, empathy

Goat Species

Potent Solutions for Impotent Dewormers: Controlling Resistant Internal Parasites

576 The development of dewormer resistance in small ruminants and consequences. W.E. Pomroy*¹, ¹Institute of Veterinary, Animal and Biomedical Science, Massey University, Palm/North, NZ.

Anthelmintic resistance is an increasing problem around the world and has already reached serious levels in areas of South America, South Africa and Australia. The problem is also rapidly emerging in the US, especially in the southern states and greater awareness of the issue is required to attempt to slow its development before the problem becomes unmanageable. The majority of the available evidence suggests that once anthelmintic resistance to any anthelmintic has developed in a population the gene frequency is stable and does not decline. There are only 3 broad spectrum action families of anthelmintics available and no new ones likely to be available in the near future so every effort needs to be made to preserve their efficacy for as long as possible. There are some narrow spectrum anthelmintics available for *Haemonchus contortus* but most of these are not available in the USA. This review will summarise the arguments for and against the commonly promoted recommendations to delay the onset of anthelmintic resistance: to decrease the number of times animals are dewormed, to quarantine drench all incoming animals, to rotate between action families on an annual basis and to avoid underdosing. The advantages and disadvantages of long acting anthelmintics such as moxidectin will be discussed as will the additional challenges of worm control in goats by comparison with sheep. It is well recognised that goats metabolise anthelmintics more rapidly than sheep and this has implications for the choice of dose rate.

Key Words: Goats, Internal parasites, Dewormer resistance

577 Emerging issues in control of nematode parasites of goats: anthelmintic resistance and biological control using nematophagous fungi. T.H. Terrill*¹, R.M. Kaplan², M. Larsen³, and J.E. Miller⁴, ¹Fort Valley State University, Fort Valley, GA, ²The University of Georgia, Athens, GA, ³The Royal Veterinary and Agricultural University, Copenhagen, Denmark, ⁴Louisiana State University, Baton Rouge, LA.

Gastrointestinal nematode (GIN) parasitism is the most important disease of goats throughout the world. Infection with GIN parasites causes significant losses in growth and productivity and may lead to animal deaths if not controlled. The conventional method of controlling GINs in goats is frequent deworming with anthelmintics, which increases selection for drug resistance in the parasites. As a result, prevalence of multiple-drug resistant GINs in goats is reaching alarming proportions in many parts of the world. Recent reports from the southern United States show that GIN resistance to all three available classes of anthelmintics is an emerging problem, suggesting that alternatives/additions to anthelmintic control of goat parasites are needed. A novel approach to controlling goat GINs is using the nematode-trapping fungus *Duddingtonia flagrans* as a biological control agent. Spores of this fungus are fed to the animal, pass onto pasture in feces, and then trap and kill developing parasite larvae in the fecal pellet. This technique has been shown to reduce development of GIN larvae in feces by over 90% in goats and sheep in confinement. This reducing effect in feces has been confirmed in controlled field trials with sheep and preliminary grazing experiments with goats. Successful control of goat GINs in the future may require use of both novel (biological control, GIN vaccines, etc.), and conventional (strategic use of effective anthelmintics plus grazing management) strategies in an integrated program.

Key Words: Goats, Gastrointestinal nematodes, Anthelmintic resistance, Biological control

578 Tannins for suppression of internal parasites. B.R. Min* and S.P. Hart, *E (Kika) dela Garza Institute for Goat Research, Langston University, OK, 73050, USA.*

Condensed tannins (CT) have biological effects that may aid in the control of dewormer-resistant internal parasites (IP). It is increasingly evident that control programs based on dewormers are failing to control IP as dewormer resistance has become more prevalent. Thus, alternative IP control strategies are necessary. The CT in forages have potential to be a component of IP control programs. The CT bind proteins and other molecules tightly at near neutral pH, such as occurs in the rumen, with dissociation in the acidic pH of the abomasum, freeing them for digestion. Effects of CT on parasitism can be assessed by grazing ruminants on forages that contain different levels of CT but otherwise are of similar nutritive value. Plant CT may have direct or indirect effects on IP. Direct effects might be mediated through CT-nematode interactions affecting physiological functioning of IP. Recently, *in vitro* and *in vivo* studies have shown that CT in several temperate and tropical forages (*Hedysarum coronarium*, *Onobrychis viciifolia*, *Lotus pedunculatus*, *L. corniculatus*, *Lespedeza cuneata*, and Quebracho CT) can inhibit infective gut worm larvae of sheep and goats and both gut and lung worms in farmed deer, with effects influenced by both concentration and structure of CT. Furthermore, preliminary research showed a 57% reduction in fecal egg counts (2,722 vs 1,162 eggs/g) and a 74% reduction in total fecal egg output (173 vs 45 x 10⁴ eggs/d) in goats consuming forage *Sericea lespedeza* (4.6% extractable CT/kg DM) compared with rye/crabgrass. Indirectly, CT can improve protein nutrition by binding to plant proteins in the rumen and preventing microbial degradation, thereby increasing amino acid flow to the duodenum. Several ovine studies have shown that improved protein nutrition reduces parasite infestation. This is assumed to be mediated by enhanced host immunity, which may be especially important with selection for immunity to IP. In conclusion, CT in forages may have potential to aid in the control of IP.

Key Words: Condensed tannins, Internal parasites

579 Pasture and animal management for control of gastrointestinal nematodes. Daniel Miller*¹ and T. M. Craig², ¹*E (Kika) de la Garza Institute for Goat Research, Langston Univ. OK,* ²*Texas A & M University.*

Parasitism is a numbers game, a few parasites may stimulate a level of resistance to greater numbers. However, an excessive number of parasites will cause disease. Weather conditions determine how successfully parasites are transmitted. Sufficient moisture for the movement of infective larvae from the fecal pellet onto the vegetation is essential. Tactical treatment 2 weeks following rain may aid in controlling worms. Daily management of the flock results in different levels of exposure to parasites. Exposure may be limited by strategies that use alternate species grazing or resting of pastures. A diversity of forage producing plants and the commingling of grazing species may serve to dilute the number of gastrointestinal parasites ingested. Rotational grazing systems may result in greater numbers of parasites to which animals are exposed, however, the effects on the host may be lessened due to improved nutrition. In the humid tropics rotation is useful in controlling parasitic disease. However, in conditions of drought or cool weather, larvae may survive 6 months or longer on pasture. Therefore, if there is going to be a meaningful reduction of parasite numbers in a pasture the susceptible goats must remain off the pasture for 2 to 6 months. A pasture on which animals may safely graze during the winter becomes dangerous during the spring. Worms which infect goats in the spring are those which survive on pasture or are the progeny of arrested larvae that overwintered inside the goats. Larvae acquired during autumn grazing cease development but remain in the digestive tract without feeding or reproducing. Parturition and spring grass growth are associated with emergence of arrested larvae. Eggs passed in the feces and subsequent development of infective larvae coincide with the time when kids begin to graze. Strategic (winter) use of anthelmintics protects goats from catastrophic numbers of worms. A few individuals have a large portion of the entire worm population and selective removal or treatment of these goats may aid in controlling disease in the entire flock.

Key Words: goats

Physiology Developmental Endocrinology

580 Integration of nutrient supply and growth during fetal life: roles of leptin and the IGF system. R.A. Ehrhardt*¹, A.W. Bell¹, and Y.R. Boisclair¹, ¹*Dept. of Animal Science, Cornell University, Ithaca, NY.*

Extracellular signals integrate somatic growth with nutrient supply growth during fetal life. Several components of the IGF system are regulated by nutrient supply during late fetal life in sheep and are likely to be important determinants of size at birth. Conversely, nutrient supply regulates maturation of the endocrine IGF system. For example, underfed fetuses have lower hepatic expression of the ALS and IGF-1 genes than well fed fetuses. The novel hormone leptin has been suggested as a possible regulator of fetal growth. To address this, we examined the spatial and developmental regulation of leptin in fetal sheep as well as the nutritional regulation of leptin during late pregnancy and early postnatal life. Fetal plasma leptin concentration increased steadily from early fetal life to near term and was not related to fetal or placental weight. Leptin mRNA was detected in fetal brain and liver during most of pregnancy and in fetal adipose tissue during the last trimester, suggesting that fetal plasma leptin originates mostly from non-adipose sources early in pregnancy and in addition, from fetal adipose tissue nearer term. Moderate maternal undernutrition during late pregnancy did not alter fetal plasma leptin despite an acute reduction in maternal concentration. In contrast, during early postnatal life, plasma leptin was acutely regulated by energy status and closely associated with the rate of fat accretion. Overall, these data do not support the hypothesis that leptin is a growth factor during fetal life. Instead, leptin expression in non-adipose tissue may promote developmental processes such as hematopoiesis and angiogenesis. In summary, the IGF system has an important functional interplay with nutrient supply during late fetal life in regulating fetal growth and development. The role of fetal plasma leptin is less certain but the sheep fetus provides an ideal model to test its functional role(s).

Key Words: Fetal life, Leptin, IGF system

581 Integrated roles of growth factors, integrins, and matrix proteins in conceptus development and implantation. Laurie A. Jaeger*¹, Greg A. Johnson², Robert C. Burghardt¹, and Fuller W. Bazer¹, ¹*Texas A&M University, College Station, Texas, USA,* ²*University of Idaho, Moscow, Idaho, USA.*

Maternal recognition of pregnancy, conceptus elongation, attachment, and implantation are critical for embryonic survival in domestic swine and ruminant species. Steroid hormones, growth factors, and cytokines play important roles in controlling conceptus development and implantation in these species, in part through effects on and interactions with extracellular matrix proteins (ECMs) and their integrin receptors. Results from immunofluorescence and RT-PCR analyses indicate the presence of multiple integrin subunits and potential integrin heterodimers, on conceptus and maternal cells, that are capable of binding ECMs present at the conceptus-maternal interface. TGF β s appear to play multiple roles in implantation; evidence suggests that TGF β s can modulate expression of ECMs as well as participate directly in adhesion. Fibronectin (FN) is present at porcine and ovine conceptus-maternal interface *in vivo*. Porcine trophectoderm produces FN, and TGF β 1 increases levels of FN mRNA in porcine trophectoderm cells (pTr2). Results of *in vitro* adhesion assays in which integrin activation is detected by monitoring aggregation of cytoskeletal molecules indicate that FN, the latency-associated peptide (LAP) that comprises part of the latent TGF β complex, and osteopontin (OPN), a molecule expressed by porcine and ovine endometrial cells during early pregnancy, activate apically-expressed integrins in porcine and ovine uterine and trophectoderm. Mechanisms of the ECM-integrin interactions in the conceptus have been further studied using the pTr2 cells. Integrin β 1 is expressed on the apical surface of pTr2 cells, and pTr2 attachment to immobilized LAP is decreased specifically by Arg-Gly-Asp peptide and monoclonal antibody to integrin β 1, suggesting that trophectoderm adhesion to LAP is, in part, due to interactions with integrin β 1. We hypothesize

that successful conceptus development and implantation entail multiple, distinct, temporally-regulated ECM-integrin interactions. Evidence suggests conservation of adhesion mechanisms among species, and that the non-invasive placentation strategies of livestock provide useful comparative models to study fundamental mechanisms of early stages of implantation in humans. (Supported in part by USDA-NRICGP 98-35203-6223, 2000-02290, and NIH 1-F32-HD08501-01A1)

Key Words: Conceptus development, Implantation, Growth factors

582 Nutritional, metabolic and endocrine status of neonatal calves. J. Blum*, *University of Berne, Switzerland.*

Neonatal calves are characterized by high morbidity and mortality rates, in part due to insufficient organ development (as of the gastrointestinal

tract, GIT) and functioning of controlling systems. Time-point and amounts of ingested colostrum influence GTI development and function, and nutritional, immune, metabolic and endocrine status. Optimal amounts of ingested colostrum are not well defined, but ad libitum availability is expectedly best, such as when calves suckle their dam. Colostrum contains high amounts of nutritional and non-nutritional (bioactive) components. For several of the ingested colostrum hormones and growth factors (insulin; insulin-like growth factors, IGFs) the GIT contains specific receptors that are affected by nutrition and exhibit ontogenetic changes. Supplementation of non-nutritional colostrum extracts (with high amounts of IGFs, insulin, lactoferrin and other growth factors), but not IGF-I alone, can slightly stimulate small intestinal development. The sum of all colostrum components exerts optimal effects, but some factors are of special importance.

Ruminant Nutrition

New Concepts and Developments in Forage and Feedstuff Analysis and Applications to Ruminant Nutrition

583 Characterizing carbohydrates in feeds? M. B. Hall*¹, ¹*Dept. of Animal Sciences, University of Florida.*

Feed carbohydrates include both fiber and nonfiber carbohydrates that vary in their chemical, physical, and nutritional characteristics. Defining systems to measure the chemical and physical attributes of feeds so that these can be correlated to their nutritional value to the animal and applicable to diet formulation has been a continuing challenge. The non-neutral detergent fiber carbohydrates (NFC) have been estimated by difference as a single fraction. However, NFC are diverse both in composition and in nutritional characteristics. Use of NFC methods that define carbohydrate fractions to reflect differences in digestibility by gut microbes or the cow, and type and yield of products from their digestion have shown some promise for on-farm application. Definitive techniques to measure physical form and rate of fermentation remain elusive as they attempt to describe complex interactions among the animal, its diet, and diet components. Evaluation of physical form, particularly of neutral detergent fiber (NDF), as an indicator of potential to stimulate rumination and good rumen function is essential for formulation of ruminant diets. It has been largely based upon particle size, but would ideally need to include some measure of digestibility for an index of potential retention time in the rumen. Available estimates of fermentation rate and potential digestibility have promise for use in prediction of metabolizable nutrient supply to the animal and animal performance. However, variation in the executions of both *in vitro* and *in situ* techniques, coupled with individual animal variation and diet effects as they affect the results of these methods, may make these values more useful for ranking feeds and diet modification based on relative differences, rather than providing absolute values for use in diet formulation. Current methods hold promise. Improvements in methods coupled with integrated guidelines and systems for diet formulation need to be developed to make better use of values meant to define the nutritional value of feeds under a broad range of conditions. It may also be useful to establish assays that have utility across animal species in order to make research data more useful.

Key Words: Carbohydrates, Methods, Diet Formulation

584 Characterization of proteins in feeds. C.G. Schwab*¹, T.P. Tytlutki², C. Sheaffer³, and M.D. Stern³, ¹*University of New Hampshire, Durham, NH,* ²*Cornell University, Ithaca, NY,* ³*University of Minnesota, St. Paul, MN.*

Much effort has been devoted to the development of methods (feed analysis and computer models) to better characterize the nutritive value of crude protein in feedstuffs. This paper will review the approaches that have been (and are being) evaluated to estimate rumen-degradable feed protein (RDP), rumen-undegradable protein (RUP), RUP digestibility, and the amino acid composition of digestible RUP (dRUP). *In situ*-derived protein fractions have been adopted for use in estimating RDP, RUP, and dRUP in the most recent Dairy NRC model (NRC, 2001). *In vitro*, chemically-determined protein fractions were used in the Cornell Net Carbohydrate and Protein System and subsequently adopted for use in the Level 2 of the Beef NRC model (NRC, 1996) and in the Cornell-Penn-Miner (CPM) model (version 1). It is suggested that research should continue to add to the data sets from which these models have been developed. The variability in content of each N fraction within a

class of feedstuffs will be reviewed to help prioritize the need for analysis vs. the appropriateness of using model-default values. The results of sensitivity analysis will also be reported for the two models. This information indicates the importance of each of the required components in the models for estimating RDP and dRUP. The aforementioned methods, along with *in vitro* incubation and near-infrared reflectance spectroscopy (NIRS) methods, will be discussed. Their strengths and weaknesses, their current level of development, and their suitability for commercial application and model-refinements, will be highlighted.

Key Words: Ruminants, Feed Analysis, Protein

585 The end products of silage fermentation and their relationships to forage management. Limin Kung, Jr.*¹ and Richard E. Muck², ¹*The University of Delaware,* ²*The US Dairy Forage Research Center, USDA, ARS.*

The analysis of silages for fermentation end products includes the determination of pH, organic acids (lactic, acetic, propionic, and butyric acids), ethanol, buffering capacity, titratable acidity, and ammonia-N. These fermentation end products are often directly related to various management practices during harvest and storage because fermentation can be dictated by factors that include moisture content, the concentration of fermentable substrates, the amount and rate of elimination of oxygen from the forage mass, and the number and type of microorganisms contributing to the process. For example, alfalfa tends to be the most difficult crop to ensile because of its high buffering capacity. Thus, when harvested at a high moisture content (< 30% DM) the fermentation of alfalfa silage is often dominated by clostridia, which results in large losses of DM, excessive protein and amino acid degradation (thus high ammonia-N), and high concentrations of butyric acid. In high DM (> 45% DM) alfalfa, clostridia are seldom found even though alfalfa undergoes a restricted fermentation because of a lack of moisture for optimum bacterial growth. Forages with very high buffering capacities (e.g. because of high protein or mineral content) often have fermentations that are prolonged and characterized by high concentrations of acetic acid due to enterobacteria or lactic acid bacteria. Slow and poorly packed silages have high amounts of air, which can result in utilization of fermentable substrates by aerobic microbes. Such silages are often characterized by excessive protein degradation and are high in yeasts that contribute to the production of ethanol, large losses of DM, and aerobic instability. In extreme cases, lack of fermentable sugars can also lead to a clostridial fermentation. The end products of silage fermentation cannot be used to balance rations, but they can provide helpful indices of silage quality and they can be used as an educational tool to help producers identify areas for improvement in their harvest and storage practices.

Key Words: Silage analyses, Silage fermentation, Lactic acid

586 Use of new concepts in ration formulation and feeding for high producing cows. R.G. Hinders*, *Hinders Nutrition Consulting, Acampo, CA, USA.*

The new NRC Nutrient Requirements of Dairy Cattle, 2001, and the CPM Dairy models offer excellent tools for formulating rations. They

are dependent on accurate nutrient evaluation of feedstuffs. The extent that different analyses of 4 forages affect predicted milk production was examined. Split samples of low fiber alfalfa hay (LFA), high fiber alfalfa hay (HFA), corn silage (CS), and almond hulls (AH) were sent to two commercial and three research labs for analyses required for the NRC and CPM models. The CP, NDF, lignin, and NSC of both alfalfa samples showed little variation among labs. The percent SP (% of CP) varied from 40 to 6% for HFA and from 40 to 19% for LFA. CP for corn silage was similar from all labs. NDF from CS varied from 53% to 46%; lignin varied from 6 to 3%; NFC varied from 34 to 27%, and SP varied from 70 to 30%. CP, NDF and NFC values from AH were similar from all labs. SP for AH varied from 11 to 5% and lignin varied from 5 to 11%. The CPM model predicted a decrease on ME allowable milk per cow per day of 1.4 lb when NDF of CS increased from 45 to 50%, and lignin increased from 3 to 5 %. The NRC model predicted a decrease

of only 0.1 lb milk allowable from NEL from the same change, but an increase of 2.2 lb milk allowable from MP (due to an increase in NFC). The CPM model predicted an increase of 1.4 lb milk allowable from ME when SP of LFA was increased from 20 to 42%, and a decrease of 4.9 lb milk allowable from MP. The ration used for this evaluation contained 10.4% CS, 6.8 alfalfa silage, 21% LFA and 4% AH on a DM basis. The CPM model showed a possible increase of 7 lb ME allowable milk daily and 4.3 lb MP allowable milk by optimizing the original ration which supported 110 lb milk per day. Total milk production, % milk fat and protein, milk fat/protein ratios and MUN can be used by the nutritionist to evaluate the accuracy of model predictions based on feed analyses used.

Key Words: Dairy Ration Formulation, Nutrient Analyses, Evaluating Rations

Breeding and Genetics Applied Animal Breeding

587 Organ weights and internal fat of Angus or Romosinuano steers finished in the feedlot or with grain-on-pasture. S. W. Coleman^{*1}, W. A. Phillips², C. C. Chase, Jr.¹, D. G. Riley¹, B. Morgan³, J. Nelson³, and T. A. Olson⁴, ¹USDA, ARS Sub-Tropical Agricultural Research Station, Brooksville, FL, ²USDA, ARS Grazinglands Research Laboratory, El Reno, OK, ³Oklahoma State University, Stillwater, OK, ⁴University of Florida, Gainesville, FL.

Tropical adaptation is a desired trait for cows located in the sub-tropical regions of the U.S.A., including the Gulf Coast and most of the Southeast. Zebu breeds have traditionally been used for this area, but have some limitations such as reproduction and carcass quality. Criollo cattle from South America, such as the Romosinuano, have been reported to have good reproduction under tropical and sub-tropical conditions. A herd of Romosinuano was established at USDA, ARS, STARS in Brooksville, FL for evaluation. The objective of this study was to characterize organ weights and fat depots in Romosinuano steers as compared to Angus. Following weaning and preconditioning, 12 Romosinuano and 12 Angus steers from contemporary STARS herds were shipped to El Reno, OK (2,025 km) and grown for 224 d (November to June). The steers were then finished under two regimens; either 1) conventional total confinement feedlot or 2) by grazing old world bluestem pastures at a stocking rate of 10 hd/ha with ad libitum access to a finishing diet. Romosinuano steers produced heavier ($P < 0.05$) empty body weight than Angus (467 vs 418 kg) when finished with grain on pasture, but breed types were similar when finished in the feedlot (437 kg). When adjusted to a constant empty body weight, there were no differences ($P > 0.10$) due to breed or finishing treatment for weight of heart or kidney. Romosinuano steers had heavier ($P < 0.05$) hide (37 vs 33 kg), spleen (1.2 vs 0.8 kg), and internal fat (23 vs 18 kg) than Angus, but lighter liver (6.8 vs 7.3 kg, $P = 0.06$), and empty rumen tissue (19.3 vs 21.9 kg, $P < 0.05$). Steers finished in the feedlot had more ($P < 0.05$) internal fat (22 vs 18 kg), and lighter ($P < 0.05$) head (15.1 vs 16.1 kg) and lung (6.4 vs 7.1 kg) weights than those finished on pasture. An interaction ($P < 0.05$) was observed for weight of empty GI tract (minus rumen) weight. These data may explain the observation that Romosinuano cattle appear to carry less finish than conventional breeds and may have implications on how tropically adapted cattle adjust to feast or famine conditions of the wet-dry tropics by storing and mobilizing internal fat.

Key Words: Romosinuano cattle, Organ weights, Internal fat depots

588 Winter and spring performance of steer calves reared in temperate or sub-tropic environments and used as stockers on winter wheat pasture in Oklahoma. W. A. Phillips^{*1}, E. E. Grings², S. W. Coleman³, R. E. Short², D. G. Riley³, C. C. Chase³, H. S. Mayeux¹, and R. K. Heitschmidt², ¹USDA-ARS Grazinglands Research Laboratory, El Reno, OK, ²USDA-ARS Fort Keogh Livestock and Range Research Laboratory, Miles City, MT, ³USDA-ARS Subtropical Agricultural Research Station, Brooksville, FL.

Each fall millions of beef calves are imported into the Southern Great Plains region of the U.S. to graze winter wheat pastures before entering a feedlot for finishing. Rather than owning the calves, winter wheat pasture producers may decide to act as subcontractors, who are paid

according to the gain accumulated by each calf. The objective of this experiment was to compare the weight gains of steers from temperate and sub-humid environments as stockers for grazing winter wheat pastures. On October 23, 2000, Angus (N=34) and Romosinuano (N=36) steers born and reared at Brooksville, FL were transported 2,025 km to El Reno, OK. On November 14, 2000, crossbred steers of temperate breeds born in February (N=24), April (N=11) or June (N=18) and reared at Miles City, MT were transported 1,710 km to El Reno, OK. All calves had been weaned for at least 21 d prior to shipment. Individual BW was taken at arrival and used as the initial BW. Because winter wheat pasture was limited due to drought conditions, all steers were combined into a single group, placed on a 28-ha dormant warm season grass pasture, and given ad libitum access to a mixed diet formulated to support an ADG of 0.8 kg for the winter period (October or November to April). In April, steers were moved to winter wheat pasture for a 63-d spring grazing period. Angus steers were 26 kg heavier (433 vs 407 kg; $P = 0.11$) upon arrival and gained more weight ($P < 0.01$) during the winter (297.5 vs 221.6 kg) than Romosinuano steers. During the spring when temperatures were warmer, Romosinuano steers gained more weight ($P < 0.01$) than Angus steers (36.9 vs 26.0 kg). Crossbred calves born in February were heavier ($P < 0.01$) than calves born in April or June (244 > 197 and 175 kg) and gained more ($P < 0.02$) weight during the winter than calves born in June (139 vs 123 kg). Overall gain (winter + spring) was similar among the three age groups (151 kg). In general, calves from temperate breeds performed better as winter stocker calves than calves from a tropically adapted breed.

Key Words: Tropical breed, Stocker calves, Winter wheat

589 Scrotal circumference in yearling bulls may be related to number of facial hair whorls within a breeding program. M. Meola^{*}, T. Grandin, P. Burns, and M. Enns, Colorado State University, Fort Collins, Colorado, USA.

The objective of this study was to determine the relationship between number of facial hair whorls and scrotal circumference in yearling bulls. Scrotal circumference measurements were taken on 129 yearling bulls (mean = 371 ± 1.7 d of age) from the Eastern Colorado Research Center (ECRC) Bull Test Station in Akron, CO and 63 Angus yearling bulls (mean = 350 ± 1.3 d of age) from the John E. Rouse CSU Beef Improvement Center (BIC) in Saratoga, WY. The breeding program at BIC focuses on purebred Black Angus cattle with specific selection criteria for fertility, calving ease and pulmonary artery pressure, while the population of bulls at ECRC comes from various breeds and breeding programs. Scrotal circumference was measured to the nearest 0.5 cm using a scrotal tape and the number of facial hair whorls (0, 1 or 2) was recorded. At ECRC, there was no relationship between breed category (British vs Continental) and number of hair whorls ($P = 0.38$). No relationship was found between scrotal circumference and number of hair whorls ($P = 0.40$) or breed category ($P = 0.39$). Bulls from ECRC with two facial hair whorls had a mean scrotal circumference of 36.3 cm, compared to bulls with one whorl (35.9 cm; $P = 0.25$), and no facial whorls (35.9 cm; $P = 0.69$). However, bulls from BIC with two facial hair whorls had smaller scrotal circumference measurements (33.8 cm) than bulls with one facial hair whorl (35.5 cm) or bulls with no facial hair whorls (36.1 cm; $P = 0.03$). There was no relationship

between age of bull and scrotal circumference at either ECRC ($P = 0.30$) or BIC ($P = 0.74$). Because hair whorl numbers are consistent from birth, within a particular breeding program, the absence and/or number of facial hair whorls may provide a visual estimate of current or future scrotal circumference in yearling bulls.

Key Words: Hair whorls, Scrotal circumference, Bulls

590 Correlated responses in carcass and meat quality traits in a line of Landrace pigs selected for increased ultrasound loin eye area. D.L. Kuhlers^{*1}, K. Nadarajah¹, S.B. Jungst², and B.L. Anderson¹, ¹Auburn University, AL, ²PIC, Franklin, KY.

Selection for increased ultrasound loin eye area (ULEA) in pigs might cause changes in carcass and meat quality traits. Five generations of single trait selection conducted in a line of Landrace pigs for increased ultrasound loin eye area (ULEA) showed a difference of 10.6 cm² in average EBVs between select (SL) and control (CL) lines for ULEA. The objective of this study was to examine the impact of increased ULEA on changes in carcass and meat quality traits. Real-time ULEA data at 10th rib of 1406 pigs at 168 d of age, and of those 192 barrows that had carcass measurements for carcass length (CLGT), backfat thickness at 10th rib (CFAT), *longissimus* muscle area (CLMA) between 10th and 11th ribs, percent lean cuts (PCNL), color (COLR) and marbling (MARB) scores (1-5 scale) were used for this study. Heritabilities and genetic correlations were estimated by the multivariate REML procedure using MTDFREML. For ULEA, the model considered the fixed effects of generation, sex, covariate of 168 d weight, and random effects of animal, litter and error. For carcass traits, fixed effect of generation, covariate of hot carcass weight and random effects of animal and error were considered. Estimates of heritabilities for ULEA, CLGT, CFAT, CLMA, PCNL, COLR and MARB were .47, .74, .71, .41, .27, .35 and .43, respectively. Genetic correlations of ULEA with CLGT, CFAT, COLR and MARB were negative and the correlation with CLMA was very high (.99). Estimates of genetic correlations of CLGT with CFAT and CLMA were -.26 and -.67, respectively. Average EBVs of SL pigs in the fifth generation were 4.35 cm less for CLGT and 0.57 cm less for CFAT than those of CL pigs. Compared to CL pigs, the average EBVs of SL pigs showed differences of 11.2 cm² for CLMA and 3.28% for PCNL, and a reduction of a point in scores for COLR and MARB, respectively. Selection for increased ULEA resulted in improvement in CLMA and CFAT with concomitant reduction in CLGT, COLR and MARB.

Key Words: Selection, Ultrasound Loin Eye Area, Carcass and Meat Quality

**Dairy Foods
Sensory**

592 Trace thiol compounds in aged cheddar cheese. J.P. Kleinhenz¹, W.J. Harper^{*1}, and M. A. Drake², ¹The Ohio State University Columbus, Ohio, USA, ²North Carolina State University, Raleigh, North Carolina, USA.

Sulfur compounds are known to be important in the flavor of Cheddar cheese and also have sensory thresholds in very small concentrations, ranging from parts per billion to parts per trillion, depending on the individual compound. A method was developed to detect very low (ppt) concentrations of thiol compounds in Cheddar cheese. Two pounds of Cheddar cheese was warmed to 37°C and centrifuged to recover about 200 g of cheese fat. This was then diluted with an equal volume of redistilled hexane, and extracted with a basic 25% ethanol solution containing Tris carboxyethyl phosphine, a disulfide reducing reagent, and p-hydroxymercuribenzoic acid, a thiol trapping salt, to capture the thiol compounds in a reduced state. The pH of the 25% ethanol solution was then lowered to 6.5, and the p-hydroxymercuribenzoic acid-thiol complex was concentrated on an ion exchange resin. The thiol compounds were eluted with aqueous cysteine, and then recovered by extracting the aqueous cysteine solution with a 2:1 solution of pentane and diethyl ether, dried over anhydrous sodium sulfate, concentrated by evaporation under nitrogen, and analyzed by GC with a Sulfur Chemiluminescence detector. The method was shown to be specific for thiol compounds. The internal standard was 3-methoxythiophenol. The method was applied to 8 commercial Cheddar cheeses more than 6 months old, which

591 Between-breed variation in response to *Haemonchus contortus* infection in sheep. H. B. Vanimisetti^{*}, S. P. Greiner, A. M. Zajac, and D. R. Notter, Virginia Polytechnic Institute and State University, Blacksburg.

The objective of this study was to compare breed differences in resistance to *H. contortus* in sheep. A total of 131 ewe lambs representing Dorset (DO) and Dorper (DP) crossbreds (out of 1/2-Dorset, 1/4-Rambouillet, 1/4-Finnsheep ewes) and straightbred Katahdins (KT) were evaluated in 2000 and 2001. In addition, 82 DO, DP, KT and Barbados Blackbelly X St. Croix (HH) wethers were evaluated in 2001. After deworming at 4 mo of age, ewes were dosed with infective larvae and evaluated in drylot, whereas wethers were evaluated on pasture with natural infection. Parasite eggs per gram of feces (FEC), log transformed FEC (LFEC), packed cell volume (PCV; %), and body weight (BW; kg) were measured 3, 4, 5 and 6 wk after deworming and reinfection. A repeated-measures analysis of variance included breed, year (for ewes), week and their interactions. Least square means and SE (in parenthesis) for ewes (E) and wethers (W) across sampling times are shown below. Breed and week influenced all traits ($P < 0.05$) except BW in ewes. The DP had highest FEC at all times followed by DO and KT. Breed x week interaction affected ($P < 0.05$) LFEC in both sexes, BW in wethers and FEC in ewes. The DP had higher PCV ($P < 0.05$) than DO despite their higher FEC. The HH wethers had lowest FEC at all times and smallest drop in PCV 6 wk after deworming. All breeds grew throughout the study, but DP wethers grew least rapidly. The DP were clearly not more resistant to parasites than DO, whereas the KT and HH were most resistant. Mean BW was negatively correlated to FEC and LFEC and positively correlated to mean PCV. Mean PCV was negatively correlated to FEC and LFEC. Clear breed differences in resistance to *H. contortus* thus exist.

Trait	DO-E	DP-E	KT-E	DO-W	DP-W	KT-W	HH-W
BW	41.5 (0.8)	42.8 (1.1)	41.2 (0.9)	32.4 (0.9)	29.8 (0.9)	26.0 (1.2)	24.5 (1.2)
PCV	26.4 (0.3)	27.9 (0.5)	29.8 (0.4)	24.3 (0.8)	24.5 (0.9)	26.7 (1.1)	27.4 (1.1)
FEC	2043 (183)	3007 (261)	1460 (227)	1931 (196)	2269 (208)	1469 (264)	673 (257)
LFEC	7.3 (0.1)	7.6 (0.1)	6.4 (0.1)	7.2 (0.1)	7.4 (0.1)	6.7 (0.2)	5.8 (0.2)

Key Words: *H. contortus*, Parasite resistance, Sheep

had been shown to differ in 4 sulfur descriptors (total sulfur, cat like, match like and egg like). Multiple thiol compounds were separated from all cheeses. The extracts from the different cheeses showed both quantitative and qualitative differences. Up to 30 compounds were shown to be present in any given cheese. Identification of the compounds has been complicated by lack of available standard compounds. One polyfunctional thiol compound shown to be present in different concentrations in most of the cheeses was 4-mercapto-4-methylpentan-2-one, which has been responsible for a catty flavor taint in Gouda cheese. Based on Kovats retention indices, other polyfunctional thiols are also present.

Key Words: Cheddar, thiols, flavor

593 Comparison of descriptive sensory analysis with electronic nose differentiation of commercial Swiss cheese. W. J. Harper^{*1}, J. Kuo¹, and M. A. Drake², ¹The Ohio State University, Columbus, Ohio, USA, ²North Carolina State University, Raleigh, NC, USA.

There is need for methods that differentiate and monitor flavor quality of cheese. This includes rapid screening analytical methods, such as electronic noses. We have shown previously that similar differentiation can be obtained for Cheddar cheese using descriptive sensory analysis and an Electronic Nose with a Mass Spectrometer detector in a Negative Chemical Ionization mode for aged Cheddar cheeses. This approach

has now been extended to commercial Swiss cheese. Twelve commercial Swiss cheeses of varying ages were obtained from 8 different sources. Sensory properties of the cheeses were evaluated in duplicate by descriptive sensory analysis with a highly trained sensory panel (n=10). The Agilent Technology Chem. Sensor 4400 (electronic nose), using a Mass Spectrometer detector in chemical ionization mode was used to analyze the headspace aroma of cheeses in triplicate. The data from sensory analysis and the electronic nose were analyzed statistically to provide both cluster and principal component analysis plots. Cluster analysis of the sensory data showed separation of all 12 cheeses from each other. One cheese, with high faecal and salty scores was unrelated to the other cheeses. The other 11 cheeses grouped into 4 other clusters with a similarity of less than 50%. Only one pair of cheese had a similarity of greater than 70%. Descriptors with scores >3.5 and not present in most other cheeses appeared to be important in the differentiation of cheese flavor by the sensory panel. Good differentiation of the cheeses was obtained also with the electronic nose. Nine of the 12 cheeses showed distinctly different clusters, but the similarity was >70%. The cluster patterns were different from those obtained by the descriptive sensory panel. Two clusters with no similarity contained 6 cheeses in each cluster. Each of these clusters subdivided into 3 separate clusters. Although good differentiation was obtained by both methods, it was clear that the basis of differentiation was different in each case.

Key Words: Swiss cheese, descriptive sensory analysis, electronic nose

594 Impact of starter culture on flavor of liquid cheddar cheese whey. M. E. Carunchia Whetstone*, J. D. Parker, D. K. Larick, and M. A. Drake, *North Carolina State University, Raleigh, NC.*

Dried whey and whey protein are commonly used in dairy products and other foods. Functionality of whey products has been studied extensively. Flavor of dried whey ingredients has not been studied as widely although problems with flavor variability exist. Flavor inconsistency and flavors which may carry through to the finished product can limit whey ingredient applications in dairy and non-dairy foods. One source of flavor variability in dried whey ingredients is the raw product - liquid whey. The scope of this research was to determine the impact of starter culture rotation on the flavor of liquid Cheddar cheese whey.

Liquid Cheddar cheese whey from five culture blends from two different Cheddar cheese manufacturing facilities were collected. Whey flavor was determined using instrumental and sensory methods. Dynamic headspace analysis with gas chromatography/mass spectrometry was used to identify volatile compounds, while solid-phase microextraction was used to determine free fatty acid profiles. Free amino acid analysis was conducted using reverse phase high performance liquid chromatography. A trained descriptive sensory panel (n=8) determined the sensory properties of the liquid wheys.

There was wide variation in the headspace volatiles between samples, especially those from different manufacturing facilities. Hexanal and diacetyl were two key volatiles that varied widely with starter culture (p<0.05). The fatty acid profiles of the whey samples were also different (p<0.05). There was no differentiation in free amino acid content of wheys (p>0.05). Differences in whey flavor profiles were also confirmed by sensory analysis. The flavor of liquid Cheddar cheese whey is variable and impacted by starter culture rotation. Results from this study will aid future studies that address the impact of liquid whey flavor variability on flavor of dried whey ingredients.

595 Effect of feeding systems on composition and organoleptic quality of goat milk cheese. A. K. Soryal, S.S. Zeng*, B. Min, S. Hart, B. Bah, and K. Tesfai, *Langston University.*

This study investigated effects of different feeding systems on chemical and biochemical composition, and organoleptic scores of a goat milk soft cheese. Three groups of lactating Alpine goats (BW = 54-10 kg) grazed with different levels of concentrate supplementation on pasture (A: no concentrate; B: 0.33 kg concentrate; C: 0.66 kg concentrate) and the fourth group (D) was confined and fed 0.66 kg concentrate and alfalfa hay *ad lib*. Ten kg of milk from each group was collected and made into a soft cheese twice monthly from April through September 2001. Cheese samples were analyzed for fatty acid, fat and protein contents, and were evaluated for sensory quality at fresh, 1 mo. and 2 mo. Results indicated that feeding system did not affect fat or protein content in cheese on dry-basis at any age (P > .05). However, there were significant differences in total fatty acid concentrations and sensory scores (P < .05), especially at fresh and 1 mo. old. Significant differences were also found

in fat, protein, and total fatty acid concentrations and in sensory scores of soft cheese at different stages of lactation. The cheeses showed higher fat content and higher total fatty acid concentration at the early and at the late lactations than in the mid-lactation stages (P < .01). The total organoleptic score (body & texture and flavor) increased linearly (P < .01) as lactation progressed. Cheese from A had more abundant short-chain fatty acids (C₆ to C₁₀) than cheese from D (P > .05). Negative correlations were found between total fatty acid concentration and sensory scores (r = -0.20 to -0.28) at all ages. In conclusion, milk from grazing goats supplemented with a high level of concentrate resulted in cheese with a higher total fatty acid content and a lower short-chain fatty acid concentration, and a lower sensory score of cheese compared with milk from goats without or with a low level of concentrate.

Key Words: Goat milk, Cheese, Fatty acids

596 Impact of pasture on sensory properties of Ragusano. S. Carpino*, J. Horne¹, C. Melilli¹, G. Licita², and D.M. Barbano³, ¹*Consorzio Ricerca Filiera Lattiero-Casaria, s.p.a. km 5, 97100 Ragusa, Italy,* ²*D.A.C.P.A., Catania University, 95100, Catania, Italy,* ³*Department of Food Science, Cornell University, Ithaca, NY 14853.*

Ragusano cheese is produced in the Hyblean region of Sicily. As the cheese is aged, the color and other sensory characteristics are changed. A quantitative descriptive sensory panel for evaluation of flavor, aroma, and texture may be biased by a darker-colored cheese and thus believe it has stronger aroma or flavor and different texture because the color would indicate it is an "older" cheese. In order to eliminate this potential source of bias in sensory analysis, colored eye glasses (Post-Mydriatic sunglasses, 100% UV protection to 400 nm, Solarettes Supplier, Optics and Service Centrostyle, Italy) that effectively blocked light of the range of wavelength reflected by Ragusano cheeses were selected and used by panelists during training and evaluation of unknown cheese samples. The objective of this study was to determine if there were any differences in flavor, aroma, and texture of cheeses made from milk produced on the same farm, but from two different groups of cows that were on different feeding regimes. One group of cattle were allowed to graze on natural Hyblean pasture, while the other group consumed a total mixed ration (TMR). Statistical analysis with repeated measures Anova was used to determine whether different feeding treatments had a significant impact (P<0.05) on panel scores for descriptive terms, and on instrumental measures of color (i.e., L, a, b-values). Pasture cheeses were found to be more yellow (higher a- and b- values) than TMR cheeses. They also reflected less light in the range of 460-500 nm. Sensory analysis demonstrated that the pasture cheeses had stronger aromatic impacts in the categories of "floral", "green", and "pungency". They also differed somewhat from the TMR cheeses in their texture qualities.

Key Words: Cheese, Sensory, Glasses

597 Flavors and off-flavors associated with full fat and low fat chocolate milk in the North Carolina marketplace and school lunch program. A.P. Hansen*, *North Carolina State University, Raleigh, N.C. USA.*

Chocolate milk samples were obtained from local dairies and grocery stores. Samples were also obtained from the school lunch program for flavor evaluation. The chocolate milk contained from 1/2 to 1% cocoa, high fructose corn sugar, vanillin, ethyl vanillin, cornstarch, guar and carageenan. Samples were evaluated over a ten-year period. The chocolate milk in the school lunch program was of the poorest quality. There tended to be more off flavors due to poor quality cocoa such as musty, malty, moldy, smoky, burnt cocoa flavors and whey flavor. Other milks lacked chocolate flavor and color with more vanillin taste.

Analysis of premium chocolate milk samples tends to yield good chocolate flavor. Some samples have a higher level of vanillin and ethyl vanillin, which tend to overpower the chocolate flavor. The store brands tend to have a better chocolate flavor than the school lunch chocolate milk. Flavors associated with store brands were malty, overheated or burnt, alkaline, lacks chocolate flavor, vanillin and ethyl vanillin. Some samples are just sweet, brown in color and almost have no chocolate flavor. Over the past 2-3 years the quality of chocolate milk store brands has been improving due to the competition from the national brands. People can taste and are looking for good quality chocolate milk.

Key Words: Chocolate milk, Flavor, Marketplace

598 Quality attributes of lightly salted sweet cream butter in the North Carolina marketplace. A.P. Hansen* and M.D. Keziah, *North Carolina State University*.

Approximately 300 samples of sweet cream butter were obtained from local stores in North Carolina and nearby states. The samples were collected over a three-year period and analyzed for flavor. This evaluation was conducted with 15 trained dairy judges according to ADSA protocol. The variation in quality and uniformity was quite different across brands. The color of the butter went from whitish to yellow in color depending on if it was winter butter or summer butter. The flavors identified in the National Brands were coarse and slight feed but they were consistently good month after month. The store brands tend to have many more flavor defects. Going from the most to the least they were as follows: old cream, high salt, neutralizer, storage, flat, coarse, acid, scorched and oxidized. The store brands also had slight coarse and slight feed as the national brands and some store brands were consistently better than other store brands. In most cases, it was related to the price of the butter.

Key Words: Butter, Marketplace, Quality

599 Characterization of volatile nutty flavor compounds in Cheddar cheese. M.A. Drake*¹, Y.K. Avsar², Y. Karagul-Yuceer¹, and K.R. Cadwallader³, ¹*North Carolina State University*, ²*Mustafa Kemal University*, ³*University of Illinois*.

Cheese flavor is the one of the most important criteria in determining consumer choice and acceptance. Cheddar cheese flavor ideally is com-

posed of sulfur and nutty flavors. The aim of the present study was to characterize the volatile compounds responsible for nutty flavors in Cheddar cheese.

Cheddar cheeses (1-3 years old) were screened for nutty flavor by a descriptive sensory analysis panel (n=7). Samples with and without nutty flavor (4 cheeses each) were selected and analyzed for volatile aroma compounds. Cheeses were grated and extracted with diethyl ether containing internal standards (2-methyl-3-heptanone and 2-methyl-pentanoic acid). Volatiles were isolated by high vacuum distillation. Volatile extracts were separated into acidic and basic/neutral fractions, which were then analyzed by gas chromatography-olfactometry (GCO). Identification of odor active compounds was carried out by comparison of GC-MS data, retention indices and odor properties against reference standards.

Results showed that the compounds found in the neutral/basic phase, 2-acetyl-1-pyrroline and 2-acetyl-2-thiazoline (popcorn/nutty/roasted), 2-isopropyl-3-methoxy pyrazine (earthy), 3-(methylthio)propanal (boiled potato), 2,3-butanedione (buttery), trimethylpyrazine (nutty/dirty) and δ -decalactone (sweet/fatty) were the most odor-active compounds and their intensities were higher in nutty cheeses. Volatile fatty acids including acetic, propionic, pentanoic and butanoic acids were found in acid fractions of both nutty cheese and not nutty cheeses. The data obtained in this study will be used for better understanding Cheddar cheese flavor and for identification of the chemical pathways for the formation of these compounds.

Key Words: Cheddar Cheese, Flavor, Nutty Flavor

Food Safety Foodborne Pathogens

600 Acid resistance status of *Escherichia coli* O157 in bovine feces as shed from naturally contaminated cattle. E. D. Berry* and G. A. Barkocy-Gallagher, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE*.

Exposure to low pH and acids in the bovine gastrointestinal (GI) tract may result in the induced acid resistance of *E. coli* O157. Because bovine feces are a source of carcass contamination, and acid tolerance of bacteria can affect the efficacy of decontamination procedures, the acid resistance of this organism as shed from cattle was determined. The objectives of this study were to examine the capacity of naturally-occurring *E. coli* O157 shed in bovine feces to survive exposure to low pH and to assess the relative acid resistance status of *E. coli* O157 as shed from cattle. Fecal grab samples and freshly-dropped feces were collected randomly from cattle in the MARC feedlot from August through October in 2000 and 2001. Initial numbers of *E. coli* O157 and numbers following exposure to pH 2.5 for 6 h were determined in fecal slurries, using a most probable number-immunomagnetic separation procedure. Isolates were confirmed as *E. coli* O157 and genotyped by pulsed-field gel electrophoresis. Fifteen positive fecal samples containing at least four distinct genotypes were obtained. Initial populations ranged from 0.99 to 4.86 log₁₀ CFU/g, and log reductions following acid challenge ranged from 0.68 to 3.21 log₁₀ CFU/g. For each unique isolate, acid resistance was determined in vitro for cells both in mid-log and stationary phases of growth, cultured with and without glucose (acid-adapted [AA] and nonacid-adapted [NA], respectively), by exposing the cells to the same acid challenge as the fecal slurries. Stationary phase cells were resistant to the acid challenge; generally, reductions of AA cells were <0.20 log₁₀ CFU/g and NA cells were <0.60 log₁₀ CFU/g. Log reductions of all mid-log phase cells were >4.00 log₁₀ CFU/g and many populations were reduced below detectable levels. Comparison of the in vivo and in vitro acid resistance data indicates that residence in the bovine GI tract does not result in the development of extreme acid resistance of *E. coli* O157.

Key Words: *E. coli* O157, Acid Resistance, Cattle

601 Effect of preconditioning and distance of transport on shedding of *Escherichia coli* and *E. coli* O157:H7 by calves destined for feedlot. S.J. Bach*¹, T.A. McAllister¹, G.J. Mears¹, A.L. Schaefer², and K.S. SchwartzkopfGenswein³, ¹*Agriculture and Agri-Food Canada, Lethbridge, AB*, ²*Agriculture and Agri-Food Canada, Lacombe, AB*, ³*Alberta Agriculture, Food and Rural Development, Lethbridge, AB*.

The effects of stressors (weaning, transport) on shedding of total *Escherichia coli* and *E. coli* O157:H7 were investigated using 174 range steer calves (80 Angus; 94 Charolais) blocked by breed and birth date and assigned to 4 treatments. The calves were preconditioned (P) or not (NP), and transported by commercial cattle liner for 15 h (long haul, L) or 3 h (short haul, S). Preconditioning comprised vaccinating 29 d prior and weaning 13 d prior to hauling; NP calves were weaned 1 d prior to transport (no vaccination). The NP calves were also penned (water only) for 24 h, followed by a second (2-h) haul. This simulated transport from ranch to feedlot for P calves; and from ranch to auction to feedlot for NP calves. Following transport, calves were allotted to 16 feedlot pens. Fecal samples were collected at weaning, day of transport, day of feedlot arrival, twice in the first week, and on d 7, 14, 21 and 28 for enumeration of *E. coli* Biotype 1, and culturing for *E. coli* O157:H7 (+ or -). Higher levels ($P < 0.005$) of *E. coli* were shed by NP-L calves than by P-L, NP-S or P-S calves at weaning, on day of arrival at the feedlot, and after 1, 7 and 21 d. Repeated measures analysis revealed the same was true over the entire experimental period ($P < 0.005$). No calves were positive for *E. coli* O157:H7 prior to transport. Chi-square analysis revealed that after transport, more ($P < 0.005$) calves were positive for *E. coli* O157:H7 in the NP-L group than in P-L, NP-S or P-S. Holding facilities or the feedlot may have served as source of infection, fostered by intensive association of animals during transport and relocation. Lack of preconditioning coupled with long-haul transport increased fecal shedding of *E. coli* and *E. coli* O157:H7 by calves following transport. Management strategies to reduce stress-associated shedding of *E. coli* O157:H7 may include preconditioning.

Key Words: Cattle Transport, *E. coli* O157:H7, Fecal Shedding

602 Intervention to reduce fecal shedding of enterohemorrhagic *Escherichia coli* O157:H7 in naturally infected cattle using neomycin sulfate. R.O. Elder^{*1}, J.E. Keen², T.E. Wittum³, T.R. Callaway¹, T.S. Edrington¹, R.C. Anderson¹, and D.J. Nisbet¹, ¹USDA/SPARC, College Station, TX, ²USDA/MARC, Clay Center, NE, ³Ohio State University, Columbus, OH.

Cattle are implicated as the major reservoir of enterohemorrhagic *Escherichia coli* (EHEC) such as EHEC O157:H7. To date effective pre-harvest strategies to reduce the number of EHEC O157:H7 positive cattle entering the food supply is limited or nonexistent. Mechanisms for short-term treatment of cattle, prior to slaughter, which eliminate or reduce the level of shedding of EHEC, can greatly impact the number of food borne outbreaks associated with EHEC. Using naturally infected EHEC O157:H7 positive cattle (n = 32) we tested and found that oral administration of neomycin sulfate at therapeutic doses reduces fecal shedding of EHEC O157:H7, to non-detectable levels compared to controls (P < 0.05), and lowers total numbers of generic *E. coli* (P < 0.05) in treated animals. Administration of neomycin sulfate reduced concentrations of *E. coli* O157:H7 24 hrs post treatment and lowered their levels beyond detection limits 72 hrs post treatment. Also, total generic *E. coli* concentrations in these cattle were also dramatically reduced 72 hrs post treatment. By day 7 post treatment generic *E. coli* levels returned to pretreatment levels, however, animals remained negative for EHEC O157:H7. These data show neomycin sulfate is an effective intervention that will reduce the risk of EHEC O157 from entering the food supply. This short-term intervention is amendable to current livestock production systems prior to cattle processing at a minimal cost.

Key Words: EHEC O157, Intervention, Food safety

603 Effect of co-mingling stress on fecal shedding of *Salmonella typhimurium* by early weaned piglets. T. R. Callaway^{*1}, J. L. Morrow², T. S. Edrington¹, K. J. Genovese¹, R. O. Elder¹, J. W. Dailey², R. C. Anderson¹, and D. J. Nisbet¹, ¹Agricultural Research Service/USDA, Food and Feed Safety Research Unit, College Station, TX, ²Agricultural Research Service/USDA, Livestock Issues Research Unit, Lubbock, TX.

Weaned pigs are often transported to grower facilities and may be co-mingled without regard to farm of origin. This study was designed to determine the effect of mixing stress on intestinal populations of *Salmonella typhimurium* in SEW pigs. Piglets (7 d old; n = 28) were separated into 4 groups (2 control and 2 mixed groups). One pig from each group of 7 was challenged with 3 x 10⁹ CFU of *S. typhimurium* via oral gavage. In the mixed groups, one piglet each day for 5 days was swapped between the two mixed groups, to simulate mixing stress; control groups were not mixed. Behavior of all 4 groups was recorded continuously. Groups indicated significant (P < 0.01) behavioral differences; mixed pigs devoted significantly less time to eating (P < 0.02), to rooting (P < 0.01) and performed less agonistic behavior (P < 0.01), indicating that the mixed groups were indeed stressed. Fecal swabs were enriched each day to qualitatively monitor shedding of *S. typhimurium*; each day more mixed pigs (P < 0.05) shed *Salmonella* than did control groups. After necropsy, rectal populations of *Salmonella* in mixed pigs were significantly (P < 0.05) greater than in control pigs but cecal *Salmonella* populations were unaffected by mixing. When tissues from the tonsils, ileo-cecal lymph node, cecum and rectum were enriched for *Salmonella*, the mixed group demonstrated more (P < 0.05) *Salmonella*-positive tonsils and lymph nodes than did control pigs. Results suggest that mixing groups of pigs from different farms can cause social stress that may increase their susceptibility to *S. typhimurium*.

Key Words: *Salmonella typhimurium*, Stress, Fecal shedding

604 The prevalence of multiple antibiotic-resistant *Salmonella* recovered from swine at a slaughter facility. F. M. Wallace^{*1}, L. Wonderling¹, P. J. Fedorka-Cray², A. Oser³, R. Pearce⁴, J. Call¹, M. L. Tamplin¹, I. F. Feder¹, L. Yoder³, and J.B. Luchansky¹, ¹USDA-ARS Wyndmoor, Pa., ²USDA-ARS Athens, Ga., ³Hatfield, Pa., ⁴National Food Center, Castleknock, Dublin, Ireland.

Carcass (100) and fecal (60) samples were collected from swine at slaughter on 10 days over a 30-day period. Seventy-four percent of carcasses and 35% of fecal samples were positive for *Salmonella*. The 582 *Salmonella* isolates obtained were analyzed by ribotyping and PFGE, as

well as for susceptibility to a panel of 17 antimicrobials used in the National Antimicrobial Resistance Monitoring System program. The majority (85%) of the isolates displayed PFGE profile types "F", "B", and "I". Ribotyping suggested that isolates displaying profiles F and I were most likely *S. Typhimurium*, whereas isolates displaying profile B were most likely *S. Derby*. When tested for antimicrobial susceptibility, a majority (85%) of the isolates exhibited resistance to antimicrobials with a wide variety of susceptibility patterns. Interestingly, multiple isolates obtained from the same sample generally displayed different resistance profiles, indicating that testing multiple isolates may be important during routine susceptibility studies. Of the 203 isolates displaying profile B, 167 (82%) were resistant to only tetracycline, sulfamethoxazole, and streptomycin. Among the 85 profile I isolates, 56 (66%) were resistant to at least ampicillin, kanamycin, streptomycin, sulfamethoxazole, and tetracycline (AKSSuT). Among the 206 profile F isolates, 199 (97%) displayed resistance to at least ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline (ACSSuT), while 28 of these 199 isolates were also resistant to amoxicillin/clavulanic acid. Further characterization of the profile F isolates by serotyping and phage typing will enable identification of those isolates that may be *S. Typhimurium* DT104. These data confirm that multiple antibiotic-resistant *Salmonella* are prevalent in swine feces/carcass samples collected at a slaughter facility.

Key Words: Swine, *Salmonella*, Antimicrobial Resistance

605 Characterization of farm management practices that contribute to number and type of gram-negative bacteria in bulk tank milk. N. V. Hedge^{*}, R. Butchko, C. Hampton, A. A. Sawant, and B. M. Jayarao, *The Pennsylvania State University, University Park, PA, USA.*

In this study, four bulk tank milk (BTM) samples were collected at intervals of 15 days from each of the 126 dairy herds that participated in the study. The BTM samples were examined for; 1) Somatic cells (BTSCC), 2) Standard plate count (SPC), 3) Preliminary incubation count (PIC), 4) Laboratory pasteurization count (LPC), 5) *Staphylococcus aureus* (SA) count, 6) Coagulase negative staphylococcal (CNS) count, 7) Streptococci and streptococci-like organisms (SSLO) count, 8) Coliform count (CC), and 9) Gram-negative non-coliform (NC) count. Coliforms were detected in 89 of 126 (70.6%) of BTM samples. Counts ranged from 0 to 4,130 cfu/ml (mean, 159 cfu/ml). Gram-negative non coliform bacteria were observed in 83 of 126 (65.8 %) of BTM samples. Counts ranged from 0 to 15,475 cfu/ml (mean, 838 cfu/ml). A total of 369 isolates from 121 BTM samples were examined to species level; 369 isolates belonged to 38 different bacterial species. Coliforms and NC accounted for 64.5 and 35.5% of the total isolates, respectively. *Escherichia coli* was isolated from 44 of 126 (34.9%) of bulk tank milk, of which 6 of 44 (13.6%) BTM samples had *E. coli* that encoded for shiga toxin 2, while one isolate (1 BTM sample) encoded for both shiga toxin 1 and 2. *Escherichia coli* O157:H7 was not detected in BTM. Coliform counts (> 50 cfu/ml) and NC (> 200 cfu/ml) were significantly associated with high SPC (> 5,000 cfu/ml) and PIC (> 20,000 cfu/ml). A critical review of farm management practices using a self-administered questionnaire followed by consultations with dairy producers strongly indicated that; 1) Use of bedding material other than sand, newspaper in particular can contribute to high NC count in BTM, 2) Most of the dairy producers (92%) who practiced fore-stripping, had none to very low (<50 cfu/ml) CC, and 3) Dairy producers who pre-rinsed their milking system before milking using an acid sanitizer had none to very low counts of CC or NC or both in BTM.

Key Words: Bulk tank milk, Coliforms, Management practices

606 Pasteurization effects on *Mycobacterium paratuberculosis*, *E. coli* O157:H7, *Salmonella* sp., *Listeria monocytogenes*, and *Staphylococcus aureus*. L. Green^{*}, S. Godden, and J. Feirtag, *University of Minnesota, St. Paul, MN.*

The objectives of this study were to evaluate the efficacy of on-farm commercial pasteurization units and the effectiveness in which they destroy *Mycobacterium paratuberculosis*, *E. coli* O157:H7, *Salmonella* sp., *Listeria monocytogenes*, and *Staphylococcus aureus* in saleable bulk tank milk inoculated with a low (between 10² and 10³ CFU/ml) and a high inoculum (between 10⁵ and 10⁶ CFU/ml). The pasteurizers (batch/vat and continuous-flow) used in this study were made for on-farm commercial use. Bulk tank milk was obtained from the University of Minnesota

campus farm. Milk was put into the respective pasteurizers and inoculated with the appropriate level of pathogens. The pasteurizers were heated to the specific time and temperatures: 145F for 30 minutes for the batch/vat pasteurizer and 161F for 15 seconds for the continuous-flow pasteurizer. Pre- and post-pasteurization (0, 24, and 48 h) samples were taken from each of the triplicate runs performed for each of the two pasteurizers. The milk samples were plated onto selective media for each pathogen and incubated at 37C for the appropriate time. All of the post-pasteurization samples showed no growth for *E. coli* 0157:H7, *Salmonella* sp., *Listeria monocytogenes*, and *Staphylococcus aureus*. The HEYM Mycobactin J slants from the milk samples for the *Mycobacterium paratuberculosis* are in week 5 of incubation. From the results obtained, pasteurization with both on-farm units (batch/vat and continuous flow) was shown to destroy *E. coli* 0157:H7, *Salmonella* sp., *Listeria monocytogenes*, and *Staphylococcus aureus* effectively. Because it will take 16 weeks to determine a true negative for *M. paratuberculosis*, results are still pending.

Key Words: Pasteurization, *Mycobacterium paratuberculosis*, Commerical pasteurizers

607 Detection comparison of *L. monocytogenes* in yogurt and cold pack cheese using enzyme-linked immunofluorescent assays. T. M. Silk* and C. W. Donnelly, *University of Vermont, Burlington, Vermont, USA.*

Recent outbreaks of *Listeria monocytogenes* have been attributed to low levels of contamination in food products. Rapid detection methods should be sensitive and accurate at reporting the presence of this

Growth and Development

608 Effect of differences in pattern of prepubertal growth on response to realimentation: Relationships to reproductive development. John Klindt*, J.T. Yen, and R. K. Christenson, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

Our previous work (Klindt et al., 2001, J. Anim. Sci. 79:2513) showed an inverse relationship between feed consumed during development and feed consumed during breeding in gilts subjected to feed restriction during development, 1/2 to 7/8 ad lib, and given ad libitum access to feed during breeding. Age at first estrus was least in the 1/2 ad lib gilts, possibly due to increased feed consumption during breeding. The current study sought to replicate the feed intakes of gilts in the previous study and measure the effect on physiological responses. Crossbred white gilts, 90.3 ± 0.5 d of age, 38.2 ± 0.7 kg BW, were assigned to receive 1/2, 5/8, 3/4, or 7/8 of calculated ad libitum feed intake (24 gilts/dietary treatment, TRT) for 12 wk. After the restriction period, all gilts were fed quantities of feed similar to those consumed by similar gilts given ad libitum access to feed in group pens previously. During realimentation, ADFI was 3.03 ± 0.06, 2.76 ± 0.08, 2.40 ± 0.07, and 2.31 ± 0.08 kg/d by gilts in the 1/2, 5/8, 3/4, and 7/8 TRT groups, respectively. On d 0, 7, 14, and 21 of realimentation, gilts were slaughtered and wts of offal and carcass components were recorded. Blood samples were collected from the gilts during the last wk of the restriction period and during realimentation for assay of serum urea, glucose, insulin, and IGF-I. Urea, glucose, insulin, and IGF-I were influenced (P < 0.03) by the interaction of TRT×wk of realimentation. Slaughter and carcass wts were influenced (P < 0.01) by the main effects of TRT and wk. Of the offal components, only liver and small intestine were influenced (P < 0.02) by TRT×wk. It is concluded that increased feed intake by the more severely restricted gilts during the early part of breeding/realimentation period allowed those gilts to exhibit compensatory gains, had effect on liver and small intestine wts, and stimulated acceleration of onset of first estrus in the most severely restricted gilts.

Key Words: Gilts, Puberty, Growth

pathogen in food. In the current study, two commercially available enzyme-linked immunofluorescent assays (ELIFAs), specific for *Listeria* spp., were used for the detection of *L. monocytogenes* in yogurt and cold-pack cheese. Food products naturally contaminated, and inoculated with *L. monocytogenes* at various inoculation levels ranging from 3.0 - 0.007 MPN/g were tested. Ten to twenty replicate samples were analyzed for each inoculation level. Detection results were compared with those obtained using the current U. S. Food and Drug Administration Bacteriological Analytical Manual (BAM) method for *Listeria* detection in food. One of the ELIFAs, lacking a secondary enrichment step, performed very poorly in comparison to the BAM method. Detection agreement values decreased as inoculation levels decreased. In food products inoculated with fractional positive levels of *L. monocytogenes*, ELIFA performance produced false negative rates approaching 100% whereas the BAM method did not produce false negative rates higher than 10%. Further cultural analysis of enrichment used for ELIFAs subsequently yielded positive *L. monocytogenes* results, indicating that the enrichment used for ELIFAs may not have increased target cell levels to those needed to elicit a positive response. The inability of the enrichment to increase *Listeria* levels may be attributed to an increased acriflavine level, which may result in a failure of these procedures to recover low levels of or injured *Listeria*, which can exist in acidic foods or those containing preservatives. Better enrichment protocols focused on the recovery of low level, or injured cell populations may increase the sensitivity of detection, ultimately improving the safety of dairy foods.

Key Words: *Listeria monocytogenes*, Detection, Enzyme-linked immunofluorescent assay

609 The effect of carbohydrate source on intestinal morphology of weaned pigs. M.A.M. Spreeuwenberg*¹, J.M.A.J. Verdonk², M.W.A. Verstegen³, and A.C. Beynen⁴, ¹*Nutreco, Boxmeer, ²IDTNO, Lelystad, ³Wageningen University, ⁴Utrecht University, The Netherlands.*

Epithelial cells need energy to maintain gut integrity as measured with histology. It is hypothesised that with increasing the number of glucose molecules bound together, glucose availability and thereby gut integrity decreases: glucose > lactose > starch. A total of 42 newly weaned barrows (26 ± 0.8 d of age, 7.8 ± 1.0 kg) was used. On the day before weaning (d -1) all pigs were weighed and assigned to 7 experimental groups (n=6). The groups differed in diet and day of dissection. On the day of weaning (d 0), dissection was performed on 1 group. The remaining groups were fed 1 of 3 diets in which glucose, lactose or starch were iso-energetically exchanged, supplying 24% of the energy. The animals received a liquid diet (meal: water = 2:1) based on net energy requirement for maintenance (M, kcal = 78×BW^{0.75}). Energy offered to the pigs increased from 0.5×M at d 0, 1.0×M at d 1, 1.5×M at d 2, 2.0×M from d 3-9. At d 0, 3 and 10 selected pigs were weighed and euthanized. Tissue samples for histology were taken at 0.5 m (prox.) and 3.5 m (mid) distal of the ligament of Treitz. Dry matter intake, body weight gain, villus height and crypt depth did not differ between diets. Dry matter intake was 59 28.0 g/pig/d from d 0-3, 173 ± 67.0 from d 3-7 and 257 ± 33.1 from d 7-10. At d 3, villus height was decreased compared to d 0. At d 10, villus height reached pre weaning levels for the lactose diet at the prox and for all diets at the mid small intestine. Crypt depth was increased at d 10 compared to d 0 and 3. It was concluded that dietary carbohydrate source does not affect intestinal morphology.

Day	0	3	10						
Diet		glu- cose	lac- tose	starch	glu- cose	lac- tose	starch	SEM	
Villus									
height	prox ¹	394 ^a	274 ^{bc}	278 ^c	272 ^{bc}	315 ^b	360 ^{ab}	298 ^b	32.5
(µm)	mid ¹	337 ^a	236 ^{bc}	200 ^c	252 ^{bc}	293 ^{ab}	304 ^a	311 ^{ab}	32.4
Crypt									
depth	prox ²	166 ^a	175 ^a	188 ^a	185 ^a	288 ^b	291 ^b	2 88 ^b	14.6
(µm)	mid ²	157 ^a	172 ^a	193 ^a	179 ^a	254 ^b	252 ^b	256 ^b	15.6

different letters within a row differ: 1, P<0.10; 2, P<0.05. Comparisons: between diets within day and between days for the same diet.

Key Words: pig, morphology, small intestine

610 Dietary betaine (Betafin) and porcine somatotropin (Reporcin) have additive effects upon growth performance in restrictively-fed boars. D Suster¹, M Mottram², B.J. Leury³, R.H. King¹, and F.R. Dunshea^{*1}, ¹Natural Resources and Environment, Werribee, Vic 3030, Australia, ²Feedworks, Hamilton, Qld 4007, Australia, ³Institute of Land and Food Resources, University of Melbourne, Vic 3010, Australia.

Twenty individually-penned entire male pigs (initial weight 64 kg) were used to investigate the interactions between dietary betaine (Betafin, Bet) and porcine somatotropin (Reporcin, pST) treatment. The study was a 2x2 factorial design with the respective factors being dietary betaine (0 or 1.5 g/kg) and pST (0 or 5 mg/d of Reporcin). Pigs were fed 2.7 kg/d of a protein adequate diet containing 3.38 MCal DE/kg and 1.1 g/kg lysine until they were slaughtered 31 days later. An Hologic QDR4500 Dual Energy X-ray Absorptiometer (DXA) was used to estimate body composition of pigs at the beginning and end of the study. Both pST and betaine increased daily gain and lean tissue deposition and decreased P2 back fat and the effects were to a large extent additive. Despite the reductions in P2 backfat, neither pST nor betaine had any effect on fat deposition. While these feed intakes were approximately 80% of ad libitum for individually-housed pigs, they are probably at the high end of feed intakes observed in group-housed pigs under commercial conditions. Therefore, it is likely that in situations where energy intake is limiting the potential for lean tissue deposition, betaine alone, or in combination with pST, can increase growth performance and lean tissue deposition.

pST, mg/d	0	0	5	5	P-value			
Betafin, g/kg	0	1.5	0	1.5	LSD	Bet	pST	BetxppST
ADG, g/d	1067	1162	1308	1379	116.3	.049	<.001	.77
FCR	2.55	2.38	2.11	2.06	.213	.16	<.001	.41
P2, mm	13.8	12.6	12.2	11.8	1.52	.081	.014	.52
Lean, g/d	673	752	863	915	83.9	.032	<.001	.65
Fat, g/d	207	216	196	205	27.8	.34	.26	.97

Key Words: Betaine, Porcine somatotropin, Growth

611 The somatotropin (ST)/insulin-like growth factor (IGF) system is not affected by an infectious disease challenge in growing pigs. W.T. Oliver^{*1}, G.W. Almond¹, S.A. Mathews¹, J.A. Brown¹, and R.J. Harrell¹, ¹North Carolina State University, Raleigh, NC.

Respiratory diseases account for considerable economic loss in the swine industry due, in part, to reduced growth performance. The objectives of this experiment were: 1) to determine the effect of porcine reproductive and respiratory syndrome virus (PRRSv) and *M. hyopneumoniae* (*M. hyo.*) on basal IGF-I concentrations, and 2) to determine if exogenous ST can stimulate the IGF system in health-challenged pigs. Barrows were weaned from the sow at 10 d of age and reared in isolated facilities to achieve high-health status. Pigs (2 replicates of 15) were randomly assigned to one of three treatment groups: 1) Non-infected, *ad libitum* intake (C); 2) Challenged with PRRSV and *M. hyo.*, *ad libitum* intake (HC); and 3) Non-infected, pair-fed to HC pigs (PF). HC pigs were infected with *M. hyo.* during jugular catheterization surgery and with PRRSV 8 d later (d 0). On d 14 of infection, pigs within a treatment group were randomly assigned to receive either 0 or 120 mg porcine ST/kg body weight⁻¹day⁻¹ for 4 days. Only infected pigs had lung lesions typical of *M. hyo.* on d 21. Initial body weight did not differ (33.91.0; P>0.64), but C pigs were heavier than both the HC and PF groups on d 21 (53.21.4 vs. 45.81.8 and 46.81.5, respectively; P<0.01). From d 0 to 21, C pigs gained 91931 g/d compared to 67840 and 60133 for HC and PF pigs, respectively (P<0.01). Infection with PRRSV and *M. hyo.* reduced feed intake beginning on d 7 of infection (P<0.04), with a maximum reduction of 50 % (P<0.01) on d 16. Disease status did not affect feed conversion (G:F, P>0.10), but PF pigs had a 17 % lower G:F than HC pigs (P<0.02). Basal circulating IGF-I levels were 32222 ng/mL, regardless of treatment (P>0.15). ST administration increased circulating IGF-I 2.5-fold (P<0.01), regardless of treatment. These results indicate that circulating IGF-I under basal conditions or stimulated with ST was not responsible for the growth reduction found in PRRSV and *M. hyo.* infected pigs.

Key Words: Swine, Somatotropin, Disease

612 Myostatin gene expression in nursery pigs infected with *Mycoplasma hyopneumoniae* (Mh) and Porcine Reproductive and Respiratory Syndrome Virus (PRRSV). J. Escobar^{*1}, T.L. Toepfer¹, W.G. Van Alstine², D.H. Baker¹, and R.W. Johnson¹, ¹University of Illinois, Urbana, IL, ²Purdue University, W. Lafayette, IN.

Respiratory pathogens such as PRRSV and Mh markedly depress growth and purportedly reduce protein accretion (PA) in pigs. It is not known, however, if myostatin (MSTN)-a negative regulator of muscle mass-is increasingly expressed by muscle during infection. The objectives of this study were to determine if PRRSV and Mh-alone or in combination-increase circulating levels of inflammatory cytokines, decrease growth performance and increase steady-state levels of MSTN mRNA in muscle. Thirty-two pigs were subjected to one of four treatment combinations (2 × 2 factorial) of Mh [intratracheal inoculation with Friis or P5722-3 (3 ml 10⁷ cfu/ml) at 4-wk of age] and PRRSV [intranasal inoculation with DMEM or VR-2385 (5 ml 10⁵ 50% TCID₅₀) at 6-wk of age]. Pigs were killed 7 d after PRRSV inoculation. Interleukin (IL)-1β and IL-6 were measured in sera collected 7 d after PRRSV inoculation using porcine-specific ELISAs. At sacrifice, triceps (T) and biceps femoris (BF) muscles were dissected, weighed and samples were taken for MSTN gene expression analysis. Whole-body protein was determined to estimate PA. Two-way ANOVA of IL-1β, IL-6, PA, ADG, FI, T and BF weights, and MSTN mRNA detected a main effect of PRRSV (P < 0.001), but neither the Mh effect nor the Mh × PRRSV interaction were significant. PRRSV induced a marked increase (P < 0.001) in IL-1β, IL-6 and MSTN mRNA, and a concomitant decrease (P < 0.001) in FI, ADG, PA and weight of BF and T muscles. MSTN mRNA expression and serum levels of IL-1β and IL-6 were negatively correlated (r = -0.4 to -0.8, P < 0.001) with FI, ADG, PA and weight of BF and T muscles. Collectively, these findings suggest that the decrease in pig performance in PRRSV-infected pigs may be due to an increase in metabolically active inflammatory cytokines and MSTN gene expression.

Key Words: Inflammatory cytokines, Myostatin, Mycoplasma and PRRSV

613 The role of JAK2 in terminal differentiation in C2C12 myoblasts. S. Miller and J.M. Reecy^{*}, Iowa State University.

Satellite cell proliferation and differentiation is critical to postnatal skeletal muscle hypertrophy. Understanding the molecular mechanisms underlying hypertrophy is necessary to facilitate treatment of muscle wasting diseases and to promote increased muscle accumulation in meat animals. Previous research in our lab has suggested that JAK2 plays a role in skeletal muscle hypertrophy. Microarray analysis of gene expression in skeletal muscle after three days of work overload demonstrated increased JAK2 expression (8.7-fold). Janus kinases (JAKs) are receptor-associated tyrosine kinases that are generally required for cytokine receptor superfamily signaling. We hypothesize that JAK2 was required for skeletal muscle differentiation. To elucidate the role of JAK2 in differentiation, C2C12 myoblasts were plated at a density of 20,000 cells/cm2. The cells were allowed to differentiate for 72 hours in serum-restricted (2% horse serum) media. Trypstatin AG490, a JAK2 specific inhibitor, was used to block JAK2 signaling during differentiation. AG490 was added 0, 24 hours and 48 hours after the addition of differentiation media. Cells were collected 72 hours after induction of differentiation. Control cells cultured without AG490 were collected at 0 and 72 hours. Creatine kinase (CK) levels were used to quantify the level of terminal differentiation. Results indicate that blocking JAK2 prevented myoblast differentiation (0 and 24 hours) and arrested differentiation in immature myotubes (48 hours). We also tested to see if differentiation could be recovered after incubation with AG490. C2C12 myoblasts were incubated with AG490 in differentiation media for 48 hours. After 48 hours these cells were washed and changed to a normal differentiation media. Cells were collected 24, 48 and 72 hours after the addition of normal differentiation media and CK levels were assayed. These cells were able to form myotubes and had significantly increased CK levels over cells continuously incubated with AG490 (p<0.0001). However, these cells had significantly lower CK levels than the control cells cultured without AG490 (p<0.0001). From these results it appears that JAK2 plays a critical role in the differentiation of skeletal muscle.

Key Words: Muscle Differentiation, myoblast, JAK2

614 Quantification of myogenin-positive satellite cells from bovine skeletal muscle. J.S. Scheffler*, N.T. Mesires, and M.E. Doumit, *Michigan State University, East Lansing, MI.*

Skeletal muscle fiber nuclei accumulate as a result of satellite cell proliferation, differentiation and incorporation into muscle fibers. Myogenin, a muscle-specific transcription factor, is an early marker for muscle cell differentiation. Our objectives were to determine the relationship between bovine semitendinosus (ST) muscle size and DNA concentration, and to quantify the proportion of myogenin-positive satellite cells in isolates from ST muscles. Holstein steers weighing 219 ± 13 kg and 503 ± 17 kg were used ($n = 4$ animals per group). Semitendinosus muscles removed at harvest from light and heavy steers weighed 810 ± 44 g and 1670 ± 233 g, respectively. Muscle protein was quantified using the biuret procedure and DNA was quantified by a fluorometric assay. Heavy steers had a higher ST muscle protein concentration (257 vs 190 mg/g muscle; $P < 0.05$) and tended to have a higher ST muscle DNA concentration (795 vs 698 $\mu\text{g/g}$ muscle; $P < 0.08$) than light steers. No difference in protein to DNA ratio was observed between weight groups, indicating that ST muscle growth is accompanied by proportional increases in protein and DNA. Satellite cells were isolated from the left ST muscle of each animal. Cells from three animals per group were separated from cellular debris using Percoll gradient centrifugation, and adsorbed to glass coverslips for fluorescent immunostaining. Satellite cells were distinguished from non-myogenic cells by positive staining for neural cell adhesion molecule (NCAM). The proportion of NCAM-positive cells (satellite cells) in isolates was similar for light and heavy steers (62 vs 66% , respectively; $P > 0.1$). Similarly, the proportion of myogenin-positive satellite cells did not differ between light and heavy steers ($P > 0.1$). Less than 10% of the satellite cells isolated from all steers were myogenin-positive. These data suggest that the proportions of differentiating satellite cells do not differ between light and heavy steers. Alternatively, changes in the rate of satellite cell incorporation into myofibers may offset differences in the proportion of differentiating satellite cells.

Key Words: Satellite cell, Myogenin, Bovine

615 Development of the Callipyge phenotype during early post-natal growth in lambs. R. D. Sainz^{*1}, J. S. Cubbage¹, M. Dally¹, F. C. Castro¹, and B. Freking², ¹*University of California, Davis, CA, USA*, ²*US Meat Animal Research Center, Clay Center, NE, USA*.

In order to determine the time-course of expression of muscle hypertrophy, several skeletal muscles were obtained by dissection of normal (N) and Callipyge (C) lambs from birth to 14 weeks of age in two experiments. In Exp. 1, genotype was established using the OY15 marker, and in Exp. 2 lambs were produced by use of homozygous semen from N or C rams. Body weights (kg) were similar ($P > 0.05$) during week 1 (5.2 and 5.5), week 3 (13.0 and 13.7), and week 8 (22.9 and 18.8), but differed ($P < 0.001$) at week 14 (28.4 and 44.2) for N and C lambs, respectively. Body weight-adjusted weights of *longissimus dorsi* (LD), *semimembranosus* (SM), *semitendinosus* (ST), *infraspinatus* (IS) and *supraspinatus* (SS) were similar ($P > 0.05$) in N and C lambs during weeks 1 and 3 of age. Muscles were heavier ($P < 0.001$) in C as compared to N lambs beginning in week 8 (LD) and 14 (SM and ST). As seen in previous studies, IS and SS muscles were similar in N and C lambs at all ages. Preliminary data indicate that DNA concentrations in each muscle were similar between genotypes and ages, suggesting that the increased muscle growth seen in C lambs was accompanied by increased incorporation of satellite cell nuclei. Skeletal muscles that are affected by the Callipyge mutation begin to express the phenotype between 8 and 14 weeks of age.

Key Words: skeletal muscle, Callipyge, growth

616 Leptin reduces feed intake and increases serum fatty acid concentrations in growing pigs, but does not regulate acetyl Co-A carboxylase activity or PPAR α expression in adipose tissue. K. M. Ajuwon^{*1}, J. Kuske¹, O. Adeola¹, D. L. Hancock², D. B. Anderson², and M. E. Spurlock¹, ¹*Purdue University, West Lafayette, Indiana*, ²*Elanco Animal Health, Inc., Greenfield, Indiana*.

To determine the effects of leptin on selected serum hormone and metabolite concentrations, we administered leptin twice daily intramuscular to barrows at 53 kg body weight at a dose of 0.05 mg kg⁻¹ day⁻¹

for 14 days. In addition, a control group was allowed ad-libitum feed intake and injected with vehicle, and a third group was injected with vehicle and had their feed intake limited to that of the group injected with leptin. Blood samples were collected on days 1, 7 and 14 for serum metabolite and hormone analyses. Relative to the control group, the mean daily feed intake of the pigs treated with leptin was depressed by 32% ($P < 0.0001$). Consistent with the lower feed intake, growth rates were reduced by 50% and 44% in the leptin-treated and pair-fed pigs, respectively ($P < 0.0001$). Serum insulin-like growth factor 1 (IGF-1) was decreased in both the leptin-treated and pair-fed groups (15% reduction, $P < 0.01$), but there was no treatment effect on serum growth hormone (GH) concentrations ($P < 0.26$). Serum urea nitrogen concentrations were lower in the pigs injected with leptin than in the control and pair-fed pigs (15% reduction, $P < 0.02$). Although serum NEFA concentrations were higher (80% increase, $P < 0.0001$) in pigs injected with leptin than in the other groups, there was no effect of leptin on serum glycerol concentrations ($P > 0.05$). The expression (mRNA abundance) of PPAR α in adipose tissue, liver or skeletal muscle was not different among treatments ($P > 0.05$). The activity of acetyl Co-A carboxylase (ACC) was reduced by 56% due to intake restriction, but there was no further reduction attributable to leptin. These data confirm that exogenous leptin regulates feed intake in the pig, and indicate that leptin influences lipid metabolism in vivo. However, the regulation of PPAR α expression by leptin previously reported in other *in-vitro* and *in-vivo* models was not evident in the pig, at least under the conditions of the present study.

Key Words: Leptin, Adipose, Pig

617 The effect of conjugated linoleic acid on the differentiation and proliferation of porcine stromal-vascular cells. T.D. Brandebourg* and C.Y. Hu, *Oregon State University, Corvallis*.

Feeding conjugated linoleic acid (CLA) decreases carcass fat in growing pigs. However the underlying mechanisms by which CLA inhibits fat accretion are poorly understood. The objective of this study was to examine the effect of CLA on adipocyte growth in pigs by determining the effect of CLA administration on the differentiation and proliferation of cultured porcine stromal-vascular cells. On d -1, stromal-vascular cells were isolated from 2-day-old crossbred pigs and plated in medium containing 10% fetal bovine serum (FBS). Cells were treated with either ligand or carrier (DMSO) from d 0 to d 8 in the presence of induction media (10% FBS, 100 nM insulin, 10 ng/ml transferrin and 500 ng/ml hydrocortisone). In separate experiments ($n=6$), CLA, cis-9, trans-11 CLA, or a linoleic acid (LA) control were administered at concentrations of 25 , 50 , or 100 μM . Since trans-10,cis-12 CLA was toxic to cells in this system at concentrations greater than 25 μM , it was administered at concentrations of 6.25 , 12.5 and 25 μM . Differentiation was evaluated by measuring sn-glycerol-3-phosphate dehydrogenase (GPDH; EC 1.1.1.8) activity on d 8. CLA significantly decreased GPDH activity (nmol/(min*mg protein) versus carrier by 15% at 25 μM ($p < .001$), 37% at 50 μM ($p < .0001$), and 70% at 100 μM ($p < .0001$). Administration of the trans-10, cis-12 CLA isomer decreased GPDH activity 50% at 6.25 μM ($p < .0001$), 73% at 12 μM ($p < .0001$) and 84% at 25 μM ($p < .0001$). The cis-9,trans-11 isomer failed to affect GPDH activity at any concentration. However as expected, LA significantly increased GPDH activity at all concentrations. In order to study the effect of CLA on the proliferation of porcine stromal-vascular cells, cells were treated as described above and cleavage of the tetrazolium salt, WST-1, by mitochondrial dehydrogenases was measured on d 2. Only the 25 μM trans-10, cis-12 CLA treatment significantly decreased WST-1 ($p < .05$). These data suggest that CLA inhibits fat accretion in growing pigs in part by inhibiting fat cell differentiation and perhaps to a lesser extent by decreasing stromal-vascular cell proliferation.

Key Words: CLA, Adipose Tissue, Differentiation

Horse Species

Equine Research and Overview of Mare Reproductive Loss Syndrome

618 Temporal variables of the flat walking Tennessee Walking Horse foal. M.C. Nicodemus and K.M. Holt, *Mississippi State University, Mississippi State, MS/USA.*

Temporal variables of non-gaited horses are established as early as 4 months of age allowing for early performance prediction. However, Tennessee Walking Horse (TWH) gaits are often described as learned. TWH research noted temporal differences between flat walking weanlings. Therefore, the temporal variables of the flat walking TWH foal were measured within 24 hours of birth. Mares were lead at a consistent flat walk with foals matching the gait. 5 strides were selected from 4 TWH foals on the basis of consistency, speed, and gait correctness. 60 Hz frame-by-frame analysis determined stride duration and the following temporal variables, which were calculated as percent of stride: stance duration, bipedal support, tripodal support, advanced placement, and advanced lift-off. Means (SD) were determined and paired t-tests ($P < 0.05$) were performed between the following temporal variables: fore and hind stance, lateral and diagonal stride variables, and tripodal support with 2 hind limbs and with 2 forelimbs (Table 1). Similar to the weanlings, the foal flat walk was a symmetrical, 4-beat stepping gait alternating between bipedal and tripodal support with the majority of the stride spent in stance. Tripodal support was longer than weanlings while the stride duration was shorter, which suggests foals move at a slower velocity with a faster stride rate. All foals had an irregular rhythm with lateral couplets, which was only present in half of the weanlings studied. The variations between the temporal variables of weanlings were not evident in the foals indicating foals start out with similar gaits; but with growth, environmental factors influence the continued gait development.

	Means (SD)
Stride Duration (ms)	958 (109)
Fore Stance (%)	68 (2)
Hind Stance (%)	69 (3)
Lateral Advanced Placement (%)	18 (4) ^a
Diagonal Advanced Placement (%)	29 (6) ^b
Lateral Advanced Lift-Off (%)	23 (4)
Diagonal Advanced Lift-Off (%)	27 (4)
Lateral Bipedal Support (%)	23 (5) ^c
Diagonal Bipedal Support (%)	9 (2) ^d
Tripodal Support-2 Hind (%)	33 (2)
Tripodal Support-2 Fore (%)	35 (3)

Table 1: Means (SD) for the temporal variables of the foal group. Different superscripts between variables denote significant differences.

Key Words: Temporal variables, Tennessee Walking Horses, Foals

619 The effect of *Kluyveromyces marxianus* and *Saccharomyces cerevisiae* on lactose concentration of equine milk. P. M. Yocum* and B. Alston-Mills, *North Carolina State University, Raleigh, NC/USA.*

Yeasts are living organisms that benefit intestinal microflora, which in turn promotes good health for the animal. The milk sugar, lactose, is a vital energy source for the newborn foal and milk from the mare is the only natural source. Because there is a link between nutrient digestibility and milk composition, 2 different yeast species were used to determine differences in lactose concentrations within the milk. Twelve mares were randomly assigned to 1 of 3 groups. The composition of the herd was consistent with common breeds and ages of horses in North Carolina. Mares were allowed access to grass pastures and water ad lib. A commercial pelleted feed was administered at 1% body weight divided into 3 feedings per day along with coastal bermuda grass hay as needed to maintain a body condition score of 5-6. Yeast treatments to mares began 14 days before expected foaling date to allow for maximum treatment effect before sampling. Yeast treatments were standardized to colony forming units (CFU). Group 1 served as the control group. Group 2 was given 20g of Turval[®] 12 fodder, which included live *Kluyveromyces marxianus* yeast, for 5 days on and 2 days off. Group 3 was given 8g of BIOSAF[®], a concentrate of live *Saccharomyces cerevisiae* yeast cells, for 5 days on and 2 days off. Treatments ceased on day 42 post-partum. Twenty-five mls were hand milked from each mare on day 0 (parturition) and days 14, 28, 42, and 56 after parturition. Milk samples were refrigerated until analyzed. Lactose concentrations were determined using a YSI model 2700 select biochemistry analyzer.

The highest concentration of lactose (4.77%) was noted in the control group at day 56. Statistical differences ($p < .05$) were noted over time. This study shows dietary yeast supplementation may affect lactose concentration in equine milk. Despite low lactose concentration in milk when supplemented with yeast, other benefits of yeast supplementation should be considered.

Key Words: Lactose, *Saccharomyces cerevisiae*, *Kluyveromyces marxianus*

620 An ideal protein for the lactating mare. C.L. Wickens*, P.K. Ku, and N.L. Trottier, *Michigan State University, East Lansing, Michigan, USA.*

Empirical estimates on amino acid (AA) requirements for the lactating mare are not available. The objective of this study was to estimate the AA requirement of the lactating mare based on a factorial approach using milk and muscle amino acid profiles. Five mature multiparous Arabian mares with a body condition score ranging from 4.5-7 post foaling were used to determine milk AA concentration. Mares were initially fed high quality alfalfa hay at 2% of their body weight (BW) and concentrate at 1-2% of their BW. Mares were given access to mixed alfalfa-grass pasture during the third and fourth week post foaling, and milk was collected manually on day 30 of lactation. Coefficient of variation (CV, %) among mares for milk AA concentrations were Arg, 12.19; His, 11.65; Ile, 11.35; Leu, 11.69; Lys, 11.32; Met, 14.48; Phe, 12.61; Thr, 13.31; Val, 13.33. Three mature horses (two 4-year-old geldings and one 15-year-old mare) were used to determine AA concentration in muscle (gluteus and gastrocnemius). The CV for muscle AA concentrations were Arg, 0.58; His, 6.23; Ile, 2.64; Leu, 3.59; Lys, 3.91; Met, 2.65; Phe, 3.71; Thr, 3.38; Val, 3.72. The AA profiles in both muscle and milk were obtained by expressing each AA concentration as a ratio to lysine concentration. Maintenance (maint) requirement (reqt) for each individual AA were estimated as the product of their respective ratio in muscle relative to lysine and the digestible lysine requirement of 25.30 mg lysine/kg BW. Digestible (Dig) AA requirements for milk production (prod) were estimated as the product of their respective ratio in milk relative to lysine and lysine concentration in milk (1.7 g/kg milk) adjusted for an efficiency of utilization of 0.65 ($1.7 \text{ g}/0.65 = 2.62 \text{ g digestible lysine/kg milk}$). In conclusion, these results provide a basis on which total AA requirement for lactation can be derived.

Amino acid	Muscle AA:Lys	Milk AA:Lys	Reqd for maint (mg Dig AA/kg BW)	Reqd for milk prod (g Dig AA/kg milk)
Arginine	.75	.69	18.98	1.81
Histidine	.75	.33	18.98	0.86
Isoleucine	.58	.78	14.68	2.04
Leucine	.95	1.47	24.04	3.85
Lysine	1.00	1.00	25.30	2.62
Methionine	.32	.32	8.09	0.84
Phenylalanine	.47	.53	11.89	1.39
Threonine	.51	.72	12.93	1.88
Valine	.59	.97	14.91	2.54

Key Words: horse, lactation, amino acids

621 Influence of short duration, high intensity exercise on bone mineral content in stalled weanlings. K.M. Hiney*, B.D. Nielsen, and D. Rosenstein, *Michigan State University, East Lansing, MI, USA.*

Confinement housing has been shown to decrease skeletal strength due to the lack of loading placed on the bone. Stalling young horses results in decreased bone density compared to those allowed free exercise. However, only a few loading cycles may be needed to stimulate an osteogenic response. In order to investigate the hypothesis that short duration exercise may ameliorate the reduction in bone mass witnessed with confinement, 18 Quarter Horses were weaned at 4 mo of age and placed into box stalls. After 5 wk, individuals were grouped by age and weight, and then divided randomly into three treatment groups - group housed (GR), confined with no exercise (CF), and confined with exercise (EX). The CF and EX groups were housed in a 3.7 m x 3.7 m box stalls for the 56 d duration of the trial. The EX group was sprinted

82 m/d, 5 d/wk. The sprint was performed in a fenced grass alleyway. The GR horses were housed together in 992 m² drylot with free access to exercise. On d 0, 28 and 56, dorsopalmar and lateromedial radiographs of the left third metacarpal bone were taken in order to estimate changes in bone mineral content. An aluminum penetrometer was attached to the radiographic cassettes to allow the calculation of radiographic bone aluminum equivalence (RBAE). Mean values of medial, lateral, and total RBAE increased over time ($P < 0.05$), while dorsal and palmar RBAE did not change significantly. There was a trend ($P < 0.1$) for a treatment*day interaction in the dorsal, medial and total RBAE, with values increasing over time in the EX group. When values were normalized to account for differences in horses at the start of the trial, there was again a trend for a trt*day interaction in the dorsal cortex, with the gain in RBAE of EX being greater than CF on d 56. Normalized medial and total RBAE tended to differ ($P < 0.1$) with treatment, with EX greater than CF. As differences between treatments approached significance, this indicates such short term exercise may be beneficial to the stalled animal.

Key Words: Bone development, Confinement, Exercise

622 Feeding-fasting cycle in meal fed yearling horses. W. B. Stanier^{*1}, D. S. Kronfeld¹, R. M. Akers¹, J. R. Burk¹, and P. A. Harris², ¹Virginia Polytechnic Institute and State University, Blacksburg, VA, ²Equine Studies Group, WALTHAM Centre for Pet Nutrition, Melton Mowbray, UK.

A meal that results in high glycemic and insulinemic responses may also affect the secretion of growth hormone (GH) and insulin-like growth factor I (IGF-I), key hormones in the somatotrophic axis that regulates skeletal development. Our objective was to characterize the feeding-fasting cycle of plasma concentrations of glucose, insulin, GH and IGF-I, and to compare two feeds differing in DE sources. Twelve Thoroughbred yearlings were randomly assigned to two dietary groups. Isocaloric feeds (SS and FF) contained 53 and 17% hydrolyzable carbohydrates (CHO-H), 57 and 19% non-structural carbohydrates (NSC), 11 and 23% ADF, 19 and 37% NDF, and 3 and 17% ether extract, respectively. Meals, 1.6 kg, were fed at 0 and 6.5 h in a 24 h period, and animals had *ad libitum* access to hay. Blood samples were taken every 30 min for assay of insulin, GH, and IGF-I by RIA and glucose by enzyme assay. Glycemic response was higher ($P = 0.048$) in the FF group than SS. The effect of meals was revealed by changes in plasma glucose and insulin with time ($P < 0.0001$). Plasma glucose peaked 1.3 h, plasma insulin 2 h, after meals. Plasma GH exhibited 6.6 0.6 GH secretory episodes averaging 15 1.9 ng/ml per day. Four distinct secretory episodes (3.2 0.17, 8.6 0.17, 16 0.32, and 22 0.22 h) suggested a synchronizing effect of the feeding-fasting cycle. Plasma IGF-I concentration was 239 3.8 ng/ml with no feed or meal effect. This study demonstrates a feeding-fasting cycle in plasma glucose and insulin concentrations. Failure of 17% CHO-H to reduce glucose and insulin responses contrasts with effectiveness of 14% in a similar experiment over 6 hr in our laboratory. Also, pre-meal plasma IGF-I was lower in horses fed a 16% CHO-H feed in a 12 mo study. These comparisons indicate that the degree of starch restriction is critical to minimize the feeding-fasting cycle and putative perturbations of skeletal development.

Key Words: Feeding-fasting cycle, Somatotrophic axis

623 Pyrimethamine and sulfadiazine administration lowers plasma folate and increases plasma homocysteine in horses. A. L. Ordakowski^{*1}, D. S. Kronfeld², C. A. Williams², J. L. Holland², and L. S. Gay², ¹University of Maryland, College Park, MD 20742, ²Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

A depletion-repletion study of folate status was conducted on 8 healthy mature Thoroughbred geldings (583.3 20.1 kg initial BW). Oral administration of pyrimethamine (PYR) and sulfadiazine (SDZ) for 9 wk (Period 1) was followed by coadministration of these anti-folate drugs with either peptidoglycan (PG) or folic acid (FA) for 6 wk (Period 2). Geldings were maintained on a 0.5-acre dry lot with an adjacent shed, and were fed orchardgrass/alfalfa hay. During Period 1, each horse was orally administered 1 mg/kg BW of PYR and 20 mg/kg BW SKZ once daily. During Period 2, were paired by age and BW and randomly assigned to either once daily oral administration of 20 mg FA or 35 g of PG as a source of formylated folate derivatives. Body wt, rectal

temperature, and jugular blood samples were obtained weekly. Hematological indexes assessed were variable, but were within normal limits for horses during both periods. After 1 wk of PYR/SDZ administration, plasma folate concentrations decreased 59 % compared to baseline levels ($P < 0.05$). Folate status was impaired during 9 wk of PYR/SDZ administration as determined by a decreased plasma folate concentration ($P < 0.05$) and an increased plasma homocysteine concentration ($P < 0.05$). During Period 2, coadministration of either PG or FA was not effective in preventing further decline of plasma folate and increases in plasma homocysteine. Despite a lowered folate status in the horses, no abnormal hematological indexes were found indicating clinical anemia did not occur. A moderate case of hyperhomocysteinemia occurred as a result from an impaired folate status, but not from lowered B₁₂ status in our horses during the experimental period. The stable concentrations of plasma B₁₂ indicated that administration of PYR and SDZ did not impair microbial synthesis of that B-vitamin. These results demonstrate that an impaired folate status can be induced by commonly used anti-folate drugs in the horse, and that this impaired folate status is refractory to the coadministration of natural and synthetic folates.

Key Words: Folate, Homocysteine, Anti-folate drugs

624 Age and exercise training alter plasma beta-endorphin, cortisol, and immune parameters in horses. K. Malinowski^{*1}, E. Shock¹, V. Roegner¹, P. Rochelle¹, C.F. Kearns¹, P.D. Guirnalda², and K.H. McKeever¹, ¹Rutgers University, New Brunswick, NJ, USA, ²Sloan Kettering, New York, New York, USA.

Objective was to determine if training and age [Y 7 yr; n=6], middle-aged (MA 15 yr; n=6), and old (O 27 yr; n=5)] affect plasma β -endorphin (BE), cortisol (F), and immune responses to acute exercise in unfit mares. A graded exercise test (GXT) was performed before and after 12 wk training at 60 % HR_{max}. Leukocyte number, CD4+ and CD8+ cell subsets, lymphoproliferative response (LPR), and BE and F were measured in jugular blood. BE and F were measured at rest and at 5, 10, 20, 40, 60 and 120 min post-GXT. F rose by 5 min post-GXT in Y and MA mares ($P < 0.05$) and remained elevated until 40 min and 60 min post-GXT, respectively, during both pre- and post-training GXT. There was no rise in F in O mares post-GXT after either GXT ($P > 0.05$). Pre-training BE rose ($P < 0.05$) by 5 min post-GXT in all mares. After training, BE was higher in Y and O vs. MA ($P < 0.05$) at 5 min post-GXT. Post-training BE was higher at 5 min post-GXT in Y and O vs. pre-training ($P < 0.05$). BE was higher at 10 min post-GXT in O post-training vs. pre-training. Monocyte number was lower ($P < 0.05$) post-GXT in O vs. Y after training. After GXT, lymphocyte number rose in all mares ($P < 0.05$); however lower numbers ($P < 0.05$) were seen in MA vs. Y and O vs. MA ($P < 0.05$). CD4+ lymphocytes were higher at rest in O and MA vs. Y ($P < 0.05$). A reduction ($P < 0.05$) in CD4+ lymphocytes was seen in O and MA during the pre-training GXT and in all mares during post-training GXT. Age had no effect on resting CD8+ lymphocytes ($P > 0.05$). CD8+ lymphocytes rose ($P < 0.05$) after GXT in all ages. The O had reduced LPR to Con A stimulation ($P < 0.05$) compared to Y and MA after GXT during both tests. The O displayed reduced ($P < 0.05$) LPR to PHA only after post-training GXT. GXT and training had no effect ($P > 0.05$) on Con A or PHA induced LPR. LPR to PWM was lower ($P < 0.05$) in O vs. Y and MA after pre-training GXT only. Training caused an increase in resting LPR to PWM in MA only ($P < 0.05$). Age and training affected post-GXT F and BE. Age affected immune function.

Key Words: Age, Exercise, Horse

625 Effect of method and time of hydration on structure of dried milk proteins. B. S. Oommen^{*1} and D. J. McMahon¹, ¹*Utah State University.*

Microstructure of caseins in non-fat dried milk, calcium caseinate, and sodium caseinate were studied using transmission electron microscopy. Solutions of all the dried products were made to a casein concentration of 2.4% and the pH of the solution adjusted to 6.7. The powders were hydrated at 40 °C, and allowed to stabilize for 4, 10, and 18 h. Another set of these powders were hydrated at high shear for 5 min using a hand held high speed blender and subsequently stabilized for 55 min with moderate mechanical stirring. These solutions were diluted 100 times and the casein micelles were adsorbed on to parlodion coated copper grids. Parlodion coated copper grids were coated with poly-L-lysine to improve the adsorption of protein on to the film. These grids were stained using uranyl acetate and oxalic acid, quick frozen in liquefied Freon 22, and freeze dried so that whole casein micelles in a form as close to their native state was imaged. Images were photographed at 50,000x, 85,000x and 140,000x. After 4h of hydration and moderate mechanical stirring, small casein micelles in non-fat dried milk were seen as agglomerates, calcium caseinate micelles were seen connected with proteins, and sodium caseinate appeared to be a mesh of proteins. After longer hydration of 10 h or with high shear the agglomeration of the micelles were not seen. Micelles appeared as individual units distributed randomly in the field. In case of sodium caseinate where micellar structure is minimal, the proteins formed strands or small aggregates of strands when hydrated longer or sheared at a higher rate. These structural differences show the effect of hydration time and method on the structure of milk proteins.

Key Words: caseinates, TEM, structure

626 Aggregation reactions of apo- and holo- α -lactalbumin at neutral pH. M.K. McGuffey^{*} and E.A. Foegeding, *North Carolina State University, Raleigh, NC.*

α -Lactalbumin (LA) is the most thermostable whey protein to aggregation and consequently has tremendous potential in thermally-processed beverages. The objective of this research was to characterize NaCl-dependence (0-100 mM) of aggregates formed by heating (75°C) apo- (A; calcium free) and holo- (H; calcium bound) LA at pH 6.8. A commercial preparation of LA was obtained from Davisco Foods and contained 96% total protein (w/w) (91% LA and 5% β -lactoglobulin). Dispersions of the LA were extensively dialyzed and ALA was prepared by calcium chelation with EDTA. The transition temperature, denaturation enthalpy and % reversibility were determined by differential scanning calorimetry and were consistent with literature values. The fraction of native-like protein was determined by absorbance at 280 nm with size-exclusion chromatography. The concentration dependence of turbidity was used to determine the apparent molecular weight (M_w) and the second virial coefficient (A_2). Dispersions of both ALA and HLA (4% w/v) demonstrated first order reaction kinetics for all NaCl levels. The rate constant for ALA loss was $1.46 \times 10^{-4} \text{ s}^{-1}$, which increased dramatically (80%) when 50 mM NaCl was added, but only increased 11% from 50 to 100 mM NaCl. The rate constant for HLA loss was $1.85 \times 10^{-4} \text{ s}^{-1}$, which increased 36% from 0 to 50 mM NaCl and 31% from 50 to 100 mM NaCl. The turbidity data indicated the apparent M_w of ALA and HLA were $\sim 1,200 \text{ kDa}$ and $\sim 330 \text{ kDa}$, respectively, and were relatively insensitive to NaCl addition. The value for ALA may be overestimated because a high degree of polydispersity caused a few very large aggregates to scatter disproportionately. This polydispersity was demonstrated in native PAGE where the ALA aggregates were smeared throughout the stacking and resolving gels whereas HLA aggregates yielded two sharp bands. For all NaCl levels, ALA had an $A_2 > 0$, which indicates a net repulsive interaction between proteins causing them to swell and interact with the solvent. Aggregates of HLA had an $A_2 < 0$, which indicates the Ca^{2+} binding results in a net attractive interaction between proteins. The aggregates are primarily disulfide bonded according to reducing SDS PAGE.

Key Words: alpha-lactalbumin, aggregation, second virial coefficient

627 The change of insulin-like growth factor-1 (IGF-1) in bovine milk during lactation period. S. H. Kang^{*1}, J. W. Kim², J. Y. Imm³, S. J. Oh⁴, and S. H. Kim², ¹*Seoul Dairy Cooperatives*, ²*Korea University, Division of Food Science*, ³*Kookmin University, Dept. of Food & Nutrition*, ⁴*Korea Yakult Co. Ltd.*

The objectives of this study were to examine the change of Insulin-Like Growth Factor-1 (IGF-1) content in bovine milk during an year lactation period and to identify parameters affecting IGF-1 content in bovine milk. Individual milk was collected from 70 lactating Holstein cows at Kyong-Ki province in Korea. The IGF-1 content was determined by radioimmunoassay using 125I after acid-ethanol treatment. The proximate composition of milk was determined by near infrared milk analyzer. The data were analyzed using GLM and CORR procedures of SAS to examine significant differences ($p < 0.05$) within groups (lactation period, season, parity and dairy farms). Tukey's test was used for multiple comparison. Different feeding pattern between dairy farms may have influenced the IGF-1 content in milk. IGF-1 content (36.6 ng/ml) in the middle lactation period (91 180 days) was higher than that of early (28.7 ng/ml) and late lactation period (30.3 ng/ml). Parity did not significantly affect IGF-1 content. Although it was not significant positive correlation was found between IGF-1 and total protein content.

Key Words: IGF-1, Milk, Lactation period

628 The effect of stage of lactation on milk protein composition. J. A. Maas^{*1}, ¹*Department of Animal and Food Sciences, University of Delaware.*

The effects of stage of lactation on milk protein composition were tested in milk samples of four individual lactating Holstein cows managed in a standard TMR fed, free stall dairy. AM and PM milk samples were obtained at four points in the lactation corresponding approximately to days 61, 122, 183 and 244 of lactation respectively and analyzed for content of 6 individual mammary-origin milk proteins (α -lactalbumin, β -lactoglobulin, α S1-, α S2-, β -, and κ -casein) by capillary electrophoresis. Stage of lactation significantly affected the concentration of the whey proteins α -lactalbumin, and β -lactoglobulin ($P > .05$). Stage of lactation did not affect the concentration of the individual caseins as a proportion of the sum of total of the 6 mammary origin proteins. The concentration of each of the individual caseins, as a proportion of total casein protein was also not altered by stage of lactation. There was a nonsignificant trend towards increased α S2-casein content at the two mid lactation sampling dates. The concentration of whey proteins was highest in milk from the first and last sampling dates and lowest in milk from the two mid lactation sampling dates. These data suggest that there are effects of stage of lactation on milk protein composition, however, most of the effects are manifested through changes in the concentration of whey proteins only. Milk casein composition appears to be quite stable, within cow, over the entire lactation irrespective of changes in milk volume. This suggests that the limitation to increased milk protein synthesis and secretion is at stage other than substrate nutrient supply and absorption by the mammary gland.

Key Words: protein, casein, composition

629 Antihypertensive effect of milk-based media fermented by *Lactobacillus helveticus* R-211 and R-389. P.-L. Leclerc^{*1}, S. F. Gauthier¹, H. Bachelard², and D. Roy³, ¹*Laval University, Quebec, Canada*, ²*Hypertension unit, Laval University, Quebec, Canada*, ³*Agriculture and Agri-Food Canada, St-Hyacinthe, Canada.*

Antihypertensive activity of milks fermented by *Lactobacillus helveticus* has been demonstrated both with spontaneously hypertensive rats (SHR) and human subjects. The effects have been related to the release of milk protein-derived peptides inhibiting angiotensin I-converting enzyme (ACE) as a result of the action of microbial proteinases. The objective of this study was to assess the potential of two strains of *Lactobacillus helveticus* (R-211 and R-389) for the production of antihypertensive fermented milks from reconstituted skim milk media enriched or not with milk proteins (caseins and whey proteins). Results indicated that bacterial growth of both strains was similar in all type of culture media, whereas the proteolysis (free NH_3 groups) and ACE-inhibitory

activity (IC₅₀) were higher in casein-enriched media. Hence, the antihypertensive activity of casein-enriched media fermented by R-211 and R-389 strains was evaluated *in vivo* in SHR rats (0.5, 1.0 and 2.5 g/kg of body weight), and compared to unfermented milk. A significant decrease ($p < 0.05$) in arterial blood pressure was measured in SHR rats for the three doses of milk fermented by both strains of *L. helveticus* when compared to PBS control (phosphate buffer saline). However, a lowering effect on arterial blood pressure was also measured in rats given the two highest doses (1.0 and 2.5 g/kg of BW) of unfermented casein-enriched milk. Antihypertensive effect of unfermented medium could be explained by the release of ACE-inhibitor peptides from caseins during gastrointestinal digestion process. In conclusion, these results suggest that milk-based media fermented by *L. helveticus* may have an antihypertensive effect, which can be accentuated by the enrichment of milk with caseins.

Key Words: Fermented milk, Antihypertensive effect

630 Molecular structure and interactions of β -lactoglobulin studied by Fourier transform infrared spectroscopy. T Lefèvre¹ and M Subirade², ¹Université Laval CERSIM, ²Université Laval STELA.

Fourier transform infrared (FT-IR) spectroscopy is a powerful and versatile tool used to determine the molecular structure of biomolecules. This technique is now widely used in biochemistry to study the conformation of biopolymers in aqueous solutions and complex systems. However, its enormous potential in the study of food biopolymers has yet to be reached. The aim of this paper is principally to provide information on biopolymers using FT-IR spectroscopy. β -Lactoglobulin (β -Lg), the major whey protein in the milk of ruminants, is chosen as a model. New aspects of β -Lg structure which have not previously been found by this technique are presented. First, it is shown that FT-IR spectra are sensitive to the quaternary structure of β -Lg, as deduced from the study of the protein amide I band as a function of concentration, pH, and temperature. Second, β -Lg fine-stranded and particulate thermal gels have been investigated. We revealed differences in the denaturation mechanism, in the unfolded state of the protein, in the aggregate formation, and in the strength of the intermolecular interactions as a function of pH. These specificities of each gel could be associated to the macroscopic and microstructural properties of each gel network. Finally, interactions between β -Lg and two zwitterionic phospholipids have been analyzed. Dipalmitoylphosphatidylcholine bilayers are unaffected in the presence of β -Lg, suggesting that no interaction occurs. In contrast, β -Lg increases the lipid chain conformational disorder of milk sphingomyelin (SM) as a consequence of hydrophobic interactions of β -Lg with SM.

Since this effect occurs at and above the gel-to-liquid-crystalline phase transition, it is suggested that membrane fluidity plays an important role in these interactions. These conclusions are supported by other recent works that emphasized the important role of the lipid chain fluidity in the protein-phospholipid interactions.

631 Effects of Beta-Lactoglobulin enriched colostrum on IgG transport in neonatal piglets. L.F. Sutton*¹ and B. Alston-Mills¹, ¹North Carolina State University.

The effects of the bovine milk whey protein Beta-Lactoglobulin (BLG) were investigated in the neonatal, colostrum deprived piglet. Objectives were to determine if BLG had stimulatory properties on mucosal growth, enzymatic activity, DNA proliferation and IgG uptake and endogenous Ig production. Two experiments were done, the first lasting 5 days (Exp 1), the second 28 days (Exp 2). For each, a total of 18 piglets were taken from three sows following parturition and divided into three experimental groups: two removed from the sow immediately (colostrum deprived) and one group remaining on the sow to serve as controls ($n=6$). The colostrum deprived piglets were further divided into two experimental groups: one receiving commercial bovine colostrum supplemented with an extra 10% BLG derived from whey protein concentrate (WPC) (Treatment 1, $n=6$) and the final group receiving only bovine colostrum (Treatment 2, $n=6$). After 36 hours, all piglets on the bovine colostrum were placed onto a liquid neonatal diet without additional supplementation. After the 5th day of Exp.1, animals were sacrificed, blood and intestinal samples were taken for enzymatic and DNA analysis. For Exp.2, all piglets were weaned at 21 days and placed onto a dry feed piglet diet. Blood samples were collected daily for the first five days and then every third day for 28 days. All blood samples were cast against both porcine and bovine anti-IgG, M, and A for sera concentrations. Intestinal tissue was also taken from the small bowel for total DNA, enzymatic activity, and morphology. For both experiments, animals receiving the WPC with 10% BLG supplementation had highest uptake of IgG within the first 5 days as compared to those of other diets ($p < .01$). Treatment 1 also showed higher DNA proliferation after 5 days in Exp.1. BLG did not stimulate endogenous production of IgG, however, endogenous production was highest in controls ($p < .001$). Villi heights were highest in controls on day 28 ($p < .01$), although treatment 1 tended to have slightly higher villus height than treatment 2. These results suggest that BLG from WPC may facilitate uptake of IgG prior to gut closure, induce DNA proliferation, and affect intestinal morphology.

Key Words: Beta-Lactoglobulin, IgG, colostrum

632 Withdrawn. . .

Nonruminant Nutrition Nutrient Metabolism, Evaluation, and Modeling

633 Effects of feed restriction and subsequent re-feeding on energy utilization in growing pigs. P. A. Lovatto*¹, J. van Milgen², J. Noblet², and D. Sauvant³, ¹Universidade Federal de Santa Maria, Santa Maria, RS, Brasil, ²INRA, UMR sur le Veau et le Porc, Saint Gilles, France, ³INAPG/INRA, UMR Physiologie de la Nutrition et Alimentation, Paris, France.

An experiment was carried out to evaluate the metabolic utilization of energy in crossbred barrows during feed restriction and re-feeding. Ten animals, initially weighing 52 kg, were used in five blocks of two littermates each. A 7-d adaptation period (P1) was used in which pigs were fed a diet containing (on a DM basis) 18 MJ ME and 1% lysine at 2.60 MJ ME.kg^{-0.60}.d⁻¹. Following the adaptation period, one animal of each block continued to receive feed at this level for 7 d (P2), whereas its littermate received the same feed at 1.55 MJ ME.kg^{-0.60}.d⁻¹ (40% restriction). During the subsequent 7-d period (P3), both animals were offered feed at 2.60 MJ ME.kg^{-0.60}.d⁻¹. Heat production (HP) was measured in each pig using an open-circuit respirometry chamber, and energy and nitrogen balances were determined for P1, P2 and P3. The HP was decomposed in HP from physical activity (HPact), short-term thermic effects of feeding (TEFst) and resting heat production (RHP). Feed restriction during P2 decreased total HP (1.16 vs 1.45 MJ.kg^{-0.60}.d⁻¹, for restricted and control animals, respectively), RHP (0.84 vs 0.99 MJ.kg^{-0.60}.d⁻¹), TEFst (0.14 vs 0.27 MJ.kg^{-0.60}.d⁻¹) and retained energy (0.41 vs 1.13 MJ.kg^{-0.60}.d⁻¹).

The HPact (0.17 MJ.kg^{-0.60}.d⁻¹) was not affected by feed restriction. Likewise, fecal N losses (5.2 vs 7.7 g.d⁻¹), urinary N losses (12.6 vs 21.0 g.d⁻¹), protein gain (107 vs 189 g.d⁻¹), lipid gain (62 vs 239 g.d⁻¹), and average daily gain (0.33 vs 1.07 kg.d⁻¹) were reduced during feed restriction. There were no differences in components of HP and energy utilization between both groups during P1 and P3. Nevertheless, urinary N loss was decreased (20.1 vs 23.6 g.d⁻¹) and ADG increased (1.45 vs 1.03 kg.d⁻¹) during P3 for animals that were fed restrictively in P2. Compensatory growth after a period of feed restriction does not appear to be related to a change in efficiency of energy utilization for energy gain, but may be due to gain of water, protein and gut contents.

Key Words: Pig, Energy, Feed restriction

634 Previous feeding level influences fasting heat production in growing pigs. C.F.M. de Lange*¹, J. van Milgen², J. Noblet², S. Dubois², and S.H. Birkett¹, ¹University of Guelph, Guelph, ON, Canada, ²Institut National de la Recherche Agronomique, St. Gilles, France.

Factorial approaches to estimate energy requirements for growing pigs require estimation of maintenance or basal energy expenditure (BE) that is related to animal characteristics only. Heat production (HP) in fasted pigs (FHP) may provide a direct estimate of BE. However, FHP may be influenced by nutrient intake. Six barrows were used to determine

effects of feeding level on components of HP, including extrapolated plateau HP following a 24 h fast (FHP). Based on a crossover design, pigs were exposed to three feeding levels (1.56, 2.05 and 2.54 MJ ME/kg BW^{-0.60}.d⁻¹) between 30 and 90 kg BW. One diet was used throughout the experiment. Following a 14 d adaptation period, HP was estimated using indirect calorimetry on pigs housed individually. Dynamics of HP was recorded in pigs for 5 d during the fed state and during a subsequent 24 h fast. Feeding behavior, animal activity and N-balance were monitored, allowing estimation of HP associated with thermic effect of feeding (TEF), activity, and body lipid and body protein deposition. Feeding level influenced ($P < 0.05$) various aspects of HP (all expressed as kJ.kg BW^{-0.60}.d⁻¹; low, medium and high ME intakes, respectively): total HP during the fed state (1068, 1232, 1431; SE 34), short term TEF (127, 195, 267; SE 13), long term TEF (133, 202, 227; SE 19) and FHP (609, 644, 729; SE 31). Feeding level did not ($P > 0.10$) influence activity HP in fed pigs (188, 185, 195; SE 11). Regression of total HP and resting HP (total HP minus activity HP and short term TEF) during the fed state to zero ME intake yielded values of 489 (SE 69) and 396 (SE 75), respectively. Extrapolation of total HP or resting HP in pigs in a fed state to zero ME intake yield lower estimates of BE than FHP in pigs previously exposed to high levels of feed intake.

Key Words: Pigs, Energy, Maintenance

635 Energy cost of excreting indigestible material in growing pigs is minimal. C.F.M. de Lange^{*1}, J. Noblet², J. van Milgen², S. Dubois², and S.H. Birkett¹, ¹University of Guelph, Guelph, ON, Canada, ²Institut National de la Recherche Agronomique, St. Gilles, France.

The nutritive value of feed ingredients is generally derived from digestible nutrient supply, while little consideration is given to the impact of indigestible material on nutrient utilization. An experiment was conducted to determine heat production (HP) associated with ingestion and excretion of indigestible material in growing pigs. Five pairs of littermate barrows were assigned to either a wheat, corn and soybean meal based diet (control) or the control to which 25% wheat straw was added (straw). Pigs were housed individually in metabolism crates and adjusted to feeding regimes for at least 10 days prior to measuring components of HP using indirect calorimetry. Dynamics of HP was recorded in pigs for 5 d during the fed state and during a subsequent 24 h fast. Feeding behavior, animal activity and N-balance were monitored, allowing us to associate HP with thermic effects of feeding (TEF, sum of short and long term TEF), activity and energy retention. Mean body weight (BW) was similar ($P > 0.10$; 61.5 kg vs 62.4; SE 0.8) for control and straw, respectively. Dry matter intake (DMI) (1774 vs 2217 g.d⁻¹, SE 4) and fecal DM excretion (201 vs 588 g.d⁻¹, SE 10) were higher ($P < 0.05$) in straw fed pigs, while ME intake was similar (2302 vs 2359 kJ.kg BW^{-0.60}.d⁻¹; SE 28). Various aspects of energy utilization (expressed as kJ.kg BW^{-0.60}.d⁻¹; control vs straw, respectively; adjusted to similar ME intakes) did not differ ($P > 0.10$) between treatments: total HP (1372 vs 1345; SE 16), fasting HP (762 vs 747; SE 6), activity HP (150 vs 164; SE 15), TEF (452 vs 444; SE 7), and energy retention (965 vs 995, SE 13). When expressed per kg of DMI, TEF was lower ($P < 0.05$) in straw fed pigs (2832 vs 2279 kJ; SE 46). The overall energy cost of ingesting and excreting indigestible material in growing pigs appears minimal and could not be identified in this experiment.

Key Words: Pigs, Energy, Nutrient excretion.

636 Modelling the effects of thermal environment and dietary composition on pig performance. I. J. Wellock^{*}, I. Kyriazakis, and G. C. Emmans, *Scottish Agricultural College, Edinburgh, UK.*

A deterministic pig growth model predicting the effect of thermal environment and feed composition on the performance of pigs fed ad libitum was developed. From the daily potential for protein gain as determined by pig genotype, the potential gains of the other chemical components, including desired lipid gain are calculated. Unconstrained voluntary feed intake, predicted from the current protein and lipid content of the pig and food composition, is that needed to fulfil both potential and compensatory growth. Compensation is accounted for in terms of compensatory lipid gain only. The composition of the food is described in terms of its metabolisable energy content (MEC), digestible crude protein content (CPC), biological value and bulkiness. Both MEC and

CPC can be limiting resources and the bulkiness of the food may constrain feed intake depending on the animal's capacity for bulk. The thermal environment is described by the ambient temperature, wind speed, floor type and humidity, which sets the maximum and minimum heat loss. A comparison with heat production determines whether the environment is hot, cold or thermoneutral. A constraint on voluntary feed intake is imposed in hot environments, while in cold environments, an extra thermal demand is placed upon the pig. Daily gains of each of the chemical components are calculated by partitioning the nutrients between protein and lipid gain according only to the MEC:CPC ratio of the food. The model predicts adequately average daily intake, growth rate and body composition of pigs raised in differing thermal conditions and fed on dietary treatments differing in CPC. The directions of response were always correctly predicted. Where model predictions differed quantitatively from those observed, it was thought to be due to (i) a greater sensitivity of the model to temperature probably due to the omission of long-term adaptation and acclimatisation, (ii) an incorrect estimation of maintenance energy costs, or (iii) an incorrect estimation of the wetness of the pig's skin.

Key Words: Mathematical modelling, Pig, Thermal environment

637 Influence of sex, genotype, and slaughter weight on performance and carcass quality of fattening pigs. M.A. Latorre^{*1}, A. Fuentetaja², R. Lazaro¹, E. Gomez³, and G.G. Mateos¹, ¹Universidad Politecnica de Madrid, Spain, ²Copese S.A., Segovia, Spain, ³Centro de Pruebas de Porcino, Segovia, Spain.

LandracexLarge White sows from a 600 sow units were crossed either with Duroc or PietrainxLarge White (PxLW) boars. Eighty hybrid pigs, with an average weight of 25 kg, were chosen at random from each type and fed a commercial wheat, barley, and soybean meal diet containing 2,275 kcal NE/kg and 1.01% total lys from 25 to 72 kg, and 2,435 kcal NE/kg and 0.70% total lys from 72 kg to slaughter. Pigs were sacrificed at either 120 or 135 kg BW. Each of the eight experimental treatments (two sexes, two genotypes, and two slaughter weights) was replicated four times (five pigs penned together). Pigs slaughtered at 135 kg ate more and had worse feed conversion than pigs slaughtered at 120 kg (2,590 vs 2,460 g/d and 2.74 vs 2.66 g/g, respectively; $P < 0.01$). Duroc pigs grew faster and had better feed conversion than PxLW pigs (947 vs 917 g/g; $P < 0.05$ and 2.64 vs 2.77 g/g, respectively; $P < 0.001$). Castrates ate 8.2% more, grew 3.3% faster, and had 4.7% worse feed conversion than females ($P < 0.05$). An interaction between male sire line and slaughter weight was detected for growth ($P = 0.06$) and feed intake ($P = 0.08$); male line influenced daily gain and feed intake of pigs slaughtered at 135 kg (970 and 914 g/d and 2,610 and 2,570 g/d for Duroc and PxLW lines, respectively) but not of pigs slaughtered at 120 kg. Increasing slaughter weight reduced loin, ham, and shoulder yield (2.7, 2.3, and 2.6%, respectively; $P < 0.001$) and increased fat thickness as measured at *Gluteus medius* muscle (21.4 vs 18.8 mm; $P < 0.001$). Carcass yield and backfat at P₂ were lower for Duroc than for PxLW pigs (77.9 vs 78.9%, and 21.7 vs 23.7 mm, respectively; $P < 0.001$). It is concluded that Duroc sire line pigs perform better and produce more ham and loin yield than PxLW pigs. Also, an increase in slaughter weight tended to improve the quality of the carcass and the meat of pigs destined to the industry of cured products.

Key Words: Genotype, Slaughter weight, Carcass quality

638 Effect of feeding strategies and sex on performance and homogeneity of pigs at slaughter. C. Pineiro^{*1}, E. Lorenzo², P. Medel³, R. Lazaro⁴, and G. G. Mateos⁴, ¹PigCHAMP Pro Europa S.A., Spain, ²Proinserga I+D, Spain, ³Imasde Agropecuaria S.A., Spain, ⁴Universidad Politecnica de Madrid, Spain.

Two trials were conducted to study the influence of sex and nutrient content of the feeds on productive performance and weight uniformity of finishing pigs. In trial 1, 480 Large White x Landrace hybrids were used to study the influence of sex (boars vs females), nutrient content of the diet (2,375 Kcal NE/kg and 1.05% lys vs 2,250 Kcal NE/kg and 0.96% lys), and number of feeds (one vs two feeds in which the fattening diet had 14% less nutrients per kcal of NE than the growing diet) on productive performance and uniformity of weights at slaughter. There were six replicates of ten pigs per treatment and the trial lasted 105 d (60 to 165 d of age). Boars grew faster (721 vs 682 g/d; $P < 0.001$) and had better feed conversion (2.53 vs 2.66; $P < 0.01$) than females. Increasing the energy of the diet improved feed intake (1.85 vs 1.78 kg/d;

P < 0.05), daily gain (730 vs 673 g; P < 0.001), and feed conversion (2.54 vs 2.65 g/g; P < 0.01). The use of two diets improved the uniformity of final weights of both males and females (P < 0.05). In trial 2, 348 commercial hybrids were used in a 3 x 2 factorial (three sexes; boars, females, and barrows and two feeding programs; one- or two feeds from 20 to 100 kg). Barrows ate more feed (1,72 vs 1,52 and 1,53 kg/d; P < 0.05) and grew faster (857 vs 804 and 784; P < 0.05) than either males or females. As a consequence, feed conversion was impaired by castration with females giving intermediate results (2.02 vs 1.97, and 1.92 for castrates, females, and males, respectively). Phase feeding did not influence feed intake or average daily gain but feed efficiency was improved when a single feed was used throughout the trial (2.24 vs 2.29, P < 0.05). Phase feeding improved uniformity of weights at slaughter (P < 0.05). Also, uniformity of weights was greater for castrates than for males or females (P < 0.05). We conclude that sex and feeding program influence animal performance and may affect uniformity of weights at slaughter.

Key Words: Weight uniformity, Nutrient density, Sex

639 Effects of WEANMOR® feed additive on sow and litter performance. J. A. Loughmiller^{*1}, B. Hardy², E. Cerchiar³, B. T. Christopherson³, H. H. Stein⁴, and K. Hugoson⁵, ¹Omega Nutrition, Fairmont, MN, ²NutriVision, Fairmont, MN, ³SODA Feed Ingredients, Brookings, SD, ⁴South Dakota State University, Brookings, ⁵Hugoson Pork, East Chain, MN.

Primiparous and multiparous sows (n=90; PIC line 42) were used in an experiment to determine the effects of an acidified mineral additive (WEANMOR®, SODA Feed Ingredients) on the number of stillborn piglets (in total or as a percent of pigs born), and on piglet preweaning mortality in a commercial production situation. Sows were moved into farrowing crates on or about d 111 of gestation and assigned to treatment in an unbalanced completely randomized design using sow and litter as the experimental unit. All sows were fed the same basal diet. Control sows (C; n = 43) received no top-dress, while treatment sows (T; n = 47) received 60 g/d of WEANMOR® top-dress for 4 d pre-farrowing and 7 d postfarrowing. Each sow was fed 1.80 kg/d of lactation diet before farrowing and to appetite during lactation. No parity effects were observed for pigs born live, stillborns, mummies, pigs weaned, or preweaning mortality (P > 0.40). Treatment effects included a 64% reduction in stillborns for T versus C (C = 0.74; T = 0.27; P < 0.01). This effect was also observed when stillborns were compared as a percent of pigs born (C = 6.11%; T = 2.30%; P < 0.01). A treatment effect was also observed for the number of pigs weaned (C = 9.97; T = 9.69; P < 0.03). No treatment effect was observed for pigs born live (C = 11.01; T = 10.99; P < 0.96), mummies (C = 0.04; T = 0.01; P < 0.65) or piglet preweaning mortality (C = 7.10%; T = 6.34%; P < 0.62). These results indicate that WEANMOR® reduces the amount of stillborn piglets from sows in commercial production.

Key Words: WEANMOR®, Stillborn piglets, Sow

640 Effect of soybean variety and processing on growth performance of young pigs. M. Palacios*, R. A. Easter, T. Hymowitz, K. T. Soltwedel, and J. E. Pettigrew, *University of Illinois, Urbana.*

The objective of this study was to evaluate the efficacy by which two different genetically modified soybeans improve growth performance in young pigs. The varieties tested were Williams 82 (WM), a commercial variety; and two isogenetic lines of Williams 82, isolate L90-8047, a lectin free variety (LF) and isolate X97-0101, a lectin free and Kunitz trypsin inhibitor free variety (LFKF). A total of seven dietary treatments formulated to 1.01% of lysine and 3600 kcal DE/kg were used in this study. Each variety, used as raw (R) or as extruded (E), was included in a corn soybean diet. Commercial available heated, solvent-extracted soybean meal (SBM) was included in a corn soybean meal diet as the positive control. One hundred and forty pigs with an average initial weight of 13.89 kg were randomly assigned (5 reps/diet and 4 pigs/pen) to the following diet for 28 days: 1)corn-SBM, 2)corn-WM-E, 3)corn-LF-E, 4)corn-LFKF-E, 5)corn-WM-R, 6)corn-LF-R and 7)corn-LFKF-R. Performance was similar (P > 0.05) among pigs fed SBM and all extruded soybeans but was poorer (P < 0.05) in pigs fed raw soybeans. The results of this study indicate that when feeding pigs with raw varieties of soybean, there is a restoration of 21% of the growth depression

caused by the raw Williams 82 variety when using a lectin free variety and restoration of 55% of that depression when using a lectin free Kunitz free variety.

Diet	1	2	3	4	5	6	7
	SBM	WM-E	LF-E	LFKF-E	WM-R	LF-R	LFKF-R
Lectin		+	-	-	+	-	-
Kunitz		+	+	-	+	+	-
ADG, g	408 ^a	449 ^a	417 ^a	407 ^a	101 ^c	164 ^{bc}	266 ^b
ADFI, g	833 ^a	809 ^a	729 ^b	775 ^{ab}	512 ^d	595 ^c	708 ^b
Gain/ Feed, g/kg	424 ^a	499 ^a	540 ^a	471 ^a	6 ^c	172 ^{bc}	319 ^{ab}

^{abcd} Values within a row with uncommon superscripts differ (P < 0.05).

Key Words: Swine, Lectin, Kunitz trypsin inhibitor

641 Effect of soybean meal origin on the growth performance in broilers and pigs. J. G. Kim*, Y. W. Shin, Y. H. Park, H. S. Kim, and K. Y. Whang, *Korea University.*

Three experiments were conducted to compare effect of soybean meal (SBM) from different origin on the growth performance in broilers and pigs. In experiment 1, 720 broiler chicks (Ross) were assigned to three dietary treatments and fed diets containing three different SBM from Korea (KSBM), Brazil (BSBM), and India (ISBM). Experimental diets were starter diet (day 1 to day 21, 19.5% CP, and 3,025 kcal/kg ME) and grower diet (day 22 to day 42, 18.5% CP, and 3,005 kcal/kg ME). The ADG of KSBM treatment was higher (P < .01) than other treatments. In starting period, the ADG of KSBM, BSBM, and ISBM treatments were 30.08 g/d, 21.84 g/d, and 28.18 g/d, respectively. And, in growing period, the ADG of KSBM, BSBM, and ISBM treatments were 49.51 g/d, 43.76 g/d, and 40.92 g/d, respectively. The ADFI and feed efficiency (G/F) of ISBM treatment was lower (P < .01) than other treatments. In experiment 2, 180 crossbred pigs (Yorkshire x Landrace x Duroc) weaned at 21 day were assigned to three dietary treatments. Pigs were fed starter I (day 1 to day 7, 22% CP, 3,370 kcal/kg ME) and starter II (day 8 to day 28, 20% CP, 3,350 kcal/kg ME) diets. The ADG of KSBM treatment was higher (P < .05) than other treatments. The ADFI and G/F were not different among treatments, but KSBM treatment had a numerically higher than other treatments. In experiment 3, 315 crossbred (Yorkshire x Landrace x Duroc) growing pigs (38.4 ± 1.6 kg) were assigned to three dietary treatments. Experimental diets contained 18.5% CP and 3,350 kcal/kg. The ADG and ADFI in ISBM treatment were lower (P < .05) than other treatments. The G/F did not differ among treatments. In these experiments, KSBM fed pigs and broilers gained more weight than BSBM or ISBM treatments. Effect of SBM origin on the growth performance differed depending on age and species.

Item	KSBM	BSBM	ISBM
Exp.1			
ADG, g/day	39.79±2.27 ^a	32.80±1.08 ^c	34.61±1.52 ^b
ADFI, g/day	80.80±4.33 ^a	78.67±1.08 ^a	73.83±4.12 ^b
Feed Efficiency, g/kg	492±18 ^a	418±35 ^b	469±19 ^a
Exp. 2			
ADG, g/day	452±30 ^d	418±13 ^d	394±37 ^c
ADFI, g/day	770±30	763±70	708±82
Feed Efficiency, g/kg	587±46	550±38	559±44
Exp. 3			
ADG, g/day	635±21 ^d	652±77 ^d	541±65 ^c
ADFI, g/day	1669±46 ^d	1641±55 ^{de}	1576±58 ^e
Feed Efficiency, g/kg	380±19	397±37	343±38

^{a,b,c} P<0.01, ^{d,e} P<0.05.

Key Words: Broilers, Pigs, Soybean meal

642 Comparison of a high starch concentrate with a low starch, added fat concentrate for weanling horses. E. A. Ott*, J. Kivipelto, and A. Kavazis, *University of Florida.*

The objective of this experiment was to compare the effect of a high (HS) starch (31%) concentrate with a low (LSF) starch (0%) with added fat

(5%) concentrate on growth, development and blood glucose concentrations in weanling horses. The HS was based on corn and oats and LSF was based on beet pulp, soybean hulls and soybean oil. Twenty foals (14 Thoroughbreds and 8 Quarter Horses) were weaned at 112 d of age and assigned at random within breed and gender subgroups to one of the two diet groups. The concentrates were fed to appetite for 2, 1.5-hr feeding periods daily and 1.0 kg C. bermudagrass hay/100 kg BW was group fed daily. The ratio of concentrate to hay was 64:36. The weanlings were weighed and measured on d 0 and at 14 d intervals for 112 d. Glucose tolerance tests were conducted at the start and completion of the experiment. There were no differences in the concentrate, hay or total intake for the two diet groups. Weight gains were higher for the weanlings fed HS (.81 vs .67 kg/d, $P = .01$) than those fed LSF. Body length gains also favored the weanlings fed HS (15.5 vs 13.2 cm, $P = .04$). No other body measurements were different. Fasting blood glucose concentrations were consistent over time and between diet groups (86.4 + .7 mg/l). Blood glucose peaks, 90 min post feeding, at the start of the experiment following a sweet feed meal or an oral glucose challenge (.25 mg/kg BW) were not different between the treatment groups. At the end of the experiment, weanlings fed HS had higher ($P = .02$) blood glucose values (155.7 + 8.9 mg/l) than those fed LSF (131.0 + 3.3 mg/l). However, after the glucose challenge, weanlings from the HS group had lower ($P = .01$) blood glucose (117.1 + 3.4 mg/l) than those fed LSF (130.8 + 3.1 mg/l). Results suggest that HS diets result in higher blood glucose concentrations than LSF diets. Even though the analyses of the diet detected no starch, a glucose peak still occurred following a diet challenge, probably as a result of the natural sugars in the ingredients. The weanlings fed the LSF concentrate apparently had a reduced ability to control blood glucose when challenged with oral glucose.

Key Words: Horses, Starch, Glucose tolerance

Nonruminant Nutrition Mineral and Vitamin Nutrition

644 Unraveling mineral essentiality in swine. Bud Harmon*, *Purdue University*.

A century ago mineral nutrition for swine was as sophisticated as offering ashes or bone meal free choice. Rickets was thought to be caused by insufficient mineral matter in the feed. Henry (1890) observed a 40% increase in bone ash and 93% increase in bone breaking strength when hardwood ashes were offered free choice to pigs receiving corn, salt, and water. Henry (1898) stated that ashes from wood or coal will always be in place in the feeding pen. In retrospect, ashes were a blend of many minerals now considered crucial in balanced swine diets. Minerals received minimal consideration as critical nutrients into the early 20th century because of beliefs such as: "Ordinarily the rations of farm animals contain all the necessary mineral matter, at least in small quantities, and since the body retains them with great tenacity when the supply is meager, these small amounts usually suffice." Many mineral studies were initiated in response to observations on swine farms. Iodine is such an example. Although goiters had been diagnosed in man and animals, the mineral I was not associated with goiters until the late 1800s. Welch and Smith (1917) investigated the cause of large numbers of dead hairless newborn pigs. They discovered these pigs had abnormally large thyroid glands with quite low levels of I. Unraveling the cause of an extremely severe exudative dermatitis, called parakeratosis, was just as remarkable. This gruesome condition seen sporadically in growing swine responds to Zn supplementation (Tucker and Salmon, 1955). Elevated levels of dietary Ca also precipitated Zn deficiency and parakeratosis. Recognition of Se by Schwarz and Folz (1957) as an essential nutrient and eventual fortification with 0.3 ppm to practical swine diets has saved countless pigs. Fe deficiency anemia in young pigs was often called "thumps" because of labored breathing, thought to be caused by lack of exercise and irritation of the digestive tract. McGowan and Crichton (1924) first attributed this malady to Fe deficiency in nursing pigs. Mineral elements have unique roles and even more unique manifestations of deficiency.

Key Words: Swine, Minerals

643 The effects of guar gum (GG), hydroxypropylated starch (HPS), and xanthan gum (XG) on digestive dynamics in dogs fed canned foods. S.E. Kitts*, R.M. Yamka¹, A.D. True¹, W.D. Schoenherr², T.M. Dubbs¹, L.A. White¹, E.S. Vanzant¹, and D.L. Harmon¹, ¹*University of Kentucky, Lexington, KY*, ²*Hill's Pet Nutrition, Topeka, KS*.

Gums and starches are added to pet foods as stabilizers/thickeners and to create the gravy portion of canned foods. These additives can produce undesirable effects on fecal quality. The goal of this research was to determine the physiological effects of GG, HPS, or XG in canned diets fed to dogs. GG (Exp. 1), HPS (Exp. 2), and XG (Exp. 3) were included at 2.5%, 11.3%, or 1.2% of DM, respectively. Each diet was compared to a control diet containing 10.7% (DM basis) corn starch (CS). Diets were evaluated in separate experiments by comparing 5-d control and 5-d test periods. Eight or nine mature dogs (18.9 kg ± 0.2 kg), fitted with an ileal T-cannula were used. In Exp. 1, DMI (g/d) decreased while fecal pH and ileal digesta pH increased for GG ($P < 0.001$). Fecal acetate and propionate (μmol/g DM; $P < 0.03$) and fecal quality ($P < 0.003$) decreased although defecation frequency was not affected by GG. Breath hydrogen concentration (BH) increased at 5 and 6 h postprandially for GG ($P < 0.01$). In Exp. 2, DMI (g/d) decreased ($P < 0.0001$) for HPS. Fecal acetate, propionate, butyrate, isovalerate, and valerate (μmol/g DM) decreased for HPS ($P < 0.05$). HPS decreased plasma electrolytes; K⁺ from 4.5 to 4.3 meq/L ($P < 0.007$), and Na⁺ from 146.3 to 140.1 meq/L ($P < 0.04$). In Exp. 3, DMI (g/d) decreased ($P < 0.0001$) for XG. Fecal moisture increased from 57.3 to 62.5% in dogs fed XG ($P < 0.0003$). Fecal acetate and propionate (μmol/g DM) decreased for XG ($P < 0.05$). Ileal digesta pH increased ($P < 0.005$) and valerate in ileal digesta (μmol/g DM) decreased for XG ($P < 0.04$). Fecal quality decreased for XG ($P < 0.04$), but defecation frequency was not affected. BH increased 1 h postprandially with the XG diet, then decreased from 3 to 8 h ($P < 0.03$). These data indicate that decreases in fecal quality with inclusion of GG, HPS, or XG were not associated with increased fermentation.

Key Words: Gums, Canine, Canned diets

645 Effect of feeding chromium tripicolinate as a top dress to boars upon sperm production. M. E. Wilson*, T. J. Gall², K.J. Rozeboom¹, R. A. Moser³, D. E. Orr³, and K. W. Purser⁴, ¹*Minutube of America, Inc., Verona, WI*, ²*Pork Technologies, Danville, IA*, ³*United Feeds, Inc., Sheridan, IN*, ⁴*Prince Agri Products, Inc., Quincy, IL*.

Chromium tripicolinate (CrTp) has been shown to positively influence reproductive performance in sows. This study was designed to test if supplementation of CrTp to boars had an impact on sperm production and sperm quality. 158 PIC boars were blocked for genetic line, age, collection frequency, and total sperm output/week and were randomly allotted to one of two treatments. All boars were fed a corn soybean meal diet (15.5% CP, .85% lysine) according to body weight to meet or exceed NRC 1998 requirement estimates. Treatment 1 (T1) were fed a top-dress of 15 g consisting of 95.25% sodium bentonite, 3.75% ground limestone and 1% mineral premix. Boars in treatment 2 (T2) were supplemented with the same top dress with CrTp substituted for a portion of the limestone to provide 30 mg/kg Cr in the top-dress (equivalent to 200 ppb Cr in 2.27 kg complete feed). Boars were fed their respective dietary treatments for 45 days prior to beginning the 90 d study. Boar ejaculates were collected on a regular schedule throughout the trial. An average of 3 ejaculates were used to set the beginning sperm count and all sperm and semen parameters and at the end of study for comparison to beginning values. ANOVA was analyzed using the GLM procedure in SAS. Bonferroni mean comparisons were used when treatment effects were detected. The beginning and ending sperm parameters were not different between the treatments. There was no difference between T1 (16.23 ± 2.5) and T2 (14.5 ± 2.5) in total sperm count (billion) per ejaculate. Although total sperm counts were different between genetic lines ($P < 0.01$), treatment x genetic interactions were non-detectable. These data suggest that addition of CrTp did not improve important sperm

production parameters in these genetic lines in healthy boars maintained in an environmentally controlled boar stud.

Key Words: Boars, Chromium tripicolinate, Sperm

646 Effect of dietary protein and mineral content on water utilization patterns in growing pigs. M.I. Shaw^{1,2}, A.D. Beaulieu^{*1}, and J.F. Patience¹, ¹*Prairie Swine Centre, Inc., Saskatoon, SK*, ²*University of Saskatchewan, Saskatoon, SK*.

Concerns relating to the use of water resources by the livestock industry, combined with the rising cost of manure management, have resulted in greater interest in more precisely defining water consumption of pigs. Limited information is available on the impact of diet composition on ad libitum water intake. The objective of this experiment was to investigate the impact of diets differing in protein and mineral content on water utilization patterns in 35-kg pigs. A total of 48 crossbred barrows (3 replicates of 16 pigs each) were randomly assigned within replicate to one of four dietary treatments for a 14-day experimental period. Each diet was based on wheat, barley and soyabean meal. A medium protein diet serving as control (MedP) at 20.9% crude protein was compared to either high (HiP, 25.7% CP) or low (LoP, 16.9% CP) protein diets. The low protein diet was supplemented with lysine, methionine, threonine and tryptophan to attain ideal amino acid ratios, and sodium bicarbonate was added to achieve recommended dietary electrolyte balance. A fourth diet (HiMin) at 20.6% CP was formulated similar to the control but with elevated calcium (1.00% vs 0.60%), available phosphorus (0.46% vs 0.24%) and salt (0.90% vs 0.40%) to attain a higher mineral level. Water consumption and spillage were measured daily, and urine and faeces were collected quantitatively on d 11-14 of the experimental period. Water intake and urine output were higher in pigs on the HiP diet ($P < 0.10$), and the water to feed ratio was higher in pigs on the HiP diet ($P < 0.01$). Average daily feed intake was elevated on the LoP diet ($P < 0.01$), while pigs on the HiP and HiMin diets had improved average daily gain (ADG, $P < 0.05$) and gain:feed (FC, $P < 0.10$). ADG, FC and water balance data in pigs on the LoP and MedP diets were not different ($P > 0.05$). In conclusion, elevated dietary protein increased water utilization, but elevated dietary minerals did not. Feeding a low crude protein diet did not result in reduced water intake.

Key Words: Swine, Water, Protein

647 Bioavailability of supplemental minerals to animals with emphasis on method of determination. C. B. Ammerman^{*} and P. R. Henry, *University of Florida*.

Diets formulated from common feed ingredients are frequently inadequate in various minerals to assure efficient animal production and health. Thus, supplemental minerals must be included in the diet and bioavailability of the mineral source must be known. The most useful expression of mineral utilization in diet formulation is relative bioavailability. This value is generated frequently by a slope-ratio procedure in which the response from the mineral source in question is compared to that from a highly soluble source of the same mineral element. Earlier, the response stressed the utilization of the mineral element in normal metabolic processes within the animal. Examples include hemoglobin formation in response to iron supplementation and bone ash deposition in response to phosphorus supplementation. These responses satisfy the strictest definition of bioavailability. More recently, a less strict definition of bioavailability has evolved in which the term is defined as the degree to which an ingested mineral element is absorbed in a form that can be utilized in metabolism by the animal. This concept of bioavailability has allowed the development of bioavailability assays for several mineral elements which can be conducted with less difficulty with regard to basal diet requirement and measurement of limited metabolic response than would otherwise be the case. Bioavailability assays conducted under this concept include those using tissue mineral accumulation from elevated dietary intakes and those using urinary excretion of the element in question. Tissue accumulation has been used in the determination of bioavailability for manganese, copper and zinc sources, for example, and urinary excretion has been used to determine the bioavailability of magnesium and potassium compounds.

Key Words: Bioavailability, Mineral nutrition, Animals

648 Bioavailability of phosphorus associated with conventional corn is underestimated for growing pigs. Y. Shen^{*}, M. Z. Fan, A. Ajakaiye, and T. Archbold, *University of Guelph, Guelph, Ontario, Canada*.

The objectives of this study were to determine true phosphorus (P) digestibility and the endogenous P outputs associated with conventional corn for growing pigs by using the regression analysis technique. Four barrows, an average initial BW of 25 kg, were fitted with a T-cannula and fed four diets according to a 4 x 4 Latin square design. Four cornstarch-based diets, containing four levels of P at 0.7, 1.5, 2.2 and 2.8 g/kg DMI, were formulated from corn. Each experimental period comprised 8 d with 4-d adaptation and 4-d collection of ileal digesta and fecal samples. The apparent ileal and fecal P digestibility values in corn were affected ($P < 0.05$) by P contents in the assay diets. The apparent ileal and fecal P digestibility values increased from -51.0 to 33.3% and from -41.4 to 39.1%, respectively, as P content increased from 0.7 to 2.8 g/kg DMI. Linear relationships ($P < 0.05$), expressed as g/kg DMI, between the apparent ileal and fecal digestible P and the total intake of dietary P, suggested that true P digestibility and the endogenous P outputs associated with corn can be determined by the regression analysis technique. There were no differences ($P > 0.05$) in true P digestibility values (54.0 ± 6.5 vs $59.8 \pm 8.5\%$) and the endogenous P outputs (0.693 ± 0.128 vs 0.670 ± 0.160 g/kg DMI) between the ileal and the fecal levels. The endogenous fecal P output represented 12.3% and 25.8% of the daily total and available P requirements in growing pigs recommended by NRC (1998). The present literature data, averaging 22%, of apparent digestibility and availability underestimate the true digestive utilization of P in corn for growing pigs by 38%. Current diet formulation on the bases of total, apparent P digestibility and availability values in corn inevitably leads to P overfeeding and excessive P excretion in pigs.

Key Words: True phosphorus digestibility, Corn, Growing pigs

649 Effect of lower dietary concentrations of zinc polysaccharide versus zinc oxide on growth performance and zinc excretion by weanling pigs. C. E. Huntington^{*1}, D. W. Bollinger¹, T. L. Veum¹, and W. A. Brommelsiek², ¹*University of Missouri Columbia, MO*, ²*Quali Tech, Inc. Chaska, MN*.

Lower dietary levels of an organic source of Zn as Zn-polysaccharide (Zn-SQM, Quali Tech) were compared with 2,000 ppm of inorganic Zn as ZnO, with growth performance and Zn excretion as the criteria. Fifty pigs averaging 6.2 kg were weaned at 21 days of age and allotted to five treatments. Pigs were fed to appetite twice daily in individual metabolism pens. The Basal Phase 1 (d 0-14) diet contained corn, 30% dried whey, SBM, 6% animal plasma, 2% corn oil, and vitamin and mineral supplementation to meet all NRC (1998) requirements. The Basal Phase 2 (d 14-35) diet contained 20% dried whey and 2% animal plasma. Treatments were: 1) Phase 1 or Phase 2 Basal diet containing 125 or 100 ppm added Zn, respectively, as Zn sulfate. 2) Basal plus 150 ppm Zn as Zn-polysaccharide (Zn-P). 3) Basal plus 300 ppm Zn as Zn-P. 4) Basal plus 450 ppm Zn as Zn-P. 5) Basal plus 2,000 ppm Zn as ZnO. Phase 2 diets contained 0.05% chromic oxide. Fecal samples and total urine collections were made twice daily from day 22 to 26. Pre-determined ANOVA single df contrasts were linear, quadratic, Diet 1 vs 5, and Diets 3 plus 4 combined vs Diet 5. There was a linear trend ($P = 0.10$) for overall gain:feed ratio to increase with increasing Zn-P up to 300 ppm Zn, with no further increase at 450 ppm. Overall ADG, ADFI and gain:feed ratio were not different ($P \geq 0.2$) for the 300 plus 450 ppm Zn as Zn-P treatments combined compared with ZnO. Pigs fed ZnO tended to have higher ($P \leq 0.07$) overall growth performance than pigs fed the control diet. There were linear increases ($P \leq 0.001$) in the mg of Zn absorbed, excreted and retained/day with increasing dietary Zn-P. However, pigs fed ZnO retained and excreted more mg of Zn/day ($P = 0.001$) than pigs fed Zn-P. In conclusion, 300 ppm Zn as Zn-polysaccharide maintained pig growth performance and reduced Zn excretion by 76% compared with pigs fed 2,000 ppm Zn as ZnO (333 vs 1,396 mg/day).

Key Words: Growth performance, Zinc, Weanling pigs

650 Contributions of swine research to understanding the roles of selenium and vitamin E. James Oldfield*, *Oregon State University.*

Despite the much-publicized findings of protective effects of selenium against myopathies in young ruminants (white muscle disease), the earliest discovery of selenium's health benefits was made with swine, in 1957. Since the body fat of pigs more closely resembles the fat in their diets than does that of ruminants, swine were useful subject animals for the investigation of dietary antioxidants and much has been learned from them concerning the metabolic functions of both selenium and vitamin E. Swine research, too, played an important role in establishing nutrient essentiality status for selenium and in gaining approval from regulatory agencies (FDA), for its supplementary addition to livestock diets. These findings, of course, added significantly to the developing knowledge of selenium's role in animal nutrition and subsequently to its acceptance as a production practice with various species of farm animals, worldwide. This paper will examine steps along the way in the assembly of information concerning dietary antioxidants, including more recently implications in human nutrition and disease control.

Key Words: Selenium, Vitamin E, Swine

651 Influence of feeding system and diet on α -tocopherol concentration in muscle and microsome membranes of Iberian pigs. C. J. Lopez-Bote¹, G. G. Mateos², A. Daza², B. Isabel¹, and R. Lazaro², ¹*Universidad Complutense de Madrid, Spain*, ²*Universidad Politécnica de Madrid, Spain.*

A trial was conducted to determine the concentration of α -tocopherol in muscle and microsome membranes of Iberian pigs reared under different feeding regimes. Six groups of 10 pigs each were fed in confinement a basal diet based on barley and soybean meal with 4% of three different mixtures of fats, varying in fatty acid composition, and two levels of α -tocopherol acetate supplementation (0 vs 200 ppm). The fat mixture consisted of a combination of lard and olive and sunflower acid oils, selected in order to vary the ratio between mono- and polyunsaturated fatty acids without modifying the saturated fatty acid portion of the diets. An additional group of 10 pigs was fed on acorns (the fruit of *Quercus ilex*, rich in starch and oleic acid) and grass under range conditions during the same period of time (56 d). The α -tocopherol content varied from 35.9 to 31.1 mg/kg dry matter for the acorns and from 244.5 to 276.5 mg/kg dry matter for the grass from the beginning to the end of the trial (100 to 160 kg of body weight), respectively. The α -tocopherol content of the fresh samples of *Longissimus dorsi* and the microsome extracts of the cellular membranes were lowest for pigs fed the non-supplemented control diet (2.51, 4.44, and 4.58 g/kg in muscle and 4.2, 10.8, and 12.7 g/kg in microsome extracts, for non-supplemented, 200 ppm α -tocopherol acetate supplemented, and extensive fed groups, respectively; $P \leq 0.05$). Composition of dietary fat, however, did not influence α -tocopherol content of the muscle or the microsomes and no interaction was observed between these two main effects ($P \leq 0.05$). Microsomal extracts of *Longissimus dorsi* from pigs fed acorns and grass had lower induced oxidation rate than extracts from pig fed the basal diet under intensive conditions (2.57 vs 3.93 vs 4.75 nmol MDA/mg protein at 120 min, for pigs fed acorns and grass, α -tocopherol supplemented, and non-supplemented diets, respectively; $P \leq 0.001$). The results indicate that some dietary constituents of the acorns or the grass consumed by pigs under range conditions, others than α -tocopherol, may play a role in the stabilization of microsomal lipids.

Key Words: Iberian pigs, α -tocopherol, Oxidation

652 Efficacy of pantothenic acid as a modifier of body composition in pigs. B.A. Autrey*, T.S. Stahly, and T.R. Lutz, *Iowa State University, Ames, IA.*

The efficacy of dietary pantothenic acid (PA) as a modifier of body composition was evaluated in pigs fed from 8 to 119 kg BW. Pigs from a high lean strain were weaned at 21 d and randomly allotted from outcome groups based on gender and weight to a basal diet (analyzed 8 ppm) supplemented with d-calcium pantothenate to provide 0, 15, 30, or 45 ppm added PA. Four pens of gilts (5 pigs/pen) and four pens of barrows were allotted to each of the four diets. The basal diet consisted of a corn-SBM-3% choice white grease mixture and contained 1.8, 1.5, 1.2, and .95% lysine for pigs fed from BW of 8 to 15, 15 to 40, 40 to

75, and 75 to 119 kg, respectively. All vitamins except PA were fortified to 600% of NRC (1998) for each stage of growth. Dietary PA additions did not alter BW gain or G:F ratios. However, PA additions linearly ($P < .01$) reduced backfat depth (16, 15, 14, 13 mm, respectively, at tenth rib off-midline; 21, 20, 19, 17 mm at last rib midline) and increased estimated carcass fat-free lean content (54.5, 55.5, 55.8, 56.5%) independent of gender as measured on chilled carcasses using backfat ruler and loin tracing. PA additions also resulted in linear reductions in backfat depth (19, 18, 17, 16 mm) and increases in estimated carcass lean content (54.0, 55.0, 55.5, 56.25%) as measured on hot carcasses using the Fat-O-Meater probe as well as CVT ultrasound (20, 19, 17, 16 mm backfat; 54.3, 54.7, 54.9, 55.6% lean). Based on these data, pantothenic acid at dietary concentrations above that needed to maximize BW gain is an efficacious modifier of body lean content of pigs.

Key Words: Pigs, Pantothenic acid, Carcass muscle

653 Dietary vitamin B₁₂ supplements in gestating gilts and B₁₂ transfer to piglets during lactation. F. Simard¹, F. Guay¹, J. P. Laforest¹, A. Giguère², C. L. Girard², and J. J. Matte^{*2}, ¹*Université Laval, Quebec, Qc, Canada*, ²*Agriculture and Agri-Food Canada, Lennoxville, Qc, Canada.*

Thirty-eight nulliparous (Large-White x Landrace) sows were randomly assigned, during gestation, to 5 dietary levels of vitamin B₁₂ (B₁₂) at 0, 20, 100, 200, and 400 ppb. Concentrations of B₁₂ in colostrum and milk as well as plasma B₁₂, homocysteine (Hcy) and BW of piglets were measured during lactation (21 d). Hcy is a detrimental intermediate metabolite of the B₁₂-dependent remethylation pathway of methionine. Treatments were applied for 2 estrous cycles before mating and throughout gestation. For all sows, the lactation diet contained 25 ppb of B₁₂. Blood samples were collected at birth (d 0, before the first suckling) and on d 1, d 7, d 14 and d 21 of lactation on 3 selected piglets per litter; colostrum and milk samples were collected at the same times. Colostral B₁₂ (d 0) increased (dietary B₁₂ quadratic, $P < 0.01$) with the dietary B₁₂ in gestation. Average values (\pm SE) (ng/mL) were 4.8 ± 0.7 , 6.1 ± 0.4 , 7.5 ± 0.7 , 10.2 ± 0.8 , and 9.9 ± 0.8 for 0, 20, 100, 200 and 400 ppb of dietary B₁₂. The maximal colostral B₁₂ was estimated to be reached with 300 ppb of dietary B₁₂ ($R^2 = 0.96$). On d 1, milk B₁₂ decreased by 40 % but a residual effect of the gestation treatments persisted (dietary B₁₂ linear, $P < 0.01$). Plasma B₁₂ of piglets on d 0 (592.9 ± 53.3 pg/mL) was similar ($P > 0.59$) among treatments. On d 1, the overall plasma B₁₂ in piglets doubled but also increased with the dietary level of B₁₂ in dam's diet (dietary B₁₂ linear, $P < 0.05$). Plasma Hcy of piglets on d 0 decreased (dietary B₁₂ linear, $P < 0.01$) as the levels of dietary B₁₂ increased. The overall plasma Hcy in piglets increased during lactation (2.6 ± 0.1 μ M on d 0 to 28.8 ± 1.1 μ M on d 21). However, plasma Hcy in piglets decreased (dietary B₁₂ linear, $P < 0.01$) as B₁₂ increased in the gestation diet. Residual treatment effects were still apparent on litter weight (dietary B₁₂ quartic, $P < 0.06$) on d 7 but disappeared, thereafter. In conclusion, the dietary B₁₂ during gestation can modulate the transfer of B₁₂ and the Hcy metabolism of piglets during lactation. Most of the transfer of B₁₂ to piglets occurred after birth via the colostrum and the milk. The importance of dietary B₁₂ during both gestation and lactation of sows on growth of suckling piglets needs to be evaluated.

Key Words: Vitamin B₁₂, Milk, Gilts

654 Effect of the meal on the utilization of some nutrients and vitamins by the mammary gland in lactating sows. J.Y. Dourmad^{*1}, J.J. Matte², and D. Renaudeau¹, ¹*INRA-UMRVP 35590 Saint-Gilles, France*, ²*Agric. and Agri-Food Canada, Lennoxville (QC), Canada, J1M 1Z3.*

The effect of the meal on the uptake of some nutrients and vitamins by the mammary gland was measured in six lactating sows. After farrowing, catheters were fitted in the right anterior mammary vein and in the carotid artery. Blood samples were drawn following an overnight fast on d 9, d 14 and d 21 of lactation, every 30-min from 60 min before to 300 min after the morning meal (2.5 kg of a lactation diet). Plasma concentrations of glucose, lactate, triglycerides (TG), NEFA, glycerol, α -amino N, folates and vitamin B₁₂ were determined on all samples. Vitamin B₂ and amino acid (AA) concentrations were measured 30 min before and 120 min after the meal only. For the vitamins, the arterio-venous (A-V) difference was not different from zero. However, the decrease of plasma

concentrations of folates and vitamin B₁₂ between d 9 and d 21 suggests that they could play a role for lactation, but in other metabolic pools. Arterial and venous plasma concentrations of glucose, lactate and α -amino N increased after the meal ($P < 0.01$), whereas concentrations of NEFA, glycerol and TG decreased ($P < 0.01$). Arterio-venous differences increased after the meal for glucose, lactate and α -amino N ($P < 0.01$), remained constant for TG, and decreased for NEFA ($P < 0.01$) and glycerol ($P < 0.05$). Arterial concentrations of all AA increased after the meal but changes of A-V with the meal differed among AA. The pattern of AA uptake was affected by the nutritional status. For instance

the valine:lysine ratio was higher (1.11) in fasted than in fed sows (.82). Arterio-venous difference of energy (7.7 kJ/L plasma) was similar in fasted and fed sows. The relative contributions of glucose, TG, lactate, NEFA, and AA to energy uptake by the mammary gland amounted to 24.0, 25.5, 2.1, 34.1 and 13.9% in fasted sow and, 51.0, 26.7, 3.9, 0 and 18.5% in fed sows, respectively. These results indicate that the mammary uptake of nutrient is greatly depending on the nutritional status of the sow.

Key Words: Sow, Lactation, Milk precursor

Undergraduate and Graduate Education

655 The use of peer review in an animal science course focusing on societal issues. W. A. Scheer* and J. N. Spain, *University of Missouri, Columbia, MO.*

This study was a post-facto analysis of the use of peer reviews to evaluate student research papers. Students ($n=72$) in a sophomore-level animal science course were assigned a research paper. Each student selected a topic that they considered to be the most critical societal issue facing animal agriculture. Students were expected to write the paper using the format of the *Journal of Animal Science* and to utilize a minimum of 15 refereed journal articles. The first edition of the paper was graded by the instructor or graduate teaching assistant. Three copies of the second edition were submitted with only student identification numbers identifying the author. Students were randomly allocated three papers to evaluate. Each student completed a review sheet and awarded up to 50 points with 20 points available for topic development, 20 points for grammar and spelling, and 10 points for proper citation format. Students were given 3 days to complete the evaluations. Peer reviews were then returned to the student writers for final revision. Students were asked to evaluate reviewers in three categories using a scale of zero to one in each category, with up to 3 total points available. The final edition of the paper was then graded by the instructor or graduate teaching assistant. The relationships between average peer review grade, grade as a reviewer, and final edition grade were evaluated. A significant ($P < 0.05$) positive correlation was found when comparing average peer review grade and final edition grade. As students' peer review grades and final edition grades increased, their grade as a peer reviewer also increased. Students who wrote papers that received higher second (peer-assigned) and final edition (instructor-assigned) grades were considered to be better reviewers as scored by their peers, indicating that students who wrote better papers provided more meaningful feedback. Peer review of research papers was a useful and effective component of this sophomore-level animal science course that allowed students to improve their writing skills and become more actively involved in the evaluation process.

Key Words: Teaching, Peer Review

656 Practical student experiences aid in the education on controversial animal topics. K. D. Ange*, *North Carolina State University, Raleigh, NC.*

The animal rights versus animal welfare conflict is an important issue for all animal scientists involved in undergraduate education. Students need to be taught the difference between animal rights and animal welfare so they can understand the current issues facing the field of animal science. Some animal rights groups frequent the media spreading propaganda about animal industries and it is important that animal science students are taught the facts so that they can form their own opinions. Undergraduate students enrolled in NCSU's Companion Animal Management course were given the opportunity to examine a current controversial animal topic first hand. The animal rights groups People for the Ethical Treatment of Animals and Humane Society of the United States have been criticizing circus animal treatment in the mainstream media (NBC News). The opinions of these animal rights groups were discussed in class and then the students were allowed to tour the animal compound of a very large traveling circus and meet with the animal care staff. The animals in this compound included alpacas, camels, elephants, horses, tigers, and zebras. After visiting the circus, students were asked to complete a questionnaire regarding their opinion of animal care in circuses. Fifteen of 18 students completed the survey. Prior to the tour, the average student opinion of circus animal care was 2.6 and their average opinion of circus animal staff (trainers and veterinarians)

was 2.9 on a 1 (very poor) to 5 (very good) point scale. After their tour, student opinion of animal care and the animal staff improved to 4.4 and 4.5, respectively ($P < 0.001$). Although all 15 students stated that they felt the circus tour improved their opinion of animal care at circuses, a few students listed enlarging animal cages, increasing exercise and changing elephant restraints as ways to improve animal care. In addition to classroom education, the results from this tour show that personal experiences dramatically affect what students think about controversial animal issues.

Key Words: Teaching, Active learning, Welfare

657 A novel method for teaching animal welfare concepts: animal welfare judging teams. C.R. Heleski*¹, A.J. Zanella¹, and E.A. Pajor, ¹*Michigan State University, East Lansing MI, USA*, ²*Purdue University, West Lafayette, IN, USA.*

Examining the welfare of animals in various production systems and making ethical evaluations of which is most appropriate continues to be a priority issue affecting many levels of animal agriculture. We have developed a model to increase education of animal welfare issues, while aligning ourselves with a traditional curriculum feature within animal science departments; i.e. judging teams.

We proposed one year ago that developing teams to educate young people about farm animal welfare then establishing competitions to assess their skill level would be one way to integrate welfare science into the mainstream of animal science curricula. Three other universities opted to join Michigan State in this pilot endeavor: Purdue University, University of Guelph and University of Wisconsin. Each team is being coached in the basics of understanding farm animals# evolutionary biology, their biological needs, indicators of differing levels of welfare and how to holistically evaluate different facilities, stockmanship and management. Based on pedagogical principles, the concept of integrating learning with competition is known to enhance learning and retention. Students are currently preparing for a competition, March 1, 2002. The competition will use CD-ROM#s with indicators of animal welfare ranging from physiological data, video and still clips, to behavioral responses and time budgets. Students will evaluate two scenarios for each species being judged, prepare their analysis, then make an oral presentation. The knowledge of welfare science, the integration of multiple measures and the persuasion of the oral presentation will be key in scoring the students.

Preliminary observations indicate that preparing the students for this competition has increased their knowledge base and has enhanced networking with university farm managers. It should be noted that while the assessment of various aspects of animal welfare can be objective and quantifiable, judgment decisions of what threshold level on the continuum between poor and good welfare is acceptable still come down to ethically examined choices.

Key Words: Animal Welfare, Welfare Assessment, Judging Teams

658 A pre-capstone seminar to foster student interaction to improve educational quality of independent learning experiences. M. A. Wattiaux*, *University of Wisconsin-Madison.*

Our objective was to develop a class to facilitate communication among students and better prepare sophomores to take full advantage of independent learning experiences (ILE) typically available to juniors or seniors such as internships, team projects in capstone courses, summer research programs and study abroad. Thus, a one credit seminar series

was designed based on the Kolb's model of experiential learning under the premise that the sharing of concrete experiences gained by those who completed ILEs, would benefit sophomores in their conceptualization and planning for their own future ILEs. Seminar speakers included primarily juniors, seniors and recently graduated students. Guidelines were developed to help them share their experiences, educational gains and personal growth. Sophomores (n=24) were expected to submit a weekly report in the form of an e-mail journal entry. Guidelines were developed to help focus the writing on analysis and assessment of the ILE discussed in class in relation to their personal interests and aspirations. Sophomores were surveyed with a questionnaire focusing on aspects of the class that helped the learning process. Possible scores (S) were on a 1-to-5 Likert-type scale (1 = strongly disagree and 5 = strongly agree). Positive aspects of the class (S>4.0) included: (a) an increased awareness of the variety of ILE opportunities, (b) learning directly from other students' experiences, and (c) better understanding of the processes involved in the realization of a successful ILE. Disliked aspects of the class (S<3.0) included: (a) the amount of time and work involved in writing a weekly journal entry and (b) the lack of an 'objective' grading system. Despite reluctance to accept writing as a part of this class, the pre-capstone helped some students to identify deficiencies in their writing skills. In summary, the pre-capstone seminar creates an educational cycle among students in which they first observe and reflect on experiences of others, then, engage in an ILE of their own, and finally, become mentors to those who follow them.

Key Words: Undergraduate education, Experiential learning, Independent learning experiences

659 "The Quail Project": Integrating fundamental nutrition concepts with cross-disciplinary skills. D.J.R. Cherney*, A.W. Bell, W.R. Butler, and E.A. Oltenacu, *Cornell University, Ithaca, NY.*

Successful graduates of animal science programs should have technical competence. Increasingly, they also are expected to develop broad skills that allow them to synthesize knowledge and contribute their expertise effectively through communication and the ability to work with others. A 2-wk study using Japanese quail (*Coturnix coturnix Japonica*) was conducted with the objective of demonstrating the effect of dietary protein level on voluntary feed intake, average daily gain and efficiency of feed utilization in growing quail to the students in our animal nutrition class (142 students). Students were responsible for daily animal care and data collection. Further objectives of "The Quail Project" were for students to learn to read scientific papers and summarize the data (by writing an abstract), and to work in groups (four students/group). Groups summarized the data from the trial, and presented the data in oral and written formats. Nineteen of 34 groups used Powerpoint presentations, suggesting that many of our students are comfortable with computer-generated formats for data presentation. A survey was conducted at semester's end to evaluate the quail project. Response rate was 65% (93 of 142; 43% transfer students, 57% non-transfers). Transfer students were less likely to indicate veterinary medicine (45% of respondents) as a vocational objective than were non-transfers (62%). Transfer students were more comfortable with a group grade (83%) than were non-transfers (67%) and more likely to think grading was fair (83% vs. 72% for transfers and non-transfers, respectively). Both groups of students reported that the project was at least somewhat useful in helping them understand protein nutrition concepts presented in lecture, although transfer students were more likely to indicate that the quail project did not help their understanding of lecture materials (15% vs. 4%, respectively for transfer and non transfer). "The Quail Project" was successful in furthering technical competence in animal nutrition, but also furthered the cross-disciplinary skills of oral communication and group cooperation.

Key Words: Teaching, Nutrition

660 Ecology of grazing lands systems: A multi-disciplinary and multi-university course. J. C. Waller*¹, R. Mitchell², O. Abaye³, and V. G. Allen², ¹University of Tennessee, ²Texas Tech University, ³Virginia Polytechnic Institute and State University.

This field-oriented graduate level course immerses students in diverse grazing lands and ecosystems across several states. Students learn about: (a) the components and functions of grazing lands and how

these vary in different ecoregions; (b) research needs, objectives and techniques in soil-plant-animal research; (c) forage-livestock ecology and systems in grazing lands (cropland, pastureland, rangeland, and forestland); (d) the role of forages in conservation practices, wildlife habitat, and sustainable agriculture; and (e) industries allied with forages and livestock. The objectives of the course are to provide students with an opportunity to: (1) experience first-hand the ecology of grazing lands in various ecoregions, and observe techniques to address the researchable needs, and (2) interact with individuals active in the areas of forage-livestock research, teaching, extension, industry and production. Instead of a textbook, students are given reading assignments to familiarize them with sites to be visited and professionals they will meet. The course requires students to: (a) participate fully in the two-week field trip with at least two multi-disciplinary faculty; (b) prepare a forage species collection of at least 50 plants accompanied by a description of each; (c) take notes during the course and write a trip report that summarizes information learned and descriptions of grazing lands systems observed; and (d) undergo an oral examination designed to facilitate summarizing and synthesizing the information gained on the trip. During the last four years (1998 - 2001), 46 students from 12 states in the US and 10 foreign countries (representing five American and two Mexican universities) have visited sites in Texas, Oklahoma, Kansas, Missouri, Nebraska, New Mexico, Arizona, Nevada, Utah, Florida, Georgia, Alabama, Tennessee, Virginia, Delaware, Maryland, Pennsylvania, South Dakota, Montana, Idaho, Wyoming, and Colorado.

Key Words: Ecosystems, Grazing systems, Experiential learning

661 SheepSim: Teaching genetic and economic management of a flock of sheep. M. L. Thonney*, K. T. Egan, and D. O. Maizon, *Cornell University, Ithaca, NY.*

SheepSim was developed to teach genetic and economic management of a flock for a course in sheep management and to enable potential farmers to evaluate economies of sheep farming. The economic component includes acres and yields of forages; amount and cost of buildings, equipment, fencing, and purchased feed; prices of lambs, sheep, and wool; and the cost of financing borrowed capital. The genetic component models litter size, birth weight, 60-d weight, mature weight and fleece weight for Dorset and Finnsheep breeds and their crosses along with the offspring of terminal Suffolk sires. The offspring genetic values are the average of their parents' genetic values plus a random term that models Mendelian segregation. Heterosis adds a constant value, which depends on the type of cross, to the phenotypic value. Fertility is dependent upon breed and season of the year defined by date in the northern hemisphere; death losses of lambs and adults are included in the simulation. The model operates in 73-d increments to allow simulation of the STAR management system with five lambing seasons per year. Four, 3, 2, or 1 lambing seasons per year can also be modeled. Although the simulation can be started with any reasonable number of Dorset and Finnsheep ewes and rams, the suggested starting numbers are 1 ram and 10 ewes of each breed to demonstrate how fast ewe numbers can be accumulated and to allow for crossbreeding. Additional breeding animals can be purchased and sheep can be sold at the end of each 73-d period. Economic information available after simulating one year shows the lambs born, lambs born alive, and lambs weaned per ewe lambing and includes an annual income statement showing current animal, building, and equipment inventory; sheep, wool, and hay sales; purchased feed; and cash and depreciation costs. Net farm income, return to unpaid operator's labor, capital, and management, and return to operator's labor and management are reported. Students change default values to fit a model farm that they operate for 10 to 15 years and write a report based upon tables and graphs they create from annual animal performance and economic information.

Key Words: Sheep, Management, Simulation

662 Meat judging as a learning tool: gender comparison. Paul Berg*¹, *North Dakota State University.*

Abstract: Discussion of differences between male and female students or workers range from arbitrary stereotypes to formal evaluation of performance. Meat judging tests a students' visual acuity, technical knowledge, application of logic, critical thinking, decision making and ability to communicate. Judging scores allow objective comparison of gender differences. Category (CAT) point (pt) totals between male (M) and female (F) contestants were evaluated for beef quality grading (QG),

yield grading (YG), fabrication specifications (SP), placing of classes (PL), reasons (RS) and total score (CN). Data were from the National Western (NW), Southeastern (SE), Iowa State Invitational (IS), American Royal (AR) and International (IN) contests from 1993 through 1999. A change in contest format in 2000 precludes addition of comparable data. A total of 2112 (1302 M and 810 F) observations were evaluated. Comparison by CAT revealed M advantage in YG (1.6 pt, $P=0.02$); SP (1.3 pt, $P=0.11$); PL (2.3 pt, $P=0.002$) and CN (1.0 pt, $P=0.66$). F advantage was shown in QG (0.2 pt, $P=0.71$) and RS (4.2 pt, $P=0.0001$). Contests are designed to be progressively more difficult. Difference between contests were significant ($P>0.001$). For QG, YG, RS, and CN a positive linear affect was shown ($P>0.001$). Cubic affects were observed for SP and PL ($P>0.001$). To test if the affect of the judging experience carries over into other academic areas, cumulative academic grade point averages (GPA) for judging team (JT) members were compared to a random sample of the general student population (RS) and to a random sample of scholarship athletes (SA). Comparison was based on individual students who matriculated and graduated from NDSU by academic year and gender. Academic status was determined by the number of completed class hours (ch) ($FR \leq 32$ ch, $SO \leq 64$ ch, $JR \leq 96$ ch, $GRAD > 128$ ch). GRAD GPA was higher than FR for all groups ($FR=2.79$, $SO=2.88$, $JR=2.92$, $GRAD=2.98$). Average GPA raised 0.18pt from FR to GRAD. Only JT students exceeded the average increase ($F JT = 0.24$ and $M JT = 0.22$ pt).

Key Words: meat judging, gender comparison

663 Travel as a teaching method. M.A. Russell^{*1}, M.A. Latour¹, J.C. Forrest¹, G.N. Hinch², and R.S. Jessop², ¹*Purdue University, W. Lafayette, IN*, ²*University of New England, Armidale, NSW, AU*.

Fieldtrips are well-known methods to gain exposure to resources not available on campus, however the travel time is often viewed as an obstacle, rather than a method. It is the purpose of this paper to share examples of the actual travel as a teaching method. The inclusion of travel experiences must match the specific learning objectives of the exercise. The Purdue University ANSC 181, "Orientation to Animal Sciences", includes an overnight industry trip with the objectives of social and academic integration of students into the university. Thus, students visit examples of production units, agribusinesses and just as importantly, become acquainted with each other on the trip. Both the University of New England AGEX 310, "Agricultural Extension" and Purdue ANSC 393 "Animal Industry Travel Course" are built around the travel experience of students with many assignments. Objectives not only include developing industry contacts, applying information and principles from classes, hearing philosophies of industry leaders, and seeing animal agriculture methods specific to different climates, but also written correspondence, public speaking, critical thinking, travel skills, and relationship building are expected outcomes. As globalization of agriculture increases both students and extension professionals need more international experiences and multicultural sensitivity education. Purdue's ANSC 295K, "Exploring International Animal Agriculture" adds to the above objectives the awareness of cultures, challenges, and agricultural practices in developing countries with the positive experience of international travel. Travel becomes a way for participants to know each other better, interact on a more personal level, and build relationships that are not possible in the classroom. Because technology transfer and content knowledge acquisition are not the only expected outcomes of education, travel can provide great opportunities if carefully planned to match learning objectives.

Key Words: Travel, International, Teaching

664 Recruitment value of an on-campus animal science youth program. J. S. McCann^{*1}, *The University of Georgia, Athens, GA*.

For the past six yr, the Animal and Dairy Science (ADS) Department invited youth who had actively exhibited livestock or horses to a two d

summer program called "Animal Science In Action" (ASIA). The goal of ASIA is to introduce the Animal and Dairy Science major as an area of study and the career options in the livestock industry. To enhance student comfort level of attending The UGA campus, students stayed in dormitories and interacted with faculty, graduate, and undergraduate students. Parents were invited to the initial and ending program sessions. Since the first ASIA in 1995, a variety of activities have been assessed. Youth experienced the evaluation and fabrication of carcasses; process of making hot dogs or hamburgers that students consumed; pig nursery practices and basics for moving pigs; ultrasound evaluation for pregnancy, loin eye size, or finish; ground driving or longing horses; working in the milking parlor; and visiting a cloning lab. Parents were more interested in the application and financial aid processes; thus, the program evolved to having separate parent sessions. A total of 373 high school students have attended the program with 51.2% being rising seniors, 44.5% rising juniors, and 4.3% rising sophomores. From the first four classes of ASIA, a mean 27.3% of the youth became UGA students. The ADS Department undergraduate numbers increased an average 61% above mean enrollment in 1992-1994. More importantly, the ADS undergraduate numbers have remained steady, averaging 155% above pre-ASIA years. The ADS students currently represent 16.3% of the College of Agriculture and Environmental Science (CAES), up from 10% of the CAES mean enrollment in 1992-1994. Comparing CAES fall 1995 to 2001 undergraduate enrollment, student enrollment decreased 26%. Surveys of 2001 participants indicated the overall educational value was 1.16 while their interest in studying ADS averaged 1.35 (scale from 1 to 5 where 1=strongly agree, 5=strongly disagree). In the wake of declining CAES enrollment, ASIA has helped the ADS Department grow and sustain undergraduate enrollment.

Key Words: Recruitment, Undergraduate

665 Participation by the Animal and Poultry Sciences Department in the University Core Curriculum. C. M. Wood^{*}, *Virginia Tech, Blacksburg, VA*.

In 1992, Virginia Tech implemented the University Core Curriculum (Core) to broaden the general education of all undergraduates. Two major changes from previous general education requirements were to define categories as Areas of Study rather than as departmental divisions, and colleges other than Arts and Sciences can offer core courses. All departments were required to have at least one in-major writing intensive (WI) course available for students entering the university in 1995. By 1999, the Core had been fully implemented. With 500 majors, the Department of Animal and Poultry Sciences (APSC) modified the required, two-credit Junior Seminar course to meet WI standards. Three to six sections of the course (15 students/section) are offered each semester. The choice presented two challenges. First was to convince the university that a two-credit course would suffice when the standard was three credits. The second was to coordinate the efforts of different instructors teaching multiple sections of the seminar so that student effort is equitable across sections. The APSC department has also gone beyond minimum compliance with the Core. In Fall 2001, the five senior-level capstone production courses gained approval as WI courses using the Writing Across the Curriculum model. Minimal modification of these courses was needed, but the challenge was to handle revision and response in large ($n=75$) classes. A college-wide course, Agriculture, the Arts and Society, was also developed by an APSC faculty member to meet Area 6 (Creativity and Aesthetic Experience) goals and gained core approval in 1999. That one-credit course is offered P/F and is open to 40 students per semester. It has been oversubscribed the past three semesters, and receives an average rating of 3.7/4.0 on student evaluations. Additionally, one APSC faculty member teaches a section of the required freshman biology course, which is included in Area 4 (Scientific Reasoning and Discovery) of the Core. In total, 14 APSC faculty teach in courses that fulfill Core requirements.

Key Words: Teaching, General Education, Writing Intensive

666 A survey of methods of analysis used for minerals in feedstuffs. Milan Ihnat*, *Agriculture and Agri-Food Canada*.

A wide range of minerals occur in feedstuffs as naturally-occurring and purposely added elements as well as by adventitious contamination. These mineral elements can generally be classified as nutritionally-essential major elements such as Na, K, Mg, Ca, N, P; nutritionally essential minor and trace elements: B, Si, F, V, Cr, Mn, Fe, Co, Cu, Zn, As, Se, Br, Mo, Sn, I; and those regarded as toxic or with an essential/toxic duality: F, V, Cr, Mn, Co, Ni, Zn, As, Se, Mo, Pd, Cd, Sn, Hg, Tl, Pb. A survey is presented of the state of the art regarding methods used for the determination of major, minor and trace elements in feedstuffs and related biological materials. Challenges posed by analytical endeavours in general, as well as challenges posed by some difficult-to-measure elemental analytes will be discussed. Currently available methods for determination of elements in feedstuffs and related materials include: atomic absorption spectrometry, atomic emission spectrometry, mass spectrometry, neutron activation analysis, X-ray emission spectrometry, molecular light absorption spectrometry, molecular fluorimetry, electrochemistry, Kjeldahl method for nitrogen, combustion elemental analysis, volumetry, ion chromatography and gravimetry. Attributes of currently available definitive, reference, routine, field, official, unofficial and recommended methods are reviewed as a basis for the formulation of recommendations of most suitable methods for feedstuffs. A summary is also presented of related work in progress to develop unified comprehensive, consolidated schemes of analysis utilizing widely utilized atomic absorption spectrometry and also the complimentary techniques of inductively coupled atomic emission and mass spectrometry for multielement measurement in biological materials.

Key Words: Minerals, Analytical methods, Feedstuffs

667 Challenges with nonfiber carbohydrate methods. and M. B. Hall*¹, ¹*Dept. of Animal Sciences, University of Florida*.

Nonfiber carbohydrates (NFC) not found in neutral detergent fiber (NDF) encompass a compositionally and nutritionally diverse group. They have often been described with a single value estimated by difference as 100% of dry matter # crude protein (CP) # NDF # NDFCP - ether extract # ash. A calculated value was used because of difficulties with the assays for individual NFC; it does not differentiate among nutritionally distinct NFC. Errors in NFC estimation can arise from not accounting for CP in NDF, and when multipliers other than 6.25 are appropriate to estimate CP. Analyses that begin to distinguish among NFC are those for starch, soluble fiber, and sugars (mono- and oligosaccharides). Many starch analyses quantitate alpha-glucans through specific hydrolysis of alpha (1->4) and (1->6) linkages in the glucan, and measurement of released glucose. Incomplete gelatinization and hydrolysis lead to underestimation of starch content. Use of enzymes preparations that hydrolyze carbohydrates other than alpha-glucan, measurement of all released monosaccharides without specificity for glucose, and failure to exclude free glucose present in the unhydrolyzed sample inflate starch values. Soluble fiber analyses can err in a fashion similar to NFC if correction for CP requires multipliers other than 6.25, or if contaminants such as CP and starch have not been properly accounted. #Sugars# have been defined as carbohydrates soluble in 78 # 80% ethanol, which separates them from the polysaccharides. They can be measured in extracts using broad spectrum colorimetric assays (e.g., phenol-sulfuric acid assay, and acid hydrolysis of the extract with reducing sugar analysis), or chromatographic methods. Colorimetric assays do not differentiate among mono- and oligosaccharides. The results of the phenol-sulfuric acid assay rely on selection of a sugar standard that reflects the predominant sugar in the sample. Reducing sugar analysis without acid hydrolysis measures only monosaccharides. HPLC can differentiate among various mono- and disaccharides; many larger oligosaccharides often lack appropriate carbohydrate standards. Current methods for NFC can separate nutritionally relevant fractions, but care needs to be taken to assure accurate measurement.

Key Words: NFC, carbohydrates, methods

668 Challenges with insoluble fiber methods. D.R. Mertens*¹, ¹*US Dairy Forage Research Center, Madison, WI*.

Insoluble fiber is an important criteria of nutritional quality because it is related to digestibility and energy value. The challenge with fiber methodology is to select those that are relevant and reproducible. Without relevance there is no purpose in measuring fiber, and without reproducibility there is no practical value in measuring it. For routine analysis, fiber methods must not only satisfy nutritional and analytical criteria, but also be convenient and economical. Fiber is unique among nutrients because it is defined in nutritional terms, but is determined using chemical, physical or enzymatic techniques. Laboratory analysis of insoluble fiber can be divided into: those that measure chemical entities, those that measure biological or enzymatic entities, and those that measure empirical entities. Crude fiber is a purely empirical method in which fiber is defined by the method. It fails to recover lignin and many components of fiber that affect nutritive value. Its status as a legal definition of fiber should be abolished. Dietary fiber that is measured by enzymatic or in vitro methods is applicable only for the animal system it was designed to mimic, and are typically difficult to reproduce among laboratories. Chemical methods of determining fiber vary considerably in approach. Some methods use extraction, hydrolysis and sugar residue analysis to quantify specific groups of insoluble polysaccharides. Others use detergents to measure cellulose, hemicellulose and lignin more directly using chemical solubility. The first approach provides more detailed and specific information, but requires more time and expense. The latter is rapid, but less specific. Both are somewhat empirical because the conditions of extraction, hydrolysis, and measurement must be followed exactly to obtain repeatable and reproducible results. Fiber analyses are of unequal value in providing useful nutritional information, and no single analysis can explain the entire complexity of nutritive value. Selection of appropriate insoluble fiber methods will always be a compromise between nutritional relevance and analytical convenience and reproducibility.

Key Words: fiber, feed analysis

669 Challenges with fats and fatty acid methods. D. L. Palmquist*¹ and T. C. Jenkins², ¹*Dept. of Animal Sciences, The Ohio State Univ., Wooster*, ²*Dept. of Animal and Veterinary Sciences, Clemson Univ., Clemson, SC*.

The content and chemical nature of lipids in feedstuffs is heterogeneous. It has long been known that ether extraction by the Weende procedure inadequately characterizes fat content of feedstuffs, yet it remains the official method. Diethyl ether (or hexanes that are often used) extracts significant amounts of non-nutritive, non-saponifiable lipids from forages, and often incompletely extracts lipids of nutritional value, especially fatty acids present as salts of divalent cations. Pre-extraction hydrolysis of insoluble fatty acid salts with acid releases these fatty acids, and this step is included in the official procedure for certain feedstuffs in the UK. However, acid hydrolysis increases analysis time, decreases precision, and increases extraction of non-nutritive materials. Acid hydrolysis also causes confusion as to the proper definition of the fat content of feedstuffs. A preferred method of fat analysis determines the total fatty acid concentration in feed samples by converting fatty acid salts, as well as the acyl components in all lipid classes, such as triacylglycerols, phospholipids, and sphingolipids, to methyl esters using a simple, direct one-step esterification procedure. Fatty acid methyl esters are then quantified by gas-liquid chromatography, which provides information on both fatty acid quantity and profile in a single analysis. Adjustments in conditions and reagents may be necessary to overcome difficulty in quantitatively preparing esters from certain types of fatty acids and their derivatives in commercial fat supplements. After correction for glycerol content, analysis of oils by this procedure provides information on the content of non-saponifiable material, such as chlorophyll, waxes and indigestible polymers formed from heat- or oxidatively-damaged fats. The correct description of feedstuffs for nutritive value of fats is the content of total fatty acids.

Key Words: Analysis, Fat, Fatty acids

670 Challenges and new opportunities in the analysis of raffinose oligosaccharides, phytate and glucosinolates. D. Vinjamoori*, P. Das, and T. Hayes, *Monsanto Co., St. Louis, MO/USA.*

Oligosaccharides of the raffinose series are major components in many grain legumes and are implicated in causing flatulence and diarrhea for both humans and livestock, as they are not hydrolyzed in the upper gut due to the absence of alpha-galactosidase enzyme. Phytic acid has been identified, as an antinutritional factor of soybean since it can reduce the bioavailability of some essential metals and phosphorous because of the formation of insoluble chelates that cannot be absorbed by the intestine under normal physiological conditions. Phytic acid has also been shown to inhibit the action of some important proteins such as trypsin, alpha-amylase and pepsin during digestion. Glucosinolates derived from Brassica species have been clearly shown to have deleterious effects such as reduced fertility and induction of goitrogenic effects in live-stock, premature death in rats and damage to vital organs stemming from the interference with the thyroid

In this presentation we will review the current status of the analytical technologies for the assays of raffinose oligosaccharides, phytic acid and glucosinolates in terms of selectivity, sensitivity and sample throughput. Implementation of innovative sample preparation schemes, use of novel separation approaches and alternate detector technologies will be presented. The challenges and opportunities posed by these assays will be highlighted along with the recommendations for best analytical practices.

Key Words: Raffinose, Phytate, Glucosinolates

ARPAS-FASS Symposium ARPAS-FASS Symposium on Animal Care Training and Certification for Research Facilities and Commercial On-Farm Assessment Programs

672 ARPAS Animal Care Certification Program. J.C. Swanson*¹, ¹*Kansas State University.*

Research and teaching institutions are required to meet training mandates for animal care workers and professionals. The *Guide for the Care and Use of Agricultural Animals In Agricultural Research and Teaching* states "It is the responsibility of the institution to ensure that scientists, agricultural animal care staff, students, and other individuals who care for or use agricultural animals are qualified to do so through training or experience." Although the American Association for Laboratory Animal Science offers certification at the level of technician and technologist for laboratory animal personnel, no program exists specific to agricultural animal care. The American Registry of Professional Animal Scientists (ARPAS) is developing a certification program specific to agricultural animal care at the professional and technician level. This program is being developed in conjunction with the Federation of Animal Science Societies' development of training modules for the different agricultural species.

Key Words: Animal care, Training, Certification

673 The ARPAS - FASS - AAA Animal Care Project. K.E. Olson*¹, B.R. Baumgardt², C.L. Sapp³, and B.P. Glenn³, ¹*KEO Consulting*, ²*American Registry of Professional Animal Scientist*, ³*Federation of Animal Science Societies.*

Animal care is an issue of increasing importance to consumers and to retailers. Most species have developed quality assurance programs or best management practices that include animal care guidelines, but in most cases consumers are unaware of these efforts and their use is not documented. The Animal Agriculture Alliance (AAA) is a relatively new organization whose mission is to support and promote animal agriculture practices that provide for farm animal well-being through sound science and public education. It is recognized that for a program to be credible with the public it must be based on sound science and be verifiable.

671 Challenges in measuring moisture content of feeds. N. Thiex*¹ and C. R. Richardson², ¹*South Dakota State University, Brookings, SD*, ²*Texas Tech University, Lubbock, TX.*

Accurate determination of the moisture (water) content in individual feed ingredients and mixed feeds is important, but often the analytical methods used differ greatly in effectiveness resulting in over or under evaluation. Bias in measuring the water content of feedstuffs directly effects accurate quantification and expression of other nutrient values and ratios. Factors affecting accurate determination include: range in moisture content, sampling of feedstuffs, transport and storage of laboratory samples, loss of volatiles other than water, and choice of analytical method. Several methods in use to determine apparent water content of feedstuffs are empirical, estimating water by loss of weight on drying, while other methods measure water directly. Poor agreement among laboratories and among methods is illustrated in results of moisture determinations reported to the American Association of Feed Control Officials Check Sample program and in the National Forage Testing Association Proficiency Testing program. Oven drying methods and a Karl Fisher method were compared in this study using forage and dried, ground animal feed. Forages tested included hay, haylage, and corn silage while feeds included various sources of mixed feed with and without urea. Oven drying of forages, compared to the Karl Fischer method, yielded recoveries for hay, haylage, and corn silage, respectively, as follows: 135° C for 2 h # 113%, 162%, and 133%; 104° C for 3 h # 96%, 122%, and 113%; 104° C for 6 h # 97%, 129%, and 117%. Mixed feeds yielded recoveries for non-urea and urea containing feed, respectively, as follows: 135° C for 2 h # 116%, and 2746%; 104° C for 3 h # 88%, and 239%; 95° C for 5 h under vacuum 83%, and 727%; 104° C for 6 h # 90%, and 427%; 110° C for 3 h # 94%, and 425%. NIR calibrations for water (moisture) based on the Karl Fischer method were ($r^2 = 0.98$; SEC = 0.20). In conclusion, a need to evaluate and improve moisture methods, and standardize practices in laboratories is apparent.

Key Words: Moisture, Oven Drying, Karl Fischer

AAA has identified six basic animal care principles felt to be critical in assuring animal well-being. They have contracted with the ARPAS and FASS to develop criteria and a process for evaluation of species specific farm-animal well-being guidelines to assess their compliance with these principles. Submitted programs that comply will be recognized. To the extent possible, quantifiable measures are used to assess compliance.

A two step process has been used in this project. Initially a steering committee, comprised of individuals with scientific backgrounds related to the species being evaluated, as well as others with expertise in animal behavior, veterinary medicine, engineering, transportation and handling, ethics, and consumer interests, developed an umbrella set of criteria for use with all species. Next, species specific subcommittees, comprised of individuals with expertise in each of the species, identified science based numeric ranges and other measures appropriate for assessing care within their species. The species reports are reviewed by the steering committee to provide the greatest consistency possible. Initial species included beef, broilers, dairy, layers, pork, sheep and turkeys. Species programs will be submitted for review and recognition of compliance. This process assures consumers that all species are being evaluated in a similar manner, buyers that there will be consistency in assessments by different individuals, and producers that the evaluations are based on the best science available.

Key Words: Animal Care, Consumers, well-being

Food Safety

Interventions and Future Directions in Food Safety

674 Preharvest intervention strategies to reduce food borne pathogens in food animals. T. R. Callaway*, R. C. Anderson, T. S. Edrington, R. O. Elder, K. J. Genovese, K. M. Bischoff, T. L. Poole, and D. J. Nisbet, *Agricultural Research Service/USDA, Food and Feed Safety Research Unit, College Station, TX.*

Annually, food borne pathogenic bacteria sicken more than 76 million Americans. Many of these illnesses are caused by consumption of foodstuffs produced from animals. Although post harvest intervention strategies are targeted at reducing bacterial contamination from the abattoir to the table, foodborne illnesses deaths still occur, suggesting that preharvest intervention strategies are needed to effectively reduce human foodborne illness. Several preharvest intervention strategies have been contemplated and are currently under investigation. Potential strategies to be discussed include vaccination, competitive exclusion, substrate-adapted competitive exclusion, the use of probiotics and prebiotics (e.g., fructooligosaccharides). Other strategies such as the use of bacteriophage to specifically target certain pathogenic bacteria, and the exploitation of the physiology of specific pathogens, the use of antibiotics to reduce specific pathogens, as well as the effects of management strategies (e.g., dietary changes, transportation and stress) will also be discussed. The use of preharvest intervention strategies at multiple critical control points can potentially reduce the incidence of human food borne illnesses by erecting multiple hurdles against entry of pathogens into the food chain.

Key Words: Preharvest Food Safety, Intervention Strategies, Pathogen Reduction

675 Practical preharvest food safety interventions for dairy production. P.L. Ruegg*, *University of Wisconsin, Dept. of Dairy Science, Madison, WI.*

Consumers are increasingly concerned about the safety of their food and uncertain about food production practices. Apprehension regarding potential liability from illnesses related to consumption of tainted food products has some food retailers considering the extension of HACCP programs to farm production units. Potential threats to human health related to dairy products and dairy farming include: errors in pasteurization, consumption of raw milk products, contamination of milk products by emerging heat resistant pathogens, emergence of antimicrobial resistance in zoonotic pathogens, chemical adulteration of milk, transmission of zoonotic pathogens to humans through animal contact and foodborne disease related to cull dairy cows. Most dairy farmers feel

responsible for the safety of milk and beef that originate on their farms but linkage between farm production practices and the quality of processed products have been weak. The safety of dairy products can be enhanced by adoption of a number of management practices. All animals should be identified and accounted for throughout their life cycle and farmers must take responsibility for the market cattle leaving their farms. Systematic procedures that divert diseased animals and adulterated or abnormal milk from the marketing chain must be in place on all farms. Many potential pathogens are shed in feces and fecal contamination of milk products, carcasses and animal facilities and equipment must be minimized. The inappropriate or prophylactic use of antimicrobial agents must be minimized to ensure that antimicrobial resistance does not develop in animal pathogens. Consumers can have confidence in food safety programs on dairy farms that promote awareness and accountability for the products that are produced.

Key Words: Food Safety, Dairy Production, Zoonotic Disease

676 Effective methods for postharvest intervention in dairy processing. J. R. Stabel*¹, *USDA-ARS, National Animal Disease Center, Ames, IA.*

Food safety has become a top priority for regulatory agencies in the US. Illness and/or death due to contamination of food products with zoonotic pathogens is rare in the US but does occur. Recent outbreaks of Bovine Spongiform Encephalopathy and Foot and Mouth Disease Virus (FMDV) in the UK have raised concerns about contamination or transmission of pathogens from farm animals to consumers. Raw milk contains a number of pathogens and the potential is high for these pathogens to cause disease in consumers if the milk is not adequately treated to destroy or reduce the pathogen load. Proper intervention methods during the processing of food products significantly reduce the risks of transmission of infectious agents from the farm to the table. This paper will summarize methods of intervention used by dairy processing plants to improve the safety of dairy products for consumers. Methods include inactivation by heat (pasteurization and ultra-high-temperature); high hydrostatic pressure; irradiation and fermentation. Efficacy of these methods for inactivation of pathogens such as *Listeria*, *Yersinia*, *Salmonella*, *E. coli*, Bovine Leukemia Virus, FMDV and *Mycobacterium paratuberculosis* will be summarized. The potential for contamination of dairy products to occur post-processing in the dairy plant environment will also be discussed.

Key Words: Dairy products, Pathogens, Intervention methods

Growth and Development

Skeletal Muscle Plasticity, Development, and Hypertrophy

677 Importance of muscle fiber types in animal agriculture. D.E. Gerrard* and A.L. Grant, *Purdue University, West Lafayette, IN USA.*

Adult skeletal muscle is a mosaic collection of muscle fiber types. There are four different muscle fiber types in porcine skeletal muscle, which are slow-oxidative or type 1, fast oxido-glycolytic or type 2A, and fast glycolytic 2X(D) and 2B fibers. This type of classification scheme is based solely on the different types of myosin heavy chain isoforms that predominate a given fiber type. Muscle fiber types are extremely sensitive to a myriad of physiological, environmental and cellular stimuli. Depending on the type and duration of a stimulus, muscle fibers can react by changing their contractile and metabolic capabilities. Therefore, fiber type composition in skeletal muscle is considered rather plastic in nature. From an agronomic standpoint, many production systems and programs provide sufficient stimuli to change muscle fiber type composition and, as a result, may alter production efficiency of the whole animal. After a discussion regarding muscle fiber typing and nomenclature, data regarding the effect of various production practices that change muscle fiber type will be explored. Furthermore, the role fiber type may play in controlling the development of meat quality will be discussed. Understanding how muscle fiber type is altered by various

stimuli may provide meaningful insights into how animal growth performance and meat quality can be improved.

Key Words: Muscle, Growth, Fiber type

678 Heterogeneity of protein expression within muscle fibers. Everett Bandman¹ and Benjamin W.C. Rosser*², ¹*University of California, Davis, CA USA*, ²*University of Saskatchewan, College of Medicine, Saskatoon, Saskatchewan, Canada.*

Skeletal muscle fibers are elongated multinucleated cells. Along its length an individual muscle fiber may contain thousands of myonuclei, each controlling protein synthesis within its surrounding cytoplasm. Thus a muscle fiber can be considered a series of nuclear domains, each responding to distinct localized signaling mechanisms that may result in differential gene expression within a single fiber. This presentation examines a number of phenomena that result in distinct subsets of proteins accumulating within different regions of a muscle fiber during growth and development. These include changes in protein expression associated with muscle maturation, denervation, and activity induced fiber type transformation. Myosin heavy chain proteins are a fundamental structural and functional component of muscle fibers that are represented by different isoforms, each of which is the product of a separate gene that may be differentially expressed during development of distinct

muscle fiber types. We have found that in adult chicken pectoralis muscle, the tapered ends of fibers contain the neonatal myosin heavy chain isoform in addition to the adult isoform found throughout the length of the fiber. We have made similar observations studying mature pigeon muscle. Examination of serial sections along the length of muscle fibers of chicken pectoralis at different stages of development, illustrated that the transition from the neonatal to adult myosin heavy chain isoform proceeds as a gradient from the centrally located motor endplate towards the ends of a muscle fiber. Additional evidence demonstrates differences in the amount of cytoplasm per nucleus at the ends of chicken pectoralis muscle fibers throughout development. In denervated adult fibers, those myonuclei furthest from the endplate are the first to re-express neonatal myosin. We examine the hypothesis that during development neonatal myosin is initially suppressed near the motor endplate and that trophic factors emanating from the vicinity of the motor endplate represent a potential localized signaling pathway that may differentially modulate myosin heavy chain gene expression in nuclear domains along the length of the muscle fiber.

Key Words: Skeletal Muscle, Myosin, Heterogeneity

679 Calcineurin and NFAT signaling in myogenesis.

G.K. Pavlath*, *Emory University, Atlanta, GA USA.*

Adequate muscle mass is crucial for the maintenance of functional muscle tissue. However, the signaling pathways that control muscle growth are unclear. The nuclear factor of activated T cells (NFAT) proteins are a family of transcription factors whose activation is controlled by calcineurin, a Ca^{2+} dependent phosphatase. Calcineurin and NFAT have distinct functions in multiple steps of myogenesis. Several NFAT isoforms are expressed in skeletal muscle. However, individual NFAT isoforms are activated during different stages of muscle development. Specifically, the NFATC2 isoform is activated only in newly formed myotubes. We have shown that adult NFATC2^{-/-} mice exhibit reduced muscle size due to a decrease in the cross sectional area of individual myofibers, suggesting that muscle growth is blunted. The growth defect is intrinsic to muscle cells as the lack of NFATC2 in primary muscle cultures results in reduced cell size and myonuclear number in myotubes. These results implicate a novel role for the transcription factor NFATC2 in regulating skeletal muscle growth. Additional evidence suggests that NFATC2 either directly or indirectly regulates the expression of a secreted molecule that regulates muscle growth. Media conditioned by wild-type myotubes contains bioactivity that can rescue

the reduced cell and myonuclear number defect of NFATC2^{-/-} muscle cells. IGF-1, a known regulator of muscle growth, does not mimic the effects of conditioned media. Biochemical characterization and fractionation of conditioned media from wild-type myotubes suggests that the factor is heat and protease sensitive with a molecular weight around 10kD. These studies may lead to the identification of novel factors that regulate muscle growth. Such factors may be useful for inducing muscle growth during periods of muscle loss associated with disease, disuse, or aging.

Key Words: muscle growth, growth factors, calcineurin

680 Calcineurin signaling in skeletal muscle growth.

R.N. Michel*, *Laurentian University, Sudbury, Ontario, Canada.*

The adult motor nerve confers to its target skeletal muscle fibers distinct morphological, biochemical and functional characteristics. This is not only achieved via nerve-mediated electrical activation signals but also by means of nerve- and muscle-derived trophic mechanisms. Though our understanding of these neural influences is rudimentary there is mounting evidence that the calcium/calmodulin-dependent phosphatase calcineurin is an important molecular signaling intermediate in this modulation. Specifically, calcineurin appears as a crucial link between upstream activity-related effectors and its specific downstream targets involved in the regulation of the muscle cell phenotype, and in particular, cellular size. Though the positioning of calcineurin at the nexus of growth is currently under debate (S. Dunn, A. Simard, R. Prudhomme and R.N. Michel, *Nature Cell Biology* 4: E46-47, 2002), its role in modeling skeletal muscle phenotype is uncontested. In this presentation, I will: 1) define the role of calmodulin-calcineurin signaling in the modulation of size and phenotype of all (fast and slow) skeletal muscle fiber types and in the promotion of satellite cell differentiation *in vivo*, 2) provide insight into the contribution of neural-linked upstream signaling and contractile loading factors in the activation of the calcineurin pathway, specifically our model of 'frequent muscle usage' above 'native' muscle activity levels as a prerequisite for calcineurin signaling, 3) provide evidence for the contribution of parallel signaling pathways cooperating with calcineurin during growth, and 4) identify the cellular substrates and gene targets of this phosphatase. Supported by NSERC Canada.

Key Words: nerve activity, cell signaling, muscle phenotype

Horse Species

Horses: Livestock Versus Companion Animals - Implication for Animal Agriculture

681 Horses ARE companions, but...

M.A. Russell*, C.M. Brady, E.A. Pajor, and A.M. Beck, *Purdue University, West Lafayette, IN USA.*

Internationally, horses have a strong affiliation with agrarian life and serve humans as food, war machines, transportation, and beasts of burden. They are included in Webster's definition of livestock: "domestic animals, such as cattle, horses, sheep, hogs, or goats, raised for home use or for profit". Many farmers, cowboys, and cavalry soldiers consider their horses as their co-workers and faithful companions. In North America, only 10-20% of the horses are owned with a commercial industry or profit motive (AHC, 1999) with availability of discretionary income determining the demand for horses. This is a function of the general, not the agricultural economy, and input suppliers and veterinarians will confirm that the majority of horseowners approach expenditures with a mentality more similar to cat or dog owners than to production farmers. Beck and Katcher (1996) reported that 87% of US Pony Club members surveyed responded that horses were part of the family and Melson (2001) reported that children "liked their horse better than a good friend". Webster defines pet as "any object kept for the affection, an animal kept for amusement or companionship, something cherished or a favorite". In interviews with youth ages ten to fourteen, 75% indicated that when they were upset they turned first to their horses (Covert et al., 1985). So are horses companion animals? They are big business! There is no doubt about the companion relationship between most horseowners and their horses, but politically we want to maintain the connection and importance of the horse industry to the agricultural business sector and heritage. There are justifiable legal, political, and economic reasons

for this position, however, the future viability of departments of animal sciences and veterinary medicine depends on how they respond to the changing demographics of our society. We must relate to an increasing number of people in a companion relationship with their animals in order to attract youth to our scientific disciplines, whether we wish to call them livestock or not.

Key Words: Companion animals, Horses

682 The California perspective- politics, reality, and society.

C. Stull*, *University of California, Davis, CA.*

Of the estimated one million horses residing in California, more than 3,000 were shipped out of state in 1997 for slaughter and sales as horse-meat for human consumption. Public opinion polls showed that California voters overwhelmingly oppose horse slaughter and oppose eating horse meat. A grass-roots organization, "Save the Horses," was founded to expose the "horrors" of horse slaughter. The Save the Horses proponents developed Proposition 6 for the November 1988 California ballot, which was successfully passed by 60 percent of the voters. Proposition 6 was entitled "Prohibition of Horse Slaughter and Sale of Horsemeat for Human Consumption Act of 1998," and made it a felony to possess, transfer, receive or hold any horse, pony, burro or mule with intent to having it killed for human consumption. Sale of horse meat is prohibited as a misdemeanor offense, with subsequent violations punishable as felonies. Arguments for supporting Proposition 6 contend that historically human beings and horses have enjoyed a special relationship, and believed Californians want to protect their companion and recreational

animals from slaughter for human consumption, as has been prohibited legally in the state for cats and dogs. Interestingly, the supporters considered horses as livestock and part of agriculture, but not food animals. The direct impact of Proposition 6 has not been extensively analyzed, but no violations have been recorded. Since 1991, the California Department of Food and Agriculture had the authority to enforce the California Equine Protection Act which included mandatory inspection of all horses leaving the state for slaughter. This program was designed to assist in detecting and recovering stolen horses, and more than 50 horses were recovered through the program in 1997. Since the passing of Proposition 6, this program has been dissolved, thus eliminating this mechanism to recover stolen or missing horses. Other impacts of Proposition 6 are less easily evaluated such as the shipment of horses to slaughter through diverted channels in neighboring states, an increase in the number of abandoned or neglected horses, unacceptable methods of carcass disposal, and the comparatively lower residual value of unwanted or unusable California horses.

Key Words: Horses, Livestock, Welfare

683 Value added equiculture: metamorphosis from livestock to companion. D. S. Kronfeld*, *Virginia Polytechnic Institute and State University.*

Equiculture has two parts. The primary industry of horse production fits into agriculture. The secondary industry of horse utilization fits into recreation. A value-added benchmark is the 5-fold factor for food in the USA; its value is about 2% of the GNP at the farm gate and about 10% at the human mouth, the added value coming from processing and distribution. The potential for recreation adds much value to horse production. A sound 2-y old Thoroughbred worth \$500 of beef-equivalents is commonly worth \$2500 for use as a companion animal, 10-times that for sports, 100-times for racing. These factors represent added value at the farm gate, with the economic flux of recreation yet to come. During their agricultural phase, horses are managed as grazing livestock by farmers who regard animals as economic commodities. Care involves improving welfare. During their recreational phase, however, horses are treated as pets by their owners, who often cater to the whims of the animal. Care concerns welfare and the animal's intrinsic rights. These are not the hard rights of extremists but the soft, usually unspoken rights awarded by most people who regard their animals as children and obtain more pleasing performance when recognizing self-awareness and self-interest. This metamorphosis of owner attitude adds value and must be observed by all who serve these owners, such as animal scientists, veterinarians, county wardens, lawyers and legislators. A critical point is reached at the time of disposal, when the horse is no longer serving the best interests of its owner or itself. Is our horse now livestock or pet? Humane societies take dead aim at the disposal of horses as livestock, promulgating horror stories about transport and slaughter. Humane societies also dispose of hundreds of thousands of unwanted dogs and cats in decompression chambers. Would they also decompress horses? More humane methods of euthanasia are approved by the AVMA. Retirement farms postpone the end, but they are expensive and natural death is seldom serene. The equine metamorphosis adds value but hurts at the terminus.

Key Words: equiculture, livestock, pet

684 Evaluation of an introductory course in therapeutic horseback riding at Mississippi State University. M.C. Nicodemus* and K.M. Holt, *Mississippi State University, Mississippi State, MS/USA.*

With the increased popularity in equine facilitated activities as related to the disabled community, 28 colleges and universities throughout the United States have implemented some form of formal coursework in this new area of equine sciences. Introduction to Therapeutic Riding, ADS 3233, was introduced to the Mississippi State University equine curriculum in the fall of 2001. The three credit hour class included both lecture and riding labs, which aimed to cover various physical and psychological disabilities and different equine activities that addressed the needs of these disabilities. Six students participated in the class (Females: 4; Males: 2) with all pursuing an animal science degree (Bachelors of Science: 5; Masters of Science: 1). All had some form of riding experience and 5 students had volunteered at active therapeutic riding programs. Students answered a 22-question survey on the first (S1) and last (S2) days of class with answers consisting of strongly agree (SA), agree (A),

disagree (D), or not applicable (NA). For S1, D was given for 7 of the questions for the majority of the students (67%). Students disagreed with the statements that their confidence were strong in the areas of setting up various therapeutic riding programs, working with the medical and educational community, selecting and training therapeutic riding horses, and finding therapeutic riding resources. Concerning these same questions in S2, 67% of the students either answered SA or A. According to S2, all students indicated a desire to participate in a therapeutic riding program and 33% planned to make a career in this field. 67% of the students suggested more hands-on equine activities for future classes. However, the largest shift in answers from S1 to S2 was in their confidence level concerning the selection and training of therapeutic riding horses (S1: 4 D; S2: 4 SA). From these surveys, development in the course curriculum for this new class can be made to better address the educational needs of the students. This course curriculum will be used as a future guideline for other universities developing a therapeutic riding program.

Key Words: Equine Facilitated Activities, Therapeutic Horseback Riding, Undergraduate Equine Curriculum

685 Dietary grain and endurance exercise. R. M. Hoffman^{*1}, T. M. Hess¹, C. A. Williams¹, D. S. Kronfeld¹, K. M. Griewe-Crandell², J. E. Waldron³, P. M. Graham-Thiers⁴, L. S. Gay¹, K. E. Saker¹, and P. A. Harris⁵, ¹*Virginia Polytechnic Institute and State University, Blacksburg, VA*, ²*High Meadows Farm, The Plains, VA*, ³*Rectortown Equine Clinic, Rectortown, VA*, ⁴*Virginia Intermont College, Bristol, VA*, ⁵*WALTHAM Centre for Pet Nutrition, Melton Mowbray, UK.*

Our objective was to observe metabolic and oxidative stress in horses in an 80 km ride, using a 2x2x2 factorial design with grain (<12% versus >17% intake), dietary vitamin E versus vitamins E plus C, and potassium-free electrolyte replacement versus commercial electrolytes with potassium. Methods and results are described in this paper and in two companion papers (Hess et al.; Williams et al.). Blood samples were taken before the race, at veterinary checkpoints 21, 37, 56 and 80 km, and 20 min after finishing. Riders scored horse intakes of food and water at stops, and assigned a performance score. Glucose, electrolytes, partial pressures of oxygen and carbon dioxide, urea, hematocrit, pH, α -tocopherol, ascorbate, creatine kinase (CK), aspartate amino transferase (AST), lactate, total protein, albumin, creatinine, cortisol and lipid hydroperoxides (LPO) were analyzed in plasma; glutathione and glutathione peroxidase (GPx) in erythrocytes. Of 46 horses to start, 34 finished, and only their data are used here. During exercise, cortisol, sodium, magnesium, lactate, hematocrit, urea, total protein, creatinine, CK, AST, LPO and GPx increased. Glucose, pH, α -tocopherol, chloride and calcium decreased. Hematocrit and lactate were higher ($P = 0.010$) in the fastest horses. Slower horses had lower pH ($P = 0.010$), cortisol ($P = 0.038$), and drank less ($P < 0.0001$) at the finish. Food intake was lower overall ($P = 0.014$) in the fastest horses fed high grain. Performance score was correlated negatively with plasma cortisol, urea, CK, AST, LPO, and positively with glucose.

Key Words: Horse, Endurance exercise, Nutrition

686 Oxidative stress and antioxidant supplementation in horses during a competitive endurance ride. C.A. Williams^{*1}, R.M. Hoffman¹, D.S. Kronfeld¹, T.M. Hess¹, J.E. Waldron², R.K. Splan¹, K.E. Saker¹, and P.A. Harris³, ¹*Virginia Polytechnic Institute and State University, Blacksburg, VA*, ²*Rectortown Equine Clinic, Rectortown, VA*, ³*WALTHAM Centre for Pet Nutrition, Melton Mowbray, U.K.*

This study investigated if antioxidant supplements influenced antioxidant status and oxidative stress during endurance exercise. A pre-competition survey enabled 46 horses to be paired by nutrition and performance then randomly assigned to two groups. Three weeks prior to the competition, one group (E) was orally supplemented with 5,000 IU vitamin E/d, the other group (EC) with 5,000 IU vitamin E plus 7 g vitamin C/d. The ride covered 50 miles of terrain ranging from 400 to 1400 ft elevation. Blood samples, temperature and heart rate, were taken the day before the race (PRE), 13 and 35 miles during the ride, at completion (50 miles), and after 20 min of recovery (REC). Plasma lipid hydroperoxides (LPO), α -tocopherol (α -TOC), ascorbate (ASC), creatine kinase (CK), and aspartate aminotransferase (AST), erythrocyte

total glutathione (GSH) and glutathione peroxidase (GPx) were analyzed. Thirty-four horses completed the race with the remaining horses not finishing for reasons including lameness, metabolic problems, and rider option. Treatment, distance, and placing were evaluated by analysis of variance in a mixed model with repeated measures. Treatment and placing had no significant effect ($P > 0.05$). Heart rate, temperature, CK (PRE 228.5 ± 21 IU/L), AST (PRE 279.3 ± 11 IU/L), GPx (PRE 46.9 ± 1.5 μ U/mg protein) and LPO (PRE 8.2 ± 1.0 μ M) increased, where GSH (PRE 118.1 ± 4.9 μ U/mg protein) decreased with distance ($P < 0.0001$). Linear regressions were found for plasma CK ($r = 0.25$; $P = 0.001$), and AST ($r = 0.33$; $P < 0.001$) on LPO. These regressions establish an association between muscle leakage and a cumulative index of oxidative stress. With the parameters measured no advantage was found for EC over E; however comparable studies have findings been inconsistent with these results.

Key Words: Glutathione, Lipid hydroperoxides, Vitamin E

687 Endurance exercise: is potassium supplementation beneficial? T.M. Hess^{*1}, R.M. Hoffman¹, J.E. Waldron², P.M. Graham-Thiers¹, C.A. Williams¹, K. Greiwe-Crandell¹, D.S. Kronfeld¹, and P.A. Harris³, ¹Virginia Polytechnic Institute and State University, Blacksburg, VA, ²Rectortown Equine Center, Rectortown, VA, ³WALTHAM Centre for Pet Nutrition, Melton Mowbray, UK.

Many clinical signs evaluated by veterinarians during endurance races are manifestations of increased neuromuscular excitability. The resting potential is mainly dependent on K^+ distribution across the cell membrane, so that neuromuscular excitability increases when K^+ is extruded from muscle cells during exercise. Plasma $[K^+]$ is increased during long exercise at speeds of 4 m/s or greater. Therefore we tested a K-free electrolyte mixture (EM-K) versus commercial mixtures rich in K in a 50-mile race. Of 46 riders, 22 used commercial mixtures (CON), 24 EM-K. Blood samples were taken from the jugular vein the day before, just prior to the start, immediately after each horse arrived at the veterinary checks at miles 13, 23, 35 and 50 and 20 minutes post race. Samples were kept on ice for less than 60 min before analysis for pH, carbon dioxide and oxygen, and electrolytes (Stat Profile M Blood Gas Electrolyte Analyzer, Nova, Waltham, MA). Effects of time (or distance), treatment (CON vs EM-K) and their interaction were evaluated by ANOVA in a mixed model with repeated measures applied to 34 horses that finished the race. During exercise, plasma $[H^+]$ increased and greater increases were associated with lower performance. Increases were also found in plasma concentrations of Na^+ , K^+ , Mg^{++} , lactate⁻, and HCO_3^- ; decreases in Cl^- , and Ca^{++} . Comparing EM-K to CON, plasma $[H^+]$ was 3% lower at 23 miles ($P=0.10$), 35 miles ($P=0.075$) and 50 miles ($P=0.056$) in the EM-K group. Similarly, plasma $[K^+]$ was 8% lower at 50 miles ($P=0.032$). Plasma $[Ca^{++}]$ was 4% higher at 13 miles ($P=0.046$). Plasma $[H^+]$ may be taken as an index of fatigue, so the lower plasma $[H^+]$ associated with EM-K may have contributed to better performance. Lower plasma $[K^+]$ and, to a lesser extent, higher plasma $[Ca^{++}]$ associated with use of EM-K should moderate increases in neuromuscular excitability and its clinical manifestations.

Key Words: Horses, Electrolytes, pH

688 Plasma hydrogen ion and bicarbonate changes during repeated sprints in horses are influenced by dietary protein. P.M. Graham-Thiers^{*1}, D.S. Kronfeld², and P.A. Harris³, ¹Virginia Intermont College, Bristol, VA, ²Virginia Polytechnic Institute and State University, Blacksburg, VA, ³WALTHAM Centre for Equine Nutrition and Care, Melton Mowbray, UK.

Dietary protein is acidogenic. A low protein diet may moderate metabolic perturbations during strenuous exercise. Twelve Arabian horses were assigned to a 2x2 factorial design with 2 levels of protein (7.5% CP supplemented with .5% lysine and .3% threonine, LP or 14.5% CP, HP) and 2 levels of fat (0%, LF or 10%, HF). After 4 weeks accommodation, horses performed a repeated sprint test: 3 min walk at 1.5 m/s and no slope, 3 min at 1.5 m/s and 3.5 m/s with 6% slope, then 6 1-min sprints at 7 m/s separated by 3 min walks, concluding with 30 min walk at 1.5 m/s and no slope. Horses then completed eleven weeks of conditioning followed by a repeated sprint test with sprints at 10 m/s. Blood samples were taken at rest, in the last 15 sec of sprint 1, 2 and 6 as well as at 5, 10, 20 and 30 min. of recovery. Samples were analyzed for lactate, pH (and H^+), pCO_2 , pO_2 , Na^+ , K^+ and Cl^- . Bicarbonate and strong ion difference (SID) were calculated. Regression

analysis was used to determine the contribution of SID, pCO_2 and Atot to changes in H^+ and HCO_3^- . In the first SET, H^+ was lower for LP groups ($p = .0056$) Regression analysis revealed that changes in H^+ were attributed mainly to changes in pCO_2 in both LP and HP groups ($r = .98$ and $.97$ respectively, $p < .0001$). Bicarbonate was not different between diets but changes were also correlated to pCO_2 ($r = .94$, $p = .0008$). In the second SET, H^+ was lower in the HFLP group ($p = .022$). The main contributor to changes in H^+ was changes in pCO_2 but Atot was also a contributor for the HFLP group ($r = .77$, $p = .021$). Bicarbonate levels were higher in the HFLP group ($p = .043$). An effect in the LP groups regardless of fat level appears to be pCO_2 (HFLP $r = .90$, $p = .003$ and LFLP $r = .91$, $p = .002$) however, Atot is also an influencing factor (HFLP $r = .92$, $p = .002$ and LFLP $r = .98$, $p = .0001$). For the HP groups, regardless of fat level, the effect of SID is significant (HFHP $r = .83$, $p = .011$ and LFHP $r = .73$, $p = .032$). Changes in pCO_2 appear to be the main controlling factors for changes in H^+ and HCO_3^- during strenuous exercise. However, smaller changes in Atot for the LP groups and decreases in SID for the HP groups contribute to the decrease in acidosis during strenuous exercise for horses fed LP fortified diets.

Key Words: Protein, Acid-Base, Horses

689 Effect of management practices and training on plasma tCO_2 concentration in horses. K.H. McKeever, A.M. Szucsik, V.B. Balaskonis, C.L. Betros, C.F. Kearns, and K. Malinowski, Rutgers University, New Brunswick, NJ, USA.

Three experiments were performed to test the hypothesis that common management practices would alter plasma total carbon dioxide (tCO_2) concentrations in horses. In Study 1, a crossover design was used to test the effect of a placebo and 7 electrolyte supplements (Lyte-Now, Stress-Dex, Summer Games, Electroplex, Enduramax, Acculytes, Performn# Win) on plasma $[tCO_2]$ measured before and after a simulated race test (SRT). Ten unfit Standardbred mares completed a SRT on a treadmill (6% grade). During the SRT horses ran for 2 min at 4 m/s, 2 min at the speed previously shown to correspond to VO_{2max} , 2 min at 4 m/s. Blood was collected before electrolyte treatment (-4 hrs), 10 min prior to exercise, and at 0 min, 60 min, and 90 min post-exercise. Study 2 used a similar protocol to examine the effects of a control diet and three pelleted feed supplements (Drive, Omelene, Strategy) on plasma $[tCO_2]$. Study 3 examined the effects of training and simulated quarantine (2 d of detraining) by comparing resting plasma $[tCO_2]$ in samples collected from 10 unfit and 17 moderately trained (12 wks @ 60% HRmax) Standardbred mares. Mares were maintained on the same diet and feeding schedule and samples were obtained at the same time of day before exercise. In Study 1, there were no differences ($P > 0.05$) in plasma $[tCO_2]$ across the 5 sampling intervals due to electrolyte treatment. In Study 2, there were no differences ($P > 0.05$) across the 5 sampling intervals due to dietary supplement. In both studies, there were differences ($P < 0.05$) in plasma $[tCO_2]$ across sampling intervals (-4 hrs, -10 min, +0 min, +60 min, +90 min) that were attributable to acute exercise (mean \pm SE; 34.4 ± 0.9 ; 33.2 ± 1.1 ; 20.2 ± 0.8 ; 31.5 ± 0.8 ; 30.3 ± 1.6 mMol/L). In Study 3, resting plasma $[tCO_2]$ was lower ($P < 0.05$) in trained (31.4 ± 1.9 mMol/L) vs. untrained horses (34.4 ± 0.9 mMol/L). There were no effects ($P > 0.05$) due to detraining. It was concluded that acute and chronic exercise affect plasma $[tCO_2]$.

Key Words: Equine, Horse, Total carbon dioxide, Exercise

Nonruminant Nutrition

An Update on Modeling Pig Growth

690 Pig growth models: Past and present. J. L. Black*, *John L. Black Consulting, Warrimoo, Australia.*

The primary aim of commercial animal production is to maximize profit while maintaining the health and welfare of stock. The net financial return from an enterprise depends on the interactions between many factors including the genotype of animals, diets, climate, stocking arrangements, disease, prices paid for products and costs of feed, breeding stock, capital, labor and other resources. Although there has been much research into these factors, the complexity of the interactions makes it virtually impossible for the human mind to assess accurately the consequences of alternative management strategies on either the efficiency of production or long-term profitability of an enterprise. By transforming the concepts and knowledge into mathematical equations and integrating them into computer programs using simulation-modeling techniques, this store of information can be applied directly to the management of commercial units. Models can be constructed in different ways and represent biological functions at different levels. For example, models applied to the pig industry have been static or dynamic, deterministic or stochastic, empirical or mechanistic. The first growth models applied to pigs in the 1950's and 1960's were static models representing factorial assessments of requirements for energy and protein based on empirical equations. However, by the 1970's, dynamic models were developed to varying complexity involving both empirical and biochemical-physiological representation of animal functions. The sophistication of these models has changed little over the last three decades, but their impact on the pig industry has been marked in some countries. For example, in Australia the AUSPIG model is now used in the management of more than half the country's pigs. The model is used most commonly for improving the formulation of diets to meet the nutrient requirements of individual pig groups by accounting for their genotype and rearing environment. It is used also to identify when climatic conditions limit productivity, excessive feed waste, effluent output, optimize slaughter weights and packers, assist in litigation, set research priority and many other areas.

Key Words: Model, Pig, Present

691 Partitioning of energy intake to heat, protein and fat in growing pigs. J. van Milgen* and J. Noblet, *INRA-UMRVP, St-Gilles, France.*

Modelling aspects of energy metabolism in growing pigs involves establishing rules on the partitioning of dietary energy between protein deposition (PD), lipid deposition (LD) and heat production (HP) at a given point in time as well as the changes that occur during growth. Growing pigs rarely retain more than 50% of the ME intake and the remainder is lost as heat. Part of the heat loss is due to the heat increment, which includes the transformation of dietary nutrients to PD and LD and to the associated energy (ATP) cost. Consequently, different nutrients are used with different efficiencies and (due to the ATP cost), PD is energetically less efficient than LD. Different modelling approaches have been adopted to represent partitioning of energy between PD and LD (e.g., by assuming minimum ratios between LD/PD, marginal LD/PD, or lipid and protein mass, and existence of an upper limit to PD). Most of the HP is associated with biophysical processes (e.g., maintenance, physical activity, thermoregulation) requiring ATP, which are not directly related to PD and LD. As it is virtually impossible to obtain direct estimates of these requirements, indirect methods have to be used. For example, the cost of maintenance may be estimated by measuring the fasting HP. Estimates of the fasting HP range from 700 to 800 kJ (kg BW)^{-0.60} d⁻¹, which corresponds to 50-60% of the total HP. Also HP associated with physical activity is an important component of HP (15%), but can be rather variable between individual animals. Feed intake in non-producing, mature mammals theoretically equals the maintenance energy requirements. This implies that, while maturing, maintenance will become an increasingly important component of energy intake. In addition, while maturing, a decreasing fraction of the energy intake above maintenance is used for PD. The result is that PD typically reaches a maximum at 60-80 kg in growing pigs and declines thereafter. In contrast, with ageing, an increasing fraction of the available energy is used for LD and maximum LD may not be reached before slaughter (110-130 kg). In modelling, this has been represented by assuming that the above-mentioned energy partitioning rules (e.g.,

minimum LD/PD ratio, upper limit to PD) change with body weight and(or) age.

Key Words: Growing pigs, Models, Energy partitioning

692 The partitioning of dietary amino acid intake — a modelling perspective. Paul J Moughan*, *Institute of Food, Nutrition and Human Health, Massey University.*

In developing a mathematical model to allow prediction of amino acid uptake and partitioning in the growing mammal, the simulation of amino acid metabolism is of particular importance, as the predicted rate of protein deposition has a disproportionate influence on predicted body mass. In reality, the absorption and metabolism of amino acids in mammals is complex and highly integrated with continuous flux within and between body cells. To model amino acid transactions, however, it is required to develop a simplified construct of metabolism describing discrete physiological and metabolic processes. In the construct discussed here a distinction is made between maintenance processes and those associated with growth. Growth is viewed as a function of nutrient deposition and support costs directly related to nutrient deposition. Several processes are emphasised and discussed: food and amino acid intake; amino acid absorption, amino acid losses at maintenance, net protein deposition, inevitable amino acid catabolism, gut endogenous amino acid loss correlated with food intake, the turnover of body protein associated with new protein synthesis, the synthesis of non-amino acid non-protein nitrogen containing compounds and preferential amino acid catabolism.

Key Words: Model, Simulation, Protein

693 Update on pig growth modeling: from chemical to physical body composition. C.F.M. de Lange*¹, P.C.H. Morel², and S.H. Birkett¹, ¹*University of Guelph, Canada,* ²*Massey University, New Zealand.*

Body lipid (L) and body protein mass (P) are key state variables in pig growth models. For predicting growth responses and carcass characteristics, P and L are related quantitatively to physical body composition. The main chemical constituents in the empty body (EB) are water (Wa), L, P and ash (A). Within pig genotypes, Wa is independent of L and closely related to P, e.g. $Wa = a \times P^b$. The parameter a ranges between 4.9 and 5.4 and appears to vary with pig genotype. The parameter b is remarkably constant across pig types, at .855, and represents changes in distribution of P over various body pools with increasing EBW and differences in Wa to P ratios among body pools. The A to P ratio is about .20 and has little impact on estimates of EBW. Gut fill, the difference between live body weight (LBW) and EBW, ranges between .03 and .10 of LBW; it varies with LBW, feeding level, diet characteristics and time off-feed. The distribution of P and L over the main physical body components (dissectible muscle and fat, viscera, blood, bone, integument) varies considerably between groups of pigs and appears influenced by EBW, pig genotype, thermal environment, feeding level and diet characteristics. Except for extreme pig genotypes, the distribution of lean over the main carcass cuts is relatively constant. Little is known about factors contributing to observed variation in the distribution of L over body fat depots. Representing dynamic effects of animal and external factors on sizes of physical body components is an apparent weakness in pig growth models. This is further complicated by inconsistencies in defining some of the physical body components, and dissectible lean tissue in particular. Improved accuracy in representing physical body composition will provide more insight on manipulation of carcass value and efficiencies of converting diet nutrients into pork products.

Key Words: Pigs, Growth modelling, Body composition

694 Characterization of pig genotypes. PW Knap^{*1}, R Roehé², K Kolstad³, C Pomar⁴, and P Luiting¹, ¹PIC International Group, Schleswig, Germany, ²Christian-Albrechts University, Kiel, Germany, ³Akvaforsk and Agricultural University, Aas, Norway, ⁴Agriculture and Agri-Food Canada, Lennoxville, Canada.

Simulation models for growing pigs are driven by descriptors of the pig's growth potential and of its environment, predicting growth from the interaction of both. Growth potential parameters relate to resource intake and its partitioning to maintenance, protein (P) deposition (PD) and lipid (L) deposition (LD), and quantify the pig's genotype (breed etc.). Simulation of a particular pig requires characterization of its genetic potential, in terms of the associated model parameters. This requires (i) a concise set of model parameters that fully describe the potential, (ii) real-life measurement of resource input and partitioning in a genotype, (iii) using those measurements to quantify those parameters for that genotype. (i) Resource partitioning is commonly covered with potential PD, required LD and maintenance requirement (MEM). The first two features often require three model parameters; MEM is here restricted to a neutral environment without additional coping functions (which would require extra parameters). Nutrient intake is most usefully modelled as resulting from nutrient requirements (for PD, LD, MEM) and constraints to physical uptake, either external (feed, climate, health, etc) or genetic (requiring an extra parameter). (ii) Resource intake/partitioning observations must reflect growth potential; hence environmental load must be minimized. Repeatedly measuring whole-body P and L and ad libitum ME intake over a wide enough maturity range (eg. 10-175 kg BW) requires serial slaughter trials with chemical analysis, or X-ray or isotope dilution techniques which allow for longitudinal studies and quantification of between-animal variation next to mean levels. (iii) Model parameters can be estimated by fitting observations to a body protein/lipid growth function. MEM comes out as the remainder of the ME budget, given valid assumptions about PD/LD efficiency. Alternatively, observed feed intake, growth rate and body composition can be fitted to their simulations by calibrating the model parameters. This "inverted modelling" avoids measurement of P and L but requires many observations per animal and an iterative routine to match resource requirements to resource allowance.

Key Words: Growth, Simulation, Genotype

695 Modelling stochasticity: dealing with populations rather than individual pigs. C. Pomar^{*1}, P. W. Knap², I. Kyriazakis³, and G. C. Emmans³, ¹Agriculture and Agri-Food Canada, Lennoxville, Quebec, Canada, ²PIC International Group, Schleswig, Germany, ³Scottish Agricultural College, Edinburgh, UK.

Pig production efficiency results from the responses of individual animals. However, it is usual to interpret experimental results on the basis of mean animal responses with little emphasis given to the variation around the means. Animals with different performance potentials may respond differently to treatments, which makes it difficult to translate average population responses into either individual animal responses or across populations having different variation between animals. Nutritional theories that form the basis of current models are all at the level of the individual animal. The problem of how properly to integrate

across individuals to obtain population predictions is rarely addressed. To illustrate the impact of between-animal variation on population responses to dietary treatments, we use a comprehensive pig growth model that predicts voluntary feed intake from potential protein deposition and the desired lipid retention. The genetic growth potential of individual animals is defined in terms of the growth rate parameter, protein weight at maturity and the ratio of body lipid to protein at maturity. The model was made stochastic by simulating variation and covariation in these genetic parameters. The population responses to increasing levels of dietary protein and energy intake are interpreted based on the individual biological phenomena represented within the model. Variation originated from within the individual animal as growth potentials and nutrient requirements evolves over time and from their variable genetic potentials for growth. The effect of increasing the between-animal genetic variation of the simulated population on feed intake, ADG and protein and lipid deposition was also simulated. Finally, it is shown that the optimal levels of intake will differ between population with different degrees of genetic variation.

Key Words: Genetic variation, Growth, Simulation models

696 Pig growth models: Future. J. L. Black^{*}, John L. Black Consulting, Warrimoo, Australia.

Current pig growth models represent the biology controlling the utilization of energy, amino acids and major minerals with a high degree of accuracy when feed intake and the growth characteristics of the pig genotype are known. Many of the determinants of voluntary feed intake are also well understood and intake is often predicted with reasonable accuracy. Further research is needed to understand better the characteristics of cereal grains and other dietary ingredients that effect the site of feed digestion, passage through the digestive tract, physical limits to gut capacity and other factors causing the wide variation seen frequently between apparently similar diets in voluntary intake. Current pig models do not predict well the effects of stress and disease encountered by pigs reared in commercial environments. However, considerable advances have been made in recent years in understanding the physiological mechanisms associated with stress and disease and these concepts are now being incorporated into some pig growth models. Pig models that predict accurately animal performance and carcass characteristics are, by themselves, unlikely to be adopted widely by industry. The models need to be integrated with least-cost feed formulation packages and resource optimization software that will allow enterprise profitability to be predicted with high accuracy. Another limitation to the widespread use of models within the pig industry is the time and effort required to collect the information needed as inputs to the models and to record animal performance for verifying the predictions. A major effort is needed to enable the industry to adopt electronic methods of data capture and the automatic separation of stock to reduce the cost of applying the models on farms. Finally, the markets for decision support software within the pig industry are small relative to the costs of development and servicing the products. Consequently, ongoing industry funds appear necessary to enable the successful and widespread adoption of models across the pig industry.

Key Words: Model, Pig, Future

Sheep Species Sheep Production in China The Importance of Small Ruminants for Managing Vegetation

697 Sheep genetic resources in northwest China. M. A. Brown^{*1}, Jianping Wu², Yuzhu Luo², and S. Soderstrom³, ¹USDA-ARS, Grazinglands Research Laboratory, El Reno, OK, ²Gansu Agricultural University, Lanzhou, Gansu, PRC, ³World Bank, Washington, D.C..

In China's northwestern pastoral areas, challenges for rural development are especially daunting. Despite the political and strategic importance of the region and progress in agricultural development throughout China, there is a need for further economic growth in this area. This growth is impeded by lack of available production capital for the herders and by grassland degradation. However, animal husbandry will remain the major source of livelihoods and real economic growth in much of northwest China in the foreseeable future, since there are major limi-

tations on opportunities for non-farm enterprises. The government is placing a major emphasis on sheep breeding in the pastoral areas since the climate is particularly suited to fine wool and mutton production. Since the 1950's, extensive effort has gone into developing breeds of fine-wool sheep, based on the introduction of Merino breeds. However, despite this active breeding program, about 60 percent of the national flock of 127,350,000 sheep are still local coarse-wool sheep. Much of the fine-wool breed improvement was conducted on State Farms, where most of the better quality fine-wool sheep are now found. Still, average grease fleece production per sheep is about 2 kg, compared with more than 4 kg in the U.S., and the clean wool yield is 40-50 percent compared with nearly 63 percent in the U.S. Wool contamination is a major problem and the inherent environmental characteristics of the semi-arid pastoral areas contribute to the low yields. The fine wool that

is produced also suffers from a number of additional quality problems. Herders are moving from fine-wool production into more profitable meat production. This reflects not only a producer response to better markets for meat sheep but also to production risks associated with fine-wool sheep. This is creating concern over genetic regression in a significant proportion of the remaining fine-wool flocks in the pastoral areas and a need to evaluate breeding programs. Additionally, there is a need for programs to characterize and utilize breeds of mutton sheep in pastoral production systems. The objective of this presentation is to discuss genetic resources available in China for improvement of both fine-wool and mutton production and breeding programs to utilize these resources.

Key Words: China, Sheep, Genetic resources

698 A new paradigm for small ruminant production. J.W. Walker^{*1}, ¹*Texas Agricultural Experiment Station.*

In light of the decades long decline in the sheep industry it appears past time to reconsider the place of the industry in U.S. agriculture. Solutions to sheep industry problems have focused either at increasing the efficiency of production or increasing consumer demand for the products. It is doubtful that the potential for increasing productivity is great enough to offset the effect of currency exchange rates and high land prices. As for increasing demand, with lamb imports supplying 37% of domestic consumption and increasing at a rate of 6% annually, there is little evidence to support the need for increased product demand. The trend toward globalization of world economies suggest that foreign competition is here to stay and the only solution is to develop markets that foreign products can not compete for. The one market that imported lamb or wool cannot compete for is the potential positive effects of sheep on grazing land ecosystems. There are many examples of using sheep and goats to control noxious weeds and manage vegetation. Although the commodity can be imported the positive effects of sheep grazing cannot be imported. The American Sheep Industry Association is to be lauded for its sheep ecology program that promotes the use of sheep to improve grazing lands. Unfortunately few producers and even fewer academics give any consideration to the potential positive environmental benefits of sheep grazing. However, as shown by the latest issue of *The Futurist* magazine, which was subtitled *Eco-Economy*, the environment is the market of the future. Sheep producers need to accept the reality of the new economy while there is still infrastructure to process the by-products, i.e., lamb and wool, of their industry.

Key Words: Ecology, Grazing, Sheep

699 Using sheep to graze noxious weeds in Montana. B. Olson^{*}, *Montana State University.*

Noxious weeds are continuing to spread across Montana, despite extensive and expensive control efforts, primarily associated with herbicides. In 1991, we began a series of studies to assess the efficacy of using sheep to control noxious weeds. Animal related studies have included grazing behavior, grazing use patterns, nutritive value of weeds versus

native plants, and rumen microbial response to noxious weeds. Plant related studies have included response of plants, plant populations, and plant communities to sheep grazing, and noxious weed seed viability after passing through the digestive tract of sheep. A related study assessed the economic feasibility of using sheep to control leafy spurge. In Montana, over 2.2 million ha are infested with the Eurasian spotted knapweed, 0.2 million ha are infested with leafy spurge, also from Eurasia. In Montana, about 45,000 ha of noxious weeds are being grazed by sheep or goats with no or little exchange of money between sheep producer and landowner. In the long term, the declining number of sheep available to graze these weeds may limit the efficacy of this ecologically and economically viable tool to control weeds.

Key Words: Sheep, Grazing, Economics

700 Using goats to control juniper. C. A. Taylor, Jr., *Texas Agricultural Experiment Station, Sonora.*

Juniper infestation of Texas rangelands is an important dilemma because of its impact on forage and livestock production, water yield and quality, wildlife habitats, and rapidly increasing costs of conventional control methods. Ashe juniper (*Juniperus ashei*) is a serious problem on approximately 4.1 million hectares and redberry juniper (*Juniperus pinchotii*) on 4.9 million hectares of Texas rangelands. Junipers contain monoterpenoid oils, which are volatile. These phytochemicals are composed of terpene compounds, which are five-carbon rings with alcohol, ketone, and hydrogen side groups. The kind of side group makes a difference in the properties of each terpenoid. The terpenoids in juniper affect its taste and a number of the animal's metabolic processes. Since we know that juniper intake is limited by the presence of terpenoids, we can overcome this limitation through two different management schemes. We can manage juniper to reduce terpenoid concentration in the foliage and/or we can manage goats to increase their tolerance of the terpenoids. Terpenoid composition for immature juniper is lower than for mature juniper. There appears to be a threshold after which leaf material becomes significantly less palatable as the juniper foliage ages and terpenoid composition increases. This has important management implications. If juniper can be maintained below this threshold with control methods such as fire, consumption by goats can be increased. Our second approach to juniper management is to increase the tolerance of goats to the terpenoids. Terpenoids are thought to deter goat browsing of juniper plants by being toxic or by reducing nutrient assimilation, or by influencing forage selection at sub-toxic levels by imposing high detoxification costs post absorption. Because of the additional demand for nutrients, adequate nutrition is important to meet the demands of detoxification. Spanish or Spanish x Boer cross goats have a higher tolerance to terpenoids than Angora goats. Spanish goats crossed with the Ibex breed (wild goats) consume even larger quantities of juniper. There also appears to be large within-breed differences in regards to juniper intake. Habitability has ranged from near 0 to 26%.

Key Words: Goat, Juniper, Rangeland

Milk Synthesis

701 Production of DNA Arrays by Expression Profiling. K.M.S. Smuga-Otto^{*}, W. Luo, J.L. Smith, E. Reinfried, and L.G. Sheffield, *University of Wisconsin, Madison.*

DNA arrays consisting of hundreds to thousands of DNA fragments arrayed on a solid support are widely available for humans and many model species. For less widely utilized species, the costs of obtaining DNA arrays can be prohibitive. Part of this cost is the redundancy involved in screening large numbers of clones to obtain complete coverage of the genome. Recently, we used display profiling to obtain a large library of low-redundancy bovine DNA sequences. mRNA was extracted from control and pokeweed mitogen-stimulated bovine leukocytes. Double stranded cDNA was synthesized and the resulting library digested with TaqI restriction endonuclease. Linkers were then ligated to the resulting sticky ends. These linkers were then used as primer sequences for PCR amplification of the library (to give a larger amount of starting material, not absolutely necessary for the procedure). Next, PCR primers containing the linker sequence, the TaqI recognition sequence and the first 3 bases of unknown sequence were synthesized. Each possible primer was synthesized independently, such that we had 64 possible primers.

These were then used in pairs to amplify the DNA fragments. A total of 2,016 non-redundant primer pairs are possible, each of which amplifies a small percentage of the possible DNA fragments in the sample. After PCR amplification with these primers, fragments were separated by PAGE electrophoresis, silver stained and bands excised manually. Each PCR reaction gave between 10 and 30 bands suitable for excision and reamplification. From 900 PCR reactions, we have isolated over 11,000 unique bands of sufficient quality for array production. Thus, this procedure provides a rapid and relatively inexpensive method of producing DNA arrays, well suited to species or projects for which a full-fledged functional genomics effort would be prohibitive.

Key Words: DNA Arrays, Expression Profiling, Array Methods

702 Relationship of lactose synthesis to glucose transport in bovine mammary epithelial cells in vitro. C.T. Xiao*, J.P. Cant, M.I. Lindinger, R.R. Hacker, and B.W. McBride, *University of Guelph*.

The relationship between lactose synthesis and glucose transport across the plasma membrane was studied in bovine mammary epithelial cells isolated from lactating Holstein cows. Two hundred μ l of cell suspension were incubated at 37 °C with 400 μ l Dulbecco's Modified Eagle's Medium containing 10 mM glucose for up to four hours or varying glucose concentrations (0.75 - 20 mM) for one hour. Lactose was assayed using a bioluminescent method. At the end of incubation lactose was mainly present in incubation media while lactose in cell lysates was negligible ($p < 0.01$), indicating the secretory capability of the cell preparation. Lactose accumulation in media containing 10 mM glucose was linear with incubation time up to 4 hours at a rate of 181 nmol per mg cell protein per hour. Facilitative glucose transport inhibitor cytochalasin B (20 μ M) significantly reduced ($p < 0.05$) lactose synthesis while no effects of SGLT1 inhibitor phloretin (200 μ M) were detected ($p > 0.05$). Synthesis of lactose exhibited Michaelis-Menten kinetics under varying extracellular glucose concentrations ($[Glc]_o$) with K_m of 1.29 mM. Assuming a K_m' of 0.16 mM for intracellular glucose utilization in lactose synthesis, the relationship between intra- and extracellular glucose concentrations was derived as $[Glc]_i / [Glc]_o = K_m' / K_m$. This provided a novel indirect estimation of the intracellular glucose concentration and indicated an 8-fold glucose concentration gradient across the plasma membrane of mammary epithelial cell. Calculated intracellular glucose concentrations were used to solve a kinetic equation for bidirectional transport of glucose.

Key Words: Mammary epithelial cell, Glucose, Lactose

703 Dose-dependent reduction in milk fat secretion with abomasal infusion of *trans*-10, *cis*-12 conjugated linoleic acid (CLA) and comparison to diet-induced milk fat depression. D. G. Peterson*, L. H. Baumgard, and D. E. Bauman, *Cornell University, Ithaca, NY*.

Trans-10, *cis*-12 conjugated linoleic acid (CLA) is a potent inhibitor of milk fat synthesis and its concentration in milk fat increases during diet-induced milk fat depression (MFD). We examined effects of abomasal infusion of low doses of *trans*-10, *cis*-12 CLA on milk fat synthesis using Holstein cows in a 4 x 4 Latin square design. Milk yield and milk protein were unaffected, but abomasal infusion of 1.25, 2.5 and 5.0 g/d of *trans*-10, *cis*-12 CLA reduced milk fat yield by 7, 16 and 29%, respectively. Changes in milk fatty acid composition indicated that yield of all fatty acids were reduced; thus, the mechanism must involve an inhibition of de novo fatty acid synthesis and the utilization of circulating fatty acids. At these low doses there was no evidence that Δ^9 -desaturase was affected based on the lack of change in fatty acid ratios representing product/substrate for this enzyme. When combined with previous data, the reduction in milk fat yield was curvilinear, relating to both quantity infused and milk fat content of *trans*-10, *cis*-12 CLA ($R^2 = 0.99$ and 0.96, respectively). Comparison with data from MFD induced by feeding a high concentrate/low fiber diet revealed a substantial divergence from the relationship between milk fat content of *trans*-10, *cis*-12 CLA and milk fat yield. This divergence suggests that in addition to *trans*-10, *cis*-12 CLA, there may be other unique fatty acids formed in rumen biohydrogenation that play a role in diet-induced MFD.

Key Words: CLA, Milk Fat, Milk Fat Depression

704 Sphingomyelin content in milk from Jersey and Holstein cows. E.L.F. Graves*, A.D. Beaulieu, and J.K. Drackley, *University of Illinois*.

Sphingomyelin is a phospholipid located in the outer leaflet of the plasma membranes of most mammalian cells. In milk, sphingomyelin is associated with the fat globule membrane. Sphingomyelin and its metabolites participate in several antiproliferative pathways that may suppress oncogenesis. Two studies were conducted to determine effects of breed, lactation stage, and parity on sphingomyelin concentration in milk and milk fat. Sphingomyelin was separated by TLC from chloroform-methanol extracts of milk fat and quantified by phosphorous analysis. In study one, milk samples were collected from 23 Holstein and 23 Jersey cows matched for parity and stage of lactation between breeds. Sphingomyelin was more concentrated ($P < 0.002$) in Holstein milk fat

(1072 \pm 139 μ g/g milk fat) than in Jersey milk fat (851 \pm 139 μ g/g milk fat). Sphingomyelin concentrations in whole milk did not differ between breeds (36.4 vs. 35.6 μ g/g milk, SEM = 3.2, $P = 0.73$). Whole milk sphingomyelin content was affected by days in milk suggesting that sphingomyelin content follows fat content in milk. In study two, milk was sampled from 32 Jersey cows in a commercial herd. Cows were grouped on lactation number (1, 2, 3, ≥ 4) with 8 cows per group; half were in early lactation (< 100 DIM) and half in late (> 200 DIM). Lactation number affected ($P < 0.05$) sphingomyelin concentration in milk fat (769 \pm 44, 794 \pm 49, 802 \pm 56 and 652 \pm 63 μ g/g milk fat respectively). Sphingomyelin per unit of whole milk tended ($P < 0.10$) to follow the same pattern. No differences in sphingomyelin concentrations in milk fat were detected between early and late lactation. However, per unit of whole milk, sphingomyelin content was greater ($P < .0001$) for late lactation than for early lactation (38.2 \pm 3.3 vs. 24.7 \pm 3.1 μ g/g milk). Our results suggest that the known larger milk fat globule size of Jersey cows decreases sphingomyelin content per gram of milk fat relative to Holstein cows. Sphingomyelin content in whole milk is not affected by breed, but may be altered by stage of lactation due to changes in milk fat content.

Key Words: Sphingomyelin, Jersey, Milk

705 Endogenous synthesis of *cis*-9, *trans*-11 conjugated linoleic acid in pasture-fed dairy cows. J.K. Kay^{*1}, T.R. Mackle², M.J. Auldist³, N.A. Thomson¹, and D.E. Bauman⁴, ¹Dexcel, Hamilton, New Zealand, ²Fonterra, Auckland, New Zealand, ³Depart. Natural Resources & Environment, Ellinbank, Victoria, Australia, ⁴Department of Animal Science, Cornell University, Ithaca, NY.

Four rumen-fistulated Friesian cows were randomly assigned to treatments in a 4 x 4 Latin square design to verify the endogenous synthesis of *cis*-9, *trans*-11 conjugated linoleic acid (CLA) in pasture-fed cows. All animals were fed fresh pasture *ad libitum* and were infused abomasally with 4kg skim milk/d. Treatments were 1) control, 2) sterculic oil (SO; abomasal infusion of 9g SO/d), 3) sunflower oil (SFO; twice daily rumen dosing of SFO (500ml/d), and 4) SO + SFO. Each of the four periods consisted of a 2-d uniformity interval, a 4-d infusion interval and an 8-d washout interval. Data from day four of the infusion interval was used for analysis. Dry matter intake, milkfat and milk protein concentrations were unaltered by SO and SFO treatments. Milk yield was unaffected by SO infusion but a small increase ($P < 0.01$) occurred with SFO administration. Infusion of SO reduced the concentration of CLA in milkfat by 71% (3.6 c.f. 12.1 mg/g fatty acid \pm 1.48; $P < 0.001$). This reduction is a minimum estimate of endogenous synthesis as the presence of *cis*-9 C14:1 in milkfat following SO infusion suggests that the $\Delta 9$ -desaturase enzyme was not completely inhibited. Concentrations of monounsaturated fatty acids containing a *cis*-9 double bond decreased ($P < 0.05$) following SO infusion and consequently the substrate to product ratios of fatty acid pairs dependent on $\Delta 9$ -desaturase increased ($P < 0.05$). Sunflower oil resulted in a 17% increase ($P < 0.05$) in *trans*-11 vaccenic acid in milkfat but no increase in CLA. Linoleic and oleic acids, the major components of SFO, increased in milkfat by 58% and 27% respectively indicating a large portion of SFO was not ruminally biohydrogenated. Overall, the results demonstrate that endogenous synthesis is the major source of CLA in milkfat of pasture-fed cows. Four days of SFO treatment had no effect on milkfat CLA concentration. This may be due to the twice-daily SFO administration method or rumen micro-organisms having insufficient time to adapt from a 100% pasture to a pasture plus SFO diet.

Key Words: Conjugated linoleic acid, Pasture, Endogenous synthesis

706 Effect of linoleic acid and oleic acid on conjugated linoleic acid (CLA) and milk fat content during feeding of low forage diet. T. W. Hanson^{*1}, M. L. Theurer¹, J.M. Griinari², and M. A. McGuire¹, ¹University of Idaho, Moscow, ²University of Helsinki, Finland.

Conjugated linoleic acid is present in products from ruminant animals including milk and beef. The predominant isomer (*cis*-9, *trans*-11 CLA) has powerful anticarcinogenic effects, whereas the *trans*-10, *cis*-12 CLA dramatically inhibits milk fat synthesis. The objective of this study was to examine the effects of rumen available linoleic (LIN) or oleic (OLE) acids on milk fat content during the feeding of a low forage diet. Our hypothesis was that feeding a low forage diet to promote milk fat depression (MFD) would only result in MFD when LIN but not OLE was

fed. Further, the ruminal production of *trans*-10, *cis*-12 CLA from LIN would be associated with MFD. Three late lactation Holstein cows fitted with ruminal cannulae were fed 4x/d for ad libitum consumption of a diet based on chopped alfalfa hay and ground degermed shelled corn. Diets were adjusted over a 3-d period to 20% forage and 80% concentrate. Cows then randomly received either an oil containing LIN (93.7%) or OLE (79.5%) (Natural Lipids, Norway) for 7 d. Oils were placed directly in the rumen (2x/d) to provide a daily dose of 200 g of fatty acid. At the end of the 7-d period, cows were switched to the other oil. Feed intake and milk yields were recorded daily. Data are the last 3 d of each 7 d period. Feed intake and milk yield were not affected by oil. Rumen pH averaged 5.56. LIN resulted in higher *cis*-9, *trans*-11 CLA (10.0 vs 6.2 mg/g fat) and *trans*-10, *cis*-12 CLA (0.94 vs 0.11 mg/g fat) in milk fat than did OLE. Milk fat content was lower during the administration of LIN ($P < 0.1$) compared to OLE (2.5 vs 3.4%). *Trans*-10, *cis*-12 CLA was correlated to milk fat percentage ($R^2 = 0.31$, $Y = -15.5x + 3.97$) but *cis*-9, *trans*-11 CLA was not. Feeding a low forage diet resulted in a decreased rumen pH. Under this condition, LIN converted to *trans*-10, *cis*-12 CLA caused MFD, whereas the biohydrogenation of OLE did not produce an intermediate to cause MFD.

Key Words: CLA, Milk Fat Depression, Biohydrogenation

707 Fatty acid changes in milk fat from Holstein cows fed rumen-protected CLA during the transition period. J. W. Perfield II*, G. Bernal-Santos, T. R. Overton, and D. E. Bauman, *Cornell University, Ithaca, NY*.

We observed that feeding Holstein cows rumen-protected CLA had no effect on milk or milk components immediately postpartum, but starting

at wk 4 there was a decrease in the fat content of milk and a simultaneous increase in milk yield (J. Dairy Sci. 84(Suppl. 1):82). Over wk 4 to 20 postpartum, milk fat averaged 2.95 vs 3.45% ($P < 0.001$) and milk yield averaged 48.4 vs. 45.2 kg/d ($P < 0.10$) for the CLA-supplemented and control groups, respectively. Our objective was to extend these data by analyzing the fatty acid composition of milk fat. Multiparous cows were blocked into two treatments- dietary supplement of EnerGII (Bioproducts, Inc.) (control) or rumen-protected Ca-salts of CLA plus palm oil fatty acids (Agribands Purina Canada Inc.; Bioproducts, Inc.). Supplements (100 g/d of fat) were top dressed on the TMR and the CLA supplement provided 43 g/d of CLA (predominant isomers were *trans*-8, *cis*-10 (9.2%), *cis*-9, *trans*-11 (25.1%), *trans*-10, *cis*-12 (28.9%), and *cis*-11, *trans*-13 (16.1%). Supplements began 2 wk prepartum and continued through wk 20 postpartum. Milk fatty acid composition did not differ between treatments for wk 1 to 3 postpartum. However, fatty acid composition shifted in CLA-supplemented group beginning at wk 4 concurrent with the decrease in milk fat content; differences persisted throughout the remainder of treatment. From wk 4 to 20, the CLA-supplemented group had a reduced fat content of fatty acids $< C16$ (23.4 vs 24.6%; $P < 0.06$), and C16 & C16:1 (26.0 vs 28.7%; $P < 0.001$), with an increased concentration of fatty acids $> C16$ (49.0 vs 46.0%; $P < 0.01$). *Trans*-10, *cis*-12 CLA is a potent inhibitor of milk fat. In contrast to the temporal changes in most milk fatty acids, fat content of *trans*-10, *cis*-12 CLA was immediately increased in the CLA-supplemented group and remained elevated throughout the 20 wk treatment period (0.03 vs $< 0.01\%$ of fatty acids; $P < 0.001$). Overall, CLA supplementation initiated at parturition had no effect on milk fat until wk 4 postpartum when a decrease in the fat content and a major shift in fatty acid composition of milk occurred.

Key Words: CLA, Milk Fat, Transition Cow

**Production, Management, and the Environment
Management and Decision-Making**

708 Flavoring drinking water for post-weaning pigs increases water and feed intake and improves average daily gain. M.J. Bertram*, J.A. Pudenz¹, and E. Roura², ¹*Pork Technologies, Ames, IA*, ²*Lucta SA, Montornés del Vallés, Barcelona, Spain*.

A study was conducted to examine the impact of adding a flavoring agent to drinking water on pig water and feed intake and growth. 1292 pigs were weaned at 13 to 17 d of age and allotted by weight to one of four drinking water treatments consisting of either fresh water or water containing a flavoring agent (Luctarom TM, Lucta USA Inc, Northbrook, IL) at the rate of .141, .282, .423 g/l. Flavoring was provided for 14 days post-weaning. Pigs were penned 28 to 32 per pen in a 7.19 m x 2.87 m wean-to-finish pen and pig number was equalized across treatment with-in rep. There were 10 reps of each treatment. Water was available ad-libitum from 2 nipple drinkers per pen. All pigs were feed a common commercial diet and feed was available ad-libitum. Pig weight and feed consumption were recorded by pen on d 5, 14, 28, 42, and 61 post weaning. Water disappearance was recorded by treatment for all pigs consuming each water treatment (1 observation per treatment) on a daily basis for the first 14 d. Daily water consumption increased with increasing flavor concentration. When comparing fresh water with the highest concentration of flavored water, consumption was increased by 34% during the first 24 h and by over 4% during the 14 d treatment period. From d 0 to 61 feed consumption and body weight gain increased linearly ($P < .05$). Average pig weight at the end of each period was increased linearly ($P < .05$) as flavor concentration in the water increased and at 61 days pigs consuming water containing .282 g/l of strawberry flavor were 1.5 kg heavier than those consuming fresh water. Feed conversion was not improved with water flavor inclusion. Based on these results, adding a flavoring agent to drinking water of pigs for 14 d post-weaning improved water consumption, feed intake and growth rate.

Water Flavor Cons, g/l	0	.141	.282	.423	Lin P<
Start Wt, kg	5.05	5.07	5.05	5.07	.55
5d Wt, kg	5.68	5.71	5.75	5.85	.07
14d Wt, kg	7.49	7.63	7.64	7.80	.02
28d Wt	12.02	12.12	12.41	12.56	.01
42d Wt	18.99	19.04	19.88	19.76	.01
61d Wt, kg	33.07	33.21	34.58	34.35	.001
ADG 0-5d, g/d	126	128	140	155	.05
ADG 0-61d, g/d	455	446	476	474	.07
ADF 0-5d	123	123	133	138	.05
ADF 0-61d, g/d	702	687	733	737	.05
GF 0-5d	1.024	1.019	1.031	1.124	.17
GF 0-61d	.649	.650	.649	.644	.29
Water Disapp. d1, l/d	2.01	2.34	2.21	2.70	N/A
Water Disapp. 0-14d, l/d	2.80	2.84	2.88	2.90	N/A

Key Words: Pigs, Water, Flavor

709 Specialization and contracting in the dairy industry: the case of custom heifer growers. C.A. Wolf*, *Michigan State University*.

As dairy farms specialize in milking cows, other enterprises are often curtailed. One increasingly common example of outsourcing is utilizing a custom replacement heifer grower. By outsourcing the heifer enterprise, a dairy farmer frees up labor, management, feed, and facilities. To examine this new industry sub-sector, nation-wide survey was undertaken to examine commercial custom heifer growers. The survey was intended to: examine the size, structure, and management of the heifer grower industry; identify important practices; and examine contract and performance specification. The survey was targeted to commercial heifer growers. Surveys were sent to 187 custom dairy heifer growers in 2001. Sixty-six respondents from across the US that identified themselves as heifer growers. The average operation had 1,223 heifers with a range from 30 to 20,000. The average operation farmed 637 acres. Just over half of the respondents indicated that they were commercial heifer growers with no off-farm employment. About forty percent were heifer growers with other significant farm operations with the most common being cash crops. Fifty-four percent indicate that

they previously had a milking herd. Most growers entered the business because they saw it as a good business opportunity. Other common reasons for commercially growing heifers were to utilize crops grown and to make use of out-of-date or unused livestock facilities. Eighty-three percent of the heifer growers had more than one dairy farmer client. Heifer facility types were almost equally distributed between free-stalls, dry lots and pasture. Forty-seven percent of the heifers were first bred at 13 months; 77 percent were first bred before 15 months of age. Eighty-five percent of the custom growers had an agreement directly with the dairy farmer while the rest used a contracting agency. Sixty-nine percent of respondents had written contracts. The most common form of compensation agreement was a set daily charge per head which was used by 52 percent of respondents. Other common forms included a rate of gain based payment and an arrangement to sell and later purchase back the heifers. Ninety-seven percent of respondents indicated that they were satisfied to extremely satisfied with their contract arrangement.

Key Words: Contracting, specialization, Replacement heifers

710 Calculating the cost of producing milk: methods and implications. C.A. Wolf* and S.B. Harsh, *Michigan State University*.

Cost of production is a key indicator of competitiveness. Other than choosing technology and production level, a dairy farm manager primarily controls cost of production to influence profitability. Cost of producing milk is difficult to accurately and efficiently calculate because dairy farms tend to be diversified into crops, replacement heifers, and other enterprises. A comparison of cost of production calculation methods examines trade-offs between accuracy and effort and reveals patterns of errors across farms. A common method to calculate cost of production uses income tax information on business expenses (cash and depreciation). As all farm operations file income taxes, the required information is readily available. However, this method ignores important costs (e.g., unpaid labor and capital) and makes many simplifying assumption. With efficiency gains to labor and capital utilization providing the primary reason for an investment decision such as a major farm expansion, ignoring operator capital, management and labor costs leads to poor management decisions. An alternative, but much more time consuming, method is detailed enterprise accounting which breaks out the milk herd enterprise but allocates costs across all relevant enterprises on the farm. The cost of operator equity capital is calculated using financial models that account for industry and individual farm risk. Detailed enterprise accounting data from Michigan dairy farms in 1998 and 1999 are used to compare the cost of production via the income tax statement and enterprise accounting methods. Using enterprise accounting method, the largest costs of production were feed, labor and replacement heifers. Cost of replacement heifers varied significantly across farms and were not accurately captured using the income tax cost method. Accounting for risk resulted in a consistently higher cost of farm capital than standard charges used in the income tax method. The milking herd was consistently the most profitable enterprise on the farm while auxiliary enterprises, such as feed crops and replacement heifers, were often unprofitable. Farms that specialized in milk production had similar cost estimates across methods while diversified operations varied widely by method.

Key Words: Cost of production, Enterprise accounting methods

711 Managing dairy herd data via interactive visualisation techniques. A. St-Onge*¹, R. Lacroix¹, and K. M. Wade¹, ¹*McGill University, Montreal, Canada*.

The paradox of multiple data sources means that, unless properly utilised, more information has the potential to hinder, rather than aid, the decision-making process. Interactive visualization techniques are proposed as a means of organising multiple agricultural information sources so as to help with the detection of problems, discover new patterns and facilitate planning at the farm level. The ability of these techniques to provide an overall picture, as well as rapid, incremental and reversible views of information, makes them promising for dairy farming computer-based tools, given the diverse and distributed sources of information that exist. Dairy producers receive data and information from many off-farm organisations on a daily basis. Combining these off-farm databases with existing on-farm information (electrical devices, on-farm databases and even personal opinions and intuition) creates a so-called *info-fog*. The formats of these various data sources differ, and there are

usually no physical links among the off-farm organisations, except that everything passes via the dairy farm itself, where all reports are stored in one format or another. Interactive visualization has the potential to be extremely useful in these kinds of situation where the development of a dynamic information retrieval system is needed in order to improve the interpretation of data. The querying of databases must be viewed as part of a larger work process, which also includes the access and analysis of data. Such an approach is proposed and outlined, whereby different sources of dairy management information are accessed and integrated, using interactive visualization techniques, and subsequently presented in an intuitive, interactive, graphical environment. The proposed system acts as a virtual workspace where all essential information can be managed through one single interface.

Key Words: Dairy Herd Management, Info-fog, Interactive Visualization

712 Effect of grain type, milling method, and diet form on dust production in a laboratory dust generator. R.C. Thaler*¹, A.J.A. Aarnink², K. Koch³, and T.E. Sauber, ¹*South Dakota State University, Brookings*, ²*IMAG, Wageningen, the Netherlands*, ³*Northern Crops Institute, Fargo, ND*, ⁴*DuPont Speciality Grains, Des Moines, IA*.

A 3 x 2 x 2 factorial study was conducted to determine if grain type (barley, corn, & high oil corn), milling method (hammer mill & roller mill), and diet form (meal & pellet) in sow gestation diets affected total and respirable (< 4 microns) dust production in a laboratory dust generator. There were 3 replicates/treatment, and each sample was placed in a dust generator for 24 hours. An air flow rate of 2 liters/minute was used to pull agitated dust onto filters in total and respirable dust collectors, and an airflow rate of 23 liters/minute was also used on another total dust collector. Total dust production at both flow rates was higher (P<.01) for barley diets than for the corn or high oil corn (HOC) diets. Respirable dust production was greater (P<.05) for barley diets than for HOC diets, with corn diets intermediate. No differences in dust production were observed between hammer and roller milled grains. Meal diets produced more respirable dust (P<.01) and tended (P<.11) to produce more total dust than pelleted diets. There was a grain x diet form interaction (P<.01) which masked some of the pelleting effect. Barley meal diets produced the most dust while barley pelleted diets produced the least amount of dust between all the treatments. During milling, regardless of which mill type was used, barley required the greatest amount of electricity while HOC required the least amount of electricity per ton. Also, the production rate (tons processed/hour) was greatest for HOC and lowest for barley. These data indicate that in laboratory dust generators, barley diets produce more dust than either corn or HOC-based diets, and at the 2 liters/minute flow rate, HOC-based diets produced numerically less dust than did corn-based diets. Also, HOC had the best production rate and energy usage of all the grains during processing.

Key Words: Dust, Respirable, High oil corn

713 Impact of nursery feeder gap adjustment and group size/density on nursery pig performance. J.F. Patience*¹, L. Smith¹, A.D. Beaulieu¹, H.W. Gonyou¹, and R.D. Boyd², ¹*Prairie Swine Inc., Saskatoon, SK.*, ²*Pig Improvement Co. Franklin, KY*.

Feed access and stocking density are important factors affecting nursery performance. Data are limited on the impact of either animal density or feeder gap adjustment. This experiment was conducted to evaluate feeder gap adjustment and group size/stocking density on nursery pig performance. The experimental treatments, arranged as a 5 X 3 factorial, included 5 feeder adjustments, from 9.2 mm to 31.5 mm, and 3 group sizes/stocking densities of 24, 20 and 16 pigs per pen, providing 0.23, 0.28 or 0.35 m²/pig, respectively. The 6 wk experiment commenced 8 d post weaning, when the average pig age was 26.2 d and average body-weight was 7.1 kg. A total of 716 pigs started the experiment. Feeder space allowance was maintained at 4 pigs per feeder space. Feed trough coverage and feed depth were determined weekly. Time spent eating was measured using a time-lapse recorder on d 3 to 6 and d 39 to 42 of the experiment. The incidence and severity of skin lesions associated with piglet aggression were scored on the final day of the experiment. Final body weight, ADG and ADFI were improved with decreasing group size and a larger feeder gap opening (P<0.05). Performance was maximized with a feeder gap of 18 mm and a group size/density of 16 pigs/0.35

m m²/pig. The group size/density effect was more pronounced at a reduced feeder gap adjustment (feeder gap x group size/density, $P < 0.05$). Feeder gap had no impact on the coefficient of variation for bodyweight at 56 d, but increasing stocking density/group size had an adverse effect. Skin lesion scores were unaffected by treatment ($P > 0.05$). Eating speed of pigs on d 3-6 was decreased at the tightest feeder adjustment (9.2 mm) when there were 16 or 20 pigs per pen, but not when there were 24 pigs per pen (adjustment x group size/density, $P < 0.05$). Performance was maximized when at least 38% of the feeder trough was covered with feed or when the group size/density was lowest. Feed trough gap adjustment and group size/density were confirmed as important aspects of nursery management.

Key Words: Swine, Group size, Feeder adjustment

714 Factors affecting the market value of cows sold through Arkansas auction barns, part 2: perceived breed composition, color, muscle and frame. M. S. Gadberry*, T. R. Troxel, D. Urell, J. Foley, R. Wiedower, S. Cline, and G. Ford, *University of Arkansas Cooperative Extension Service, Little Rock, AR.*

A study was conducted to determine the factors affecting the market price of cull cows. Data was collected from 15 auction barns in the spring (14 wk) and fall (13 wk) of 2001. The final dataset represented 43.5% of the cows marketed. The impact of cull cow characteristics for perceived breed composition, color, muscle and frame on unit price were examined. Cow characteristics were analyzed individually. They included cow type, replacement cows (R) vs. slaughter cows (S) and cow type by cow characteristic interactions. Week, cow age and weight served as covariates. All values are reported on a 45.45 kg basis. There were significant interactions ($P < 0.001$) for cow type and characteristics. In all instances, R received a higher price ($P < 0.001$). Breeds and colors were designated different at $P \leq 0.01$. Angus (A) x Charolais (C); \$50.96), A, A with 25% Brahman (B), C x Hereford (H), A x H, Limousin (L), and A x H with 25% B were the seven highest R breeds and did not differ. Limousin (\$41.80) was also valued high for S and differed from all others breed compositions except C x L (\$41.24), C x B (\$40.55), continental with 25% B (\$40.38), continental cross (\$40.32), and B cross (\$40.11). Black R (\$49.59) sold for a higher price than all colors except gray and yellow, white face. However, black S (\$39.29) was intermediate in value and differed from yellow (\$40.26), white (\$40.14), spotted (\$38.57) and red, white face (\$38.38). Price differed ($P < 0.001$) between frame sizes \$47.08, \$49.46, and \$48.11; and \$40.19, \$39.07 and \$35.28 for large, medium and small R and S, respectively. Number 1 and 2 muscled R was similarly valued ($P = 0.11$) and both were higher ($P < 0.001$) than 3's. Price was highest for number 1 and lowest for number 3 ($P < 0.001$). S. The results indicated that cow type, R vs. S, affected sale price and the effect of cull cow characteristics on sale price differed between R and S cows.

Key Words: Value, Replacement cows, Slaughter cows

715 Evaluating the Use of Benchmarks or Expert Opinion in Making Herd Management Decisions. C.N. Vierhout*¹ and J.S. Clay, ¹*North Carolina State University.*

In their daily decision-making, dairy producers often must choose between the advice of expert opinion and benchmarks of the performance of other herds. Each form of advice is readily available in popular dairy press articles, web sites and in person. But, rarely are both experts and benchmark comparisons available from a single source that encourages customization. DairyMetrics is a web-based system of dairy farm performance information that enables users to combine both experts and benchmarks in a customizable form. With this application, dairy producers, consultants and extension personnel can choose from a series of experts to evaluate herd performance. They also can filter herds for comparison depending on 85 parameters from 14,200 herds with 1.7M cows. The combination of expert opinion and benchmark comparison provides insight to what is ideal and achievable. DairyMetrics provides information about the specific herd plus means, minimums and maximums for cohort herds. It also presents percentiles for each herd performance parameter in comparison to the cohort group. Users can view and print graphs of specific performance measures for the herd and for the cohorts using monthly data from the recent year or annual data from the previous five years. Optional expert opinions can identify herd parameters that trigger either an alarm or approval. Herd parameters that are acceptable are distinguished from alarms and approved values.

Consultants can register for expert status and must provide justification of their opinions.

Key Words: DairyMetrics, Benchmarking, Dairy Management

716 Effects of neck rail position on dairy cattle behavior. Cassandra Tucker* and Daniel Weary, *University of British Columbia Vancouver BC Canada.*

Dairy producers are faced with a variety of recommendations for free-stall design, but the effects of these design options on cow behavior have received little systematic research. In a series of experiments we have assessed the effects of neck rail position on cow behavior and stall cleanliness. In one experiment, we compared 4 levels of neck rail height (none, 100, 113, and 125 cm) in a preference test. Eleven Holstein cows were individually housed with access to 4 free-stalls. Cows showed no preference based on neck rail height and when the cows were restricted to each of the 4 stalls, there was little effect of height on how long cows spent lying in stalls. However, cows spent 1.0 h / day longer standing in stalls with no neck rail compared to stalls with a 100 or 113 cm rail (repeated measures ANOVA, $P < 0.05$). In a second experiment, we examined neck rail placement in relation to distance from the curb, when height was held constant at 125 cm. Although distance of the neck rail from the curb did not affect total time spent standing in the stall, it did affect the type of standing. When the neck rail was farther from the curb (168 cm compared with 150 cm from the curb), animals averaged 15 min/day more standing with all four hooves in the stall and had an equivalent reduction in the amount of time spent standing with only front hooves in the stall (paired t-test, $P < 0.05$). In a third experiment, we compared defecation behavior (cow position and location of defecation or urination) of 14 heifers with and without a 123 cm neck rail in a cross-over design. When the heifers stood with all four hooves in the stall, in the absence of the neck rail, defecation and urination were twice as likely to contact the stall surface (paired t-test, $P < 0.05$).

Key Words: Free-stall design, Cow comfort, Preference testing

717 Explanations associated with non-optimal culling rates. G. Hadley*¹, C. Wolf², and S. Harsh², ¹*University of Wisconsin - River Falls, Agricultural Economics Department,* ²*Michigan State University, Department of Agricultural Economics.*

Average annual culling rates in the United States are consistently and significantly higher than the #optimal# culling rate estimated by researchers. Since 1996, DHIA data shows that Midwestern dairy farms exhibit average annual culling rates of 38 percent. Conversely, research conducted by Jones (2001) estimated that optimal culling rates for Wisconsin herds should range between 22 and 24%. The objective of this paper is to account for the discrepancy between actual and optimal culling rates. Using DHIA data on individual herd culling practices for 10 Midwestern and Northeastern states from 1985 - 2000, four culling rate discrepancy explanations were examined: manager error (informational problems such as incorrect genetic improvement rates and inaccurate replacement heifer costs), herd health issues (inaccurate herd health cull probabilities), omitted farm effects (labor constraints and initial farm conditions), and omitted industry and market effects (relative prices). When overly optimistic genetic improvement rates or undervalued replacement heifer costs were substituted into a culling decision model, higher culling rates were favored. Using herd health culling probabilities that more accurately reflected those encountered in the two geographical regions resulted in an estimated #optimal# culling rate that was more reflective of actual rates. Incorporating different labor constraints and initial farm conditions (i.e., constant herd size versus expanding herd size) resulted in different optimal culling rates. An OLS regression was used to determine the effects of relative prices on culling rates for Michigan DHIA herds. Significant variables included the cull cattle price # replacement heifer cost spread, the milk-feed price ratio, interest rates, and wages.

Key Words: Culling, Dairy, Farm Management

718 Issues initial expanders should consider before expanding a dairy farm. G. Hadley^{*1}, C. Wolf², and S. Harsh², ¹University of Wisconsin - River Falls, Agricultural Economics Department, ²Michigan State University, Department of Agricultural Economics.

This paper's objective is to describe issues initial expanders (managers without prior expansion experience) should consider before making an expansion decision. The key issues considered in this paper were synthesized from a case study of 20 dairy farm expansions in the Upper Midwest. An initial expander should determine why he or she desires to expand a dairy operation. The majority of successful operations in the case study expanded for economic improvement reasons. Next, the initial expander should determine whether or not someone with expansion expertise should be consulted. While previous expansion experience was nearly perfectly correlated with expansion success in the case study, having an expansion consultant improved the initial expander's probability of success. Key expansion management skills identified in the case study included human resource, operations, financial, herd, strategic and public relations management. Managers who do not possess these skills should consider taking coursework, hiring the expertise, or partner with other managers who do. Initial expanders should consider different expansion options. When modernization occurred with expansion, the expansions were more successful from a production, herd health, and financial perspective than expansions that added on to antiquated facilities. Initial expanders should also be flexible in sizing their expansion. Many of the initial expanders in the case study originally planned to expand to a smaller herd size. After conducting feasibility studies, these managers found that the smaller expansions were not financially viable. A second size consideration is to make sure that the herd is large enough to fully compensate all managing partners for their labor, capital and management. For the fourteen farms choosing to report financial information, thirteen posted positive Net Farm Incomes the first two years following expansion. Unfortunately, only two fully compensated their owners for their unpaid labor, capital and management.

Key Words: Expansion, Dairy, Farm Management

719 Identification and characterization of location factors for relocating dairy farms. J. E. Winkler^{*} and N. R. St-Pierre, *The Ohio State University, Columbus.*

A survey was conducted to determine the importance of various location factors during the location decision process of relocating dairy farms. The objectives of this study were 1) to identify the importance of location decision factors (LDF) and 2) to characterize how the importance of LDF differs among respondents with different demographic characteristics. Information was collected from randomly sampled populations of Grade A milk producers from the top 35 milk producing states in the United States and agribusiness professionals using a mailed questionnaire. Location factors (n=110) were rated in terms of importance on a numerical scale of 0 to 10, where 0 = not important and 10 = critically important. Demographic data were collected from each respondent. Of the 906 respondents, 72.4% identified their primary occupation as dairy producer. The five most important LDF overall were: availability of fresh water supplies (9.16 0.047); availability of land for waste management (8.94 0.052); average mailbox price of milk (8.79 0.050); quality of fresh water supply (8.41 0.061); and complexity of laws governing waste management (8.35 0.064). Other factors relative to dairy production activities, such as the cost of feeds, and current implications of animal agriculture were among the upper quartile in terms of importance. The four least important factors were: local presence of established niche markets (4.14 0.096); proximity to an airport (4.11 0.084); proximity to cultural centers (3.36 0.078); and proximity to recreational areas (3.24 0.081). A multivariate analysis indicated that region ($P < 0.001$) and herd size ($P < 0.01$) had a significant effect upon the overall importance of LDF. The relative importance of factors differed between western and eastern regions ($P < 0.05$). Age ($P < 0.01$), gender ($P < 0.05$), and education ($P < 0.01$) also significantly influenced the relative importance of factors. No significant difference was found between dairy producers and agribusiness respondents. The differences in importance of factors among respondents from various demographic backgrounds indicate that economic development organizations interested in enhancing their local dairy industry might benefit from targeted marketing programs.

Key Words: Farm Location

720 Real Option Analysis to evaluate products used in dairy production. D. T. Galligan¹, H. Groenendaal¹, J. D. Ferguson¹, and G. Azzaro², ¹University of Pennsylvania, ²Consorzio Ricerca Filiera Lattiero Casearia.

A real option analysis approach was used to evaluate the economic value of a product where dairy managers can exert discretion about the continued use of the product. Traditional net present value analysis (partial budgeting analysis) ignores the potential value for management to respond to resolved uncertainty at a certain time point and thus underestimates the true value of a product. Bovine somatotropin was used as the example product since production response data is available as well as knowledge about its variability (mean response of 5 kg/d with a STD of 1.3). An abandonment decision option was modeled using @Risk software in Excel where response on a herd was described as a random variable. With current milk (10 dollars per cwt) prices, marginal feed cost (3 cents/lb), product cost/cow/day 41 cents; traditional partial budget analysis yielded a 35 cent profit/day. Real option analysis, where it was assumed that management would intervene and assess production response after 1 year, suggested that this estimate was low by 9 percent. As the time to resolution of uncertainty increased, the disparity between real option analysis and traditional partial budget analysis decreased. If the variability of response was increased the difference in value between traditional analysis and real option analysis also increased. Investments that have a variability component, which can influence value and where management decisions can respond to resolved uncertainty and have better decisions will be undervalued if traditional economic approaches are used.

Key Words: Real Options, Managerial Flexibility, Net Present Value

721 The use of ear tags and injectable transponders for the electronic identification and traceability of pigs. G. Caja^{*}, M. Hernandez-Jover, D. Garin, C. Conill, X. Alabern, B. Farriol, and J. Ghirardi, *Universitat Autònoma de Barcelona, Bellaterra, Spain..*

A total of 557 piglets were identified between wk 1 and 3 of age by using different devices: 1) control button tags (C, n= 348); 2) two electronic ear tag types (E1, n= 106; and, E2, n= 103); and, 3) five sizes of injectable transponders grouped as: small (S) of 12- (n= 90) and 13-mm (n= 87), medium (M) of 23-mm (n= 89), and large (L) of 31- (n= 86) and 34-mm (n= 91). Injects were placed in two body sites: s.c. in auricle base (AB; n= 248) and intraperitoneally in the ventral abdomen (IP; n= 309). Pigs were slaughtered at 100 kg BW. Readability and traceability were recorded for all devices during the fattening period and throughout slaughtering. No negative effects were observed after the application of any device. On farm results showed that ear tag losses differed according to the device (C, 1.1%; E1, 8.8%; and E2, 44.9%; $P < 0.001$). Electronic failures were lower ($P < 0.001$) for E1 (5.5%) than E2 (55.1%) and total unreadable were 14.3% and 100% for E1 and E2, respectively. Injects losses in the farm varied ($P < 0.001$) according to injection site and transponder size. Losses in AB (S, 19.5%; M, 29.8%; and, L, 63.0%) only differed ($P < 0.001$) between extremes. Only one S transponder was lost in IP, probably as a consequence of an intestinal placement, and IP losses totaled 0.4%. The C and E1 ear tags had similar transport losses (1.2%). Slaughtering losses for C (11.3%) and E1 (6.1%) did not differ and 12.8% more E1 failed electronically. Unreadable ear tags were 12.3% for C and 20.5% for E1 ($P = 0.07$). Injection site affected losses and breakages in the slaughtering line (AB, 6.3%; and, IP, 0%; $P < 0.05$) but transponder size did not. As a result traceability varied dramatically between ear tags (C, 86.7%; E1, 68.1%; and, E2, 0%) and injects (AB: S, 72.7%; M, 70.2%; and, L, 34.6%; and, IP: S, 99.0%; M, 100%; and, L, 100%). No intraperitoneal injects were found in the carcasses. The intraperitoneal injection with 23- to 34-mm is proposed as a method for the identification of piglets and as a traceability tool for the pig industry.

Key Words: Electronic Identification, Transponder, Swine

722 Milk industry in Hungary. Huda F Salem, Zoltan Dr Lakner, J Sandor Dr Zsarnocszai^{*}, and Laszlo Dr Villanyi, *Szent Istvan University, Godollo, Hungary.*

Hungarian milk industry has developed rather rapidly in period socialist economic development between 1949 and 1989. Main pillars of this development were: the heavy subsidisation of milk production, the state ownership of milk processing capacities, subsidised consumer price of

the milk. Under consumption the impetus for product innovation were rather weak and the efficiency of milk processing was rather low. After the privatisation the overwhelming Hungarian milk production capacities were privatised by Western European investors. There were some hopes concerning the privatisation of milk factories to agricultural producers, but they did not have money either for buying or for financing the production. In some cases milk producers got a minority ownership, but this was not enough to get through their interests. The multinational enterprises follow three different strategy types: cost-leadership, differentiation and focussing local producers. Rapid development was resulted by introduction of ISO 9000 norms, and HACCP systems. Important problem of Hungarian milk sector was the limited purchasing power of Hungarian consumers. It makes a limited possibility for product development. 80% of domestic purchasing of milk and milk-products are marketed through the 6 largest commercial companies. These companies

utilise the tactic of predatory pricing or economic pressure in process of determination of prices. The government lays not enough weight on the handling of this problem, because this price-pressure strategy of commercial companies is a good tool in fighting against the inflation. This is a short-term possibility however, because the 1,5-2,0 real profit level does not give technical upgrading. The EU joining means new threats and possibilities for milk processing sector. The most important threat is the introduction of milk-quota system. It is an open question, whether after the EU joining the multinational enterprises, producing in Hungary. The higher costs and the export-defence system of non-EU members is an important factor of decision, in second case the loss of Hungarian workplaces, processing capacities and the lower level of material and human infrastructure are the most important factors.

Key Words: Milk industry, Marketing, Multinational enterprises

Ruminant Nutrition Ruminal Fermentation

723 Ruminal fluid effects on in vitro digestion kinetics of corn starch. F. M. Fickett* and M. S. Allen, *Michigan State University, East Lansing.*

Effects of rumen fluid on digestion kinetics of corn starch in vitro were evaluated. Four ruminally-cannulated cows were used in an experiment using a crossover design for diet with a 2 x 2 x 2 factorial arrangement of treatments. Rumen fluid was from cows offered diets formulated to 21% and 32% dietary starch, and collected at two times relative to feeding (one hour before, or two hours after feeding). Periods were 14 d in length for which 12 d were allowed for diet adaptation and 2 d for rumen fluid collection. One cow from each dietary treatment group was sampled both before and after feeding on each collection day. Substrate treatments were dry corn grain with floury or vitreous endosperm, ground in a Wiley mill with a 2 mm screen. Amounts of media, blended and filtered rumen fluid, and substrate used for incubations were 40 ml, 10 ml, and 0.25 g, respectively. Flasks were incubated under positive carbon dioxide pressure for 0, 1.5, 3, 6, 10.5, 16.5, and 24 h. Residual starch was determined following incubation. Disappearance curves were fit to a 1-pool exponential decay model with discrete lag using non-linear regression. No interactions of treatments were detected for rate of starch digestion, which was higher for floury compared to vitreous endosperm (43.6 and 28.5 %/h, $P < 0.001$) and higher after feeding compared to before feeding (41.2 and 30.9 %/h, $P < 0.01$). Rate of starch digestion was not affected by dietary starch concentration. An interaction was observed between dietary starch concentration and endosperm type for digestion lag time ($P < 0.01$). Lag time was greater for vitreous compared to floury endosperm for the high starch diet (2.33 vs. 1.90 h) but lower for the low starch diet (1.87 vs. 2.76 h). Lag time was greater ($P < 0.01$) when rumen fluid was collected after meals compared to before meals (2.53 h and 1.90 h). Effect of time relative to feeding on rate of digestion is attributed to differences in enzyme activity of rumen fluid, which was not different for diets varying in starch concentration.

Key Words: Starch digestion kinetics, Rumen fluid, Corn endosperm type

724 Comparison of fermentation parameters in ruminal fluid collected from lactating dairy cows at different production levels. S. A. Martin¹, T. G. Nagaraja², T. C. Jenkins³, S. E. Ives², H. J. Strobel⁴, J. Sullivan⁵, K. Murphy⁵, D. Luchini⁵, S. Koenig⁵, and J. L. Klingener¹, ¹University of Georgia, Athens, ²Kansas State University, Manhattan, KS, ³Clemson University, Clemson, SC, ⁴University of Kentucky, Lexington, ⁵Bioproducts, Inc., Fairlawn, OH.

The objective of this study was to compare ruminal fermentation parameters and ciliated protozoal populations in lactating cows at three different production levels. Ruminal contents were collected via stomach tube from Holstein cows at a commercial dairy in California. The ruminal contents were obtained approximately 1.5 h after feeding from five cows within each of three different production levels (low = 13,736 kg, medium = 16,479 kg, high = 19,716 kg). Immediately after collection of each ruminal fluid sample pH was measured and aliquots of samples were fixed in formal-saline for protozoal enumeration. Volatile fatty acids, malate, lactate, ammonia, and protein were also determined. When ruminal fluid samples from each production level ($n = 5$) were analyzed, pH was lower ($P < 0.05$) for the low producing cows compared

to the medium and high groups. Concentrations of acetate, propionate, butyrate, isovalerate, and valerate were lower ($P < 0.05$) in ruminal fluid from the medium and high producing cows. Ammonia concentrations were lower ($P < 0.05$) in the high producing cows. When compared to the ruminal fluid from the low production cows, lactate and protein concentrations were numerically lower and the acetate:propionate ratio was numerically higher in the medium and high production samples. There were no significant differences in protozoal populations between the three production levels with the exception of *Entodinium* numbers being lower ($P < 0.05$) in the medium production group compared to the low production group. While it is unclear what specific factors are responsible for these differences between production groups, our results suggest that cows at the medium and high production levels had higher ruminal pH and lower concentrations of most fermentation end products compared to the low producing cows. These differences may be associated with greater ruminal turnover and/or absorptive capacity in the medium and high production animals.

Key Words: Rumen, Fermentation, Dairy cattle

725 Dose-response effects of propionate infusion on feeding behavior and plasma metabolites in lactating dairy cows. M. Oba* and M. S. Allen, *Michigan State University, East Lansing, MI.*

Three experiments were conducted to evaluate dose-response effects of intra-ruminal infusion of propionate on DMI. Infusion treatments were mixtures of sodium propionate and sodium acetate, at ratios of 0:5, 1:4, 2:3, 3:2, 4:1 and 5:0, infused into the rumen continuously for 18 h starting 6 h before feeding. Dose-response effects of propionate on DMI and plasma metabolites, and their relationship were summarized. In experiment 1, DMI decreased and plasma glucose concentration (PG) increased linearly as propionate infusion increased. In experiment 2, DMI did not decrease at lower rates of propionate infusion which were associated with greater increases in PG, but DMI decreased at higher rates of propionate infusion associated with a much lower marginal response in PG. Marginal response in DMI (kg/12h) per mmol/min of propionate infusion was negatively related to PG across treatment means for these experiments ($r^2 = 0.26$; $P < 0.01$; marginal DMI response = $13.6 - 0.23 \times \text{PG}$). We speculated that hypophagic effects of propionate are lower when propionate is extensively utilized for gluconeogenesis and greater when the marginal effect of infused propionate on PG decreases, increasing oxidation in the liver. One inconsistency is that cows in early stage of lactation in experiment 3 decreased DMI linearly at lower rates of propionate infusion despite a greater marginal increase in PG. However, plasma concentration of β -hydroxybutyrate was greatly reduced at lower rates of propionate infusion for cows in early stage of lactation in that experiment. At lower rates of propionate infusion, propionate might have stimulated complete oxidation of acetyl CoA in the liver while partially utilized for gluconeogenesis. These observations were consistent with our hypothesis that propionate decreases feed intake in lactating dairy cows by stimulating oxidative metabolism in the liver.

Key Words: Propionate, Oxidative metabolism, Plasma glucose

726 Metabolism of stable isotopically labeled elaidic acid to stearic acid and other *trans* monoenes by ruminal microbes. J. Proell, E. E. Mosley, and T. C. Jenkins*, *Clemson University, Clemson, SC.*

A previous study (Mosley et al. 2002. *J. Lipid Res.* In Print) showed that oleic acid was converted by mixed ruminal microbes to stearic acid and also converted to a multitude of *trans* octadecenoic acid isomers. This study was conducted to trace the metabolism of one of these *trans* C18:1 isomers upon its incubation with mixed ruminal microbes. Unlabelled and labelled (^{13}C -18- *trans*-9 C18:1) elaidic acid were each added to three in vitro batch cultures of mixed ruminal microbes. Samples were taken at 0, 12, 24, and 48 h and analyzed for ^{13}C enrichment in component fatty acids by gas chromatography-mass spectrometry. Enrichments were corrected for natural ^{13}C abundance in unlabelled cultures and then triplicate enrichments were analyzed by t-test to determine if they differed from zero. At 0 h of incubation, enrichment was 37% ($P < 0.01$) for *trans*-9 C18:1, but not significant for stearic acid or any *trans* C18:1 isomer. By 48 h of incubation, ^{13}C enrichment was 18% ($P < 0.01$) for stearic acid and ranged from 7 to 30% ($P < 0.01$) for all *trans* C18:1 isomers having double bonds between carbons 6 through 16. Two additional cultures were run to determine if movement of the double bond from elaidic acid to other *trans* C18:1 isomers required the presence of the ruminal microbes. One culture contained unlabelled elaidic acid and the other contained labelled (^{13}C -18- *trans*-9 C18:1) elaidic acid, but neither were inoculated with ruminal microbes. After 48 h, ^{13}C enrichment was only detected in the original elaidic acid. This study shows that ruminal microbes transform elaidic acid to stearic acid consistent with the process of biohydrogenation. Unexpectedly, the ^{13}C label from elaidic acid was also found in a multitude of *trans* C18:1 isomers suggesting that ruminal microbes have the capacity to move the *trans* double bond in elaidic acid from carbon 9 to other carbon positions. Because double bond movement only occurred in the presence of ruminal microbes, the movement is more likely an enzymatic process involving one or more microbial isomerases than it is a nonenzymatic process such as double bond migration.

Key Words: Biohydrogenation, Ruminal Microbes, *Trans* monoenes

727 Effects of pH on nutrient digestion and microbial fermentation in a dual flow continuous culture system fed a high concentrate diet. P.W. Cardozo, S. Calsamiglia*, and A. Ferret, *Universitat Autònoma de Barcelona.*

Eight 1325-mL dual flow continuous culture fermenters were used in two replicated periods (9 days) to study the effects of pH on microbial fermentation and nutrient flow when fed a high concentrate diet. All fermenters were fed 95 g/d of a 10 to 90 forage to concentrate diet (18% crude protein, 20% neutral detergent fiber). Treatments were 8 different pH, ranging from 4.9 to 7.0 (in 0.3 unit increases) and were assigned randomly to fermenters within period. Fermenters were maintained at 39°C, with liquid and solid dilution rates at 10 and 5 %/h, respectively, and pH was controlled by infusion of 3 N HCl or 5 N NaOH. Results were analyzed for linear (L), quadratic (Q) and cubic (C) effects ($P < 0.05$). The increase in pH resulted in a L increase in the true digestion of organic matter (OM), neutral detergent fiber and acid detergent fiber, and a L decrease in true digestion of dry matter. Effects were L for total volatile fatty acid (highest at pH 6.1, 129 mM; and lowest at pH 4.9, 100 mM), for the proportion of acetate (highest at pH 7.0, 62%; and lowest at pH 4.9, 36%), propionate (highest at pH 5.5, 51%; and lowest at pH 7.0, 21%) and branched-chain VFA (highest at pH 7.0, 5.9%; and lowest at pH 5.5, 0.3%), and for the acetate to propionate ratio (highest at pH 7.0, 3.0; and lowest at pH 4.9, 0.8). Effects were Q for ammonia N concentration (highest at pH 6.7, 6.7 mg N/dL), and bacterial N flow (highest at pH 7.0, 1.3 g/d). The pH resulted in a C effects for dietary N flow (highest at pH 5.8, 2.3 g/d; and lowest at pH 6.7, 1.6 g/d), crude protein degradation (highest at pH 6.1, 24.1%; and lowest at pH 5.8, 13.4%), and the efficiency of microbial protein synthesis (highest at pH 7.0, 31.0; and lowest at pH 5.8, 18.4 g N/kg OM truly digested, respectively). Results indicated that the fermentation profile of a high concentrate diet was optimized at pH between 6.1 and 7.0, and that most measurements followed a linear response.

Key Words: Microbial fermentation, pH

728 Advancements in the quantification of protozoal nitrogen flow to the duodenum using molecular-based analyses. J. T. Sylvester*, S. K. R. Karnati¹, Z. Yu¹, C. J. Newbold², B. A. Dehority¹, M. Morrison¹, and J. L. Firkins, ¹*The Ohio State University, Columbus, OH, USA*, ²*Rowett Research Institute, Bucksburn, Aberdeen, UK.*

Attempts to quantify protozoal protein in duodenal contents have been inaccurate due to a lack of marker specificity. Current microbial markers (i.e., purines) do not separate bacteria from protozoa; therefore, procedures to measure microbial production and intra-ruminal recycling due to protozoal lysis have been limited. The current objectives are to report on progress made towards development of a molecular-based assay using 18S rDNA as a marker for protozoal N quantification. Rumen fluid was isolated from approximately 2.5 kg of rumen digesta. The particulate fraction was washed with anaerobic buffer to enhance protozoal recovery, and the wash was added to the rumen fluid. After incubation at 39°C for 45 min, the flocculent scum layer was aspirated. After fixation in 1% formalin, protozoa were enriched, washed, and isolated using centrifugation and filtration. The extraction method had linear DNA recovery for both formalin-treated and non-treated samples, and genomic DNA was successfully isolated from enriched protozoa, rumen fluid, and duodenal digesta. Ciliate protozoal specific PCR primer sets were designed to amplify a 1.5-kb fragment of the small subunit rRNA gene by conventional PCR methods, which was confirmed by electrophoresis and ethidium bromide staining and via subsequent cloning and sequencing. A second set of primers was designed and verified for real-time PCR (RT-PCR) to amplify an approximate 300-bp fragment standardized against amplified and purified PCR product containing the 1.5-kb fragment from each sample. After comparing predicted rDNA copy numbers generated by RT-PCR with microscopic counts of enriched protozoa and rumen fluid, protozoal flow to the duodenum can be estimated. More work is needed to optimize DNA recovery during purification and account for variability among replicates prior to in vivo comparison to the standard use of purines as a microbial marker.

Key Words: Protozoal N, SSU rRNA, Real-time PCR

729 Effect of medium pH on microbial crude protein yield, pH, and neutral detergent fiber digestion from fermentation of neutral detergent fiber and sucrose in vitro. L. Holtshausen*,¹ and M. B. Hall¹, ¹*Dept. of Animal Sciences, University of Florida.*

The effect of medium pH on yield of microbial crude protein (MCP), pH, and NDF digestion in fermentations of NDF and sucrose with mixed ruminal microbes was examined in two 24 h batch culture fermentations in 50 ml tubes fitted with gas release valves. Initial media pH were 6.8 (N) and 5.6 (A) for the control (Goering/Van Soest medium) and citric acid treatment (4.4 ml of 1M citric acid solution/100 ml of Goering/Van Soest medium), respectively. Substrates were isolated bermudagrass neutral detergent fiber (iNDF) and a 50:50 blend of iNDF plus sucrose (SuNDF) (240 mg of substrate/tube). Fermentation tubes for each substrate and medium were destructively sampled at 0, 4, 8, 12, 16, 20 and 24 hours and analyzed for MCP, pH, and residual NDF. MCP yield was estimated as trichloroacetic acid precipitated crude protein (TCACP) corrected for medium and substrate TCACP at 0 h and the mean of fermentation blanks for the specific hour. All values presented are least squares means. Significance was declared at $P < 0.05$. MCP yield from SuNDF and temporal pattern of yield differed between media. Maximum MCP yield was recorded at 12 h for N and 20 h for A. Maximum MCP yield was almost double for N (19.2 mg) compared to A (10.9 mg). NDF digestibility and magnitude of pH change differed between media and between substrates within each medium. At their minima, the difference in pH between iNDF and SuNDF was greater for A (6.07 at 0 h and 5.25 at 8 h, respectively) than for N (6.99 at 0 h and 6.71 at 4 h, respectively). For N, 24 h NDF digestion was greater for SuNDF (42.4%) than for iNDF (26.4%) as substrate. The reverse was true for A, (% NDF digestion for SuNDF: 2.2% and iNDF:7.8%). As compared to N, NDF digestion and MCP yield were decreased in A. Inclusion of sucrose improved NDF digestion at neutral pH, but decreased NDF digestion at acidic pH. We conclude that in vitro media pH affects NDF digestion, MCP yield, and magnitude of pH change with SuNDF substrate, and the presence of sucrose may increase NDF digestion at neutral pH.

Key Words: sucrose, nonfiber carbohydrates, fermentation

730 Enhancing ruminal concentrations of conjugated linoleic acid and trans vaccenic acid. E. S. Kolver*, M. J. de Veth, J. R. Roche, and A. Chand, *Dexel (formerly Dairying Research Corporation), Hamilton, New Zealand.*

Four continuous culture fermenters were used to test the hypothesis that supplementation of a pasture diet with unsaturated C18 fatty acids would increase ruminal synthesis of conjugated linoleic acid (CLA) and trans vaccenic acid (t11-C18:1; TVA). High quality pasture (control) was fermented and supplemented with either oleic, linoleic, or linolenic acid (3.3% of DM) according to a 4 x 4 Latin square design. Digesta samples were collected during the last 3 d of each of the four 9-d experimental periods. Ruminal concentrations of CLA and TVA in the control treatment were 0.09 mg/g ruminal DM, and 1.75 mg/g ruminal DM, respectively. Linoleic and linolenic acid increased ($P < 0.001$) ruminal concentrations of CLA by 15- and 5-fold, and TVA by 9- and 4-fold, respectively. Oleic acid increased ($P < 0.001$) TVA concentrations 2-fold, but did not change CLA concentrations. The predominant CLA isomers (as a percentage of CLA isomers) were t9,t11-CLA (39%; control), t9,t11-CLA and c9,t11-CLA (38% and 38%, respectively; oleic treatment), c9,t11-CLA (67%; linoleic treatment), and c9,c11-CLA (44%; linolenic treatment). Low ruminal concentrations of t10,c12-CLA were observed in the control (0.007 mg/g ruminal DM), with increased ($P < 0.05$) concentrations only observed in the linoleic treatment (0.155 mg/g ruminal DM). Treatments did not differ in true DM digestibility and microbial synthesis, and fiber digestibility in supplemented treatments was the same or higher ($P < 0.05$) than the control. These results can be used to predict the ruminal CLA and TVA response to lipid feed supplements. In addition, a new pathway is proposed that yields CLA intermediates from the biohydrogenation of linolenic acid. Linolenic acid is the predominant fatty acid in pasture. These results suggest that the production of CLA and TVA from linolenic acid may be the reason why high concentrations of milkfat CLA have been reported for cows fed pasture.

Key Words: CLA, Ruminal, Pasture

731 Nutrient yields from in vitro fermentations of sucrose and neutral detergent fiber by mixed ruminal microorganisms. M. B. Hall*¹ and P. J. Weimer², ¹*Dept. of Animal Sciences, University of Florida*, ²*U.S. Dairy Forage Res. Ctr., Agricultural Research Service, USDA, Madison, WI.*

The effect of level of sucrose on nutrient yield by mixed ruminal microbes was evaluated in vitro in two 24 h fermentations in sealed vials. Isolated bermudagrass (*Cynodon dactylon*) NDF (130 mg) were incubated with sucrose (Suc) (65, 130, or 195 mg) in Goering/Van Soest buffer with 15% ruminal inoculum (total volume 32 ml/vial). Vials for each level of sucrose were destructively sampled at 0, 4, 8, 12, 16, 20, and 24 h and analyzed for microbial crude protein (MCP), dextran, organic acids, and residual sucrose, glucose (Glc), and fructose (Fru). To estimate MCP, vial contents were precipitated at a concentration of 20% trichloroacetic acid (TCA), and filtered to collect unfermented NDF and precipitate. Collected residues were analyzed for crude protein (CP) as combustion N x 6.25. MCP was estimated as TCA-precipitated CP corrected for the TCA-precipitated CP content of substrates at 0 h, and the mean of fermentation blanks from each hour. Significance was declared at $P < 0.05$. Least squares mean values are reported. MCP yield increased linearly with increasing Suc, but MCP mg/Suc mg declined linearly. MCP yield peaked at the 8 h sampling, and exhibited a slow decline through 24 h. No Suc was detected in the media at 0 h. Fru declined to undetectable levels by 4 h. Glc exhibited a similar decline, but was detected through 4 or 8 h. Dextran yield increased linearly with increasing Suc and peaked at 4 h. The proportion of Suc converted to dextran decreased with increasing Suc. pH at 24 h declined linearly with increasing Suc (6.28, 6.14, and 5.94, respectively). Organic acids increased rapidly to 4 h then linearly but more slowly through 24 h. Organic acid yield at 24 h increased linearly with Suc. At 24 h, molar percentages of acetate decreased linearly, propionate increased quadratically, and butyrate increased linearly with increasing Suc. Lactate was transiently observed at 4 h. Lactate yield increased quadratically with increasing Suc. Total nutrient yield mg (MCP+dextran+organic acids)/Suc mg at 24 h decreased linearly as Suc increased (1.17, 0.89, and 0.79, respectively). Thus, increasing Suc supplementation increased nutrient yield,

decreased yield of nutrients/Suc mg, and altered the profile of organic acids produced.

Key Words: sucrose, nonfiber carbohydrates, fermentation

732 Effects of mild heat challenge on rate of passage and rumen fermentation in lactating dairy cattle. K. M. Spurlin*, J. Porter, M. Ellersieck, and J. N. Spain, *University of Missouri - Columbia.*

An environmental chamber study was conducted to evaluate passage rate and rumen fermentation of cows exposed to various levels of heat challenge. Six fistulated, lactating cows were used to compare 4 cooling strategies. Treatments were 24 h (24H), 12 h nighttime (12N; fans on between 1900 - 0700), 12 h daytime (12D; fans on between 0700 - 1900), and no fan cooling (NO). Treatments were administered during consecutive 14 d periods arranged as a 4x4 Latin Square. Periods were comprised of a 6 d thermoneutral (TN; constant 20C) period, 3 d step-up, and a 5 d heat challenge (HC). During HC, maximum ambient temperature was held at 33C from 1400 - 1800 and lowered to 23C from 0200 - 0600. Feeding occurred at 0600, 1400, and 2200 h daily with refusals and water consumption measured prior to each subsequent feeding. At the morning feeding on days 4 and 12 of each period, 110 g of Cr-mordanted alfalfa hay, 200 g of Yb-labeled soyhulls, and 200 ml of Co-EDTA were dosed into the rumen of each cow. Samples of whole rumen contents were collected at 0 (immediately before dosing), 4, 7, 10, 13, 16, 19, 22, 28, 32, 38, and 54 h post-dosing. Fluid was analyzed for pH and concentrations of ammonia, VFA, and Co. Solid contents were analyzed for Cr and Yb by atomic absorption spectroscopy. Cooling treatments were not different, thus comparisons are between TN and HC. Hay, soyhull, and liquid passage rate were 4.9, 7.4, and 11.6%/h during TN, and were 4.1, 6.7, and 11.1%/h during HC, respectively. The rate of passage for hay and soyhulls declined 16.8 and 10.2% ($P < 0.05$), respectively, during HC. Particle size influenced both absolute passage rate and the reduction due to HC. Dry matter intake was not different on day of dosing indicating heat stress directly reduced passage rate, which may contribute to gut fill and a subsequent reduction of DMI. Rumen pH reflected an acute response to HC compared to TN with the initial difference influenced by changes in intake patterns. This was followed by a chronic decline in rumen pH. Both acute and chronic responses were noted for ammonia and VFA concentrations with ammonia levels increased during chronic HC. Rumen function is altered during HC by means related to, but not solely controlled by changes in DMI.

Key Words: Heat stress, Passage rate, Fermentation

733 Characterizing volatile fatty acids and other gases in a rumen closed in vitro fermentation system. Jarett Spinhirne¹, Jacek Koziel*¹, and Norbert Chirase^{1,2}, ¹*Texas Agricultural Experiment Station, Texas A&M University*, ²*West Texas A&M University.*

Fermentation characteristics of feedstuffs in vitro reflect their metabolism in the rumen and more importantly, the kinetics of that metabolism. Qualitative and quantitative characterization of these volatile organic products in ruminal fluids involves rigorous liquid sampling and sample preparation procedures. A new method for the rapid sampling and characterization of the headspace gases of closed in vitro cultures using solid phase microextraction (SPME) was evaluated for ruminal fluid and ruminal fluid with feed containing a new feed additive. One min samples were collected every h for 27 h using a DVB/Carboxen/PDMS 50/30 SPME fibers followed by immediate analysis on a GC-MS. Trends of quantities of specific detected gases were plotted and compared for ruminal fluid and rumen fluid with additive cultures over the time of the experiment. Acetic, propionic, butyric, isobutyric, isovaleric, and valeric acids were detected in the headspace. This finding is consistent with current knowledge because low molecular weight volatile fatty acids (VFAs) have been used to determine the energetic efficiency of microbial fermentation in the ruminant. In addition, several other new compounds including hexanoic acid, toluene, dimethyl disulfide, nonanal, octanal, and pentadecane were also identified. Gas quantities above ruminal fluid with feed were always greater than those of ruminal fluid alone except for samples obtained 1 to 2 h post incubation. SPME technology facilitated rapid sampling and immediate analysis to identify specific end products of microbial digestion in the headspace. These end products are frequently used for predicting diet quality, effectiveness of feed additives in selecting against specific

rumen microbes and for manipulation of diets to reduce the production of odorous compounds. SPME-based approach could serve as a novel technique for the development of an alternative method for characterization of ruminal fermentation end products, and effects of important variables on their kinetics. Characterization of rumen gases that were not detectable or previously not of interest may open new approaches and applications related to animal (and perhaps in the future human) metabolism.

Key Words: Detection, Ruminal gases, Gas chromatography - mass spectrometry

734 Inhibition of methanogenesis in *Methanobrevibacter (Mbr.) smithii* cultures and ruminal cultures by p-aminobenzoate (pABA) analogs. B. A. DeMontigny*, R. Dumitru, S. Schroeder, H. Palencia, S. W. Ragsdale, J. M. Takacs, and J. L. Miner, ¹*University of Nebraska-Lincoln.*

Ruminal methane production causes a loss of 2 to 12% of feed gross energy during digestion. Methane is a greenhouse gas and livestock account for 17% of total methane emissions. Inhibition of ruminal methanogenesis could both increase feed efficiency and mitigate global warming. Methanogenic archaea use a unique pathway to synthesize methane. The enzyme, 4-(β -D-ribofuranosyl) aminobenzene 5'-phosphate synthetase is a promising target for inhibition. A natural substrate of this enzyme is pABA. We hypothesize that analogs of pABA could inhibit methane production in mixed rumen cultures and pure cultures of *Mbr. smithii*. Methanogenesis assays were conducted in 30-hour, 4-ml anaerobic incubations of bovine rumen fluid in buffer containing trypticase, cellobiose and trace nutrients, with 5.4 ml of headspace pressurized (190 kPa) with H₂/CO₂ (80:20). Headspace methane was quantified by gas chromatography (GC) using a silica gel column, thermal conductivity detection (TCD), and adjustment for headspace pressure, and VFA analyses were completed by GC. Three pABA analogs were included in the cultures from 0 mM to 10 mM. Five mM 4-ethylamino-benzoate (EB), 9 mM 4-isopropylamino-benzoate (IB), and 6mM 4-(2-hydroxy-ethylamino)-benzoate (HEB) each completely inhibited methane production. Eight mM IB enhanced ($P < 0.02$) total VFA production but EB and HEB did not. To determine if these pABA analogs inhibit growth of methanogenic archaea as well as inhibit methane synthesis, we grew pure cultures of *Mbr. smithii*, media included EB, IB, or HEB at 0, 1 and 10mM. Absorbance was measured two times daily for one week via spectrophotometry. After 117 hours, headspace samples were analyzed for methane content. At

10mM, all three compounds completely ($P < 0.01$) inhibited methane production and cell growth. One mM EB and IB each delayed ($P < 0.01$) the growth curve of *Mbr. smithii* >20hours. We conclude that these pABA analogs inhibit methane production as well as the growth of methanogenic archaea.

Key Words: *Mbr. smithii*, rumen, methane

735 Modeling starch digestion in the rumen: a comparative approach. A. Offner*¹, A. Bach², and D. Sauvant¹, ¹*INA P-G INRA, Paris, France, ²Agribands, Barcelona, Spain.*

Digestibility of starch in the rumen (dR, %) is highly variable. This study was conducted to evaluate and compare three different rumen models (Lescoat and Sauvant **LE**, 1995; Molly **MO**, 1999; CNCPS **CO**, 2001) on their ability to predict the partitioning of starch digestion. To perform this study, an independent dataset with complete data on animal characteristics, rations and starch digestibility was built: 31 references (110 treatments) on dairy cows were pooled. Starch content in the experimental diets ranged from 12.1 to 54.7 % of DM (average starch = 30.1 ± 8.6) and the observed dR ranged from 27.2 to 96.7 % (dR = 65.2 ± 16.2). One single library with complete feed model inputs was created for the 43 feedstuffs used in the references. Thus, the comparative simulations were based on identical inputs. The results were evaluated and compared among models and with observed values. Three parameters were used to estimate the accuracy of dR predictions: the coefficient of determination (R^2), the residual standard deviation (rsd, %) and the slope (b). The values were respectively of 0.26, 13.9 % and 0.98 for CO and 0.22, 14.3 % and 0.59 for LE. The regression with MO was not significant. MO tended to underestimate dR (dR *MO*, % = 62.3 ± 9.7) whereas starch digestibility was rather overpredicted in CO and LE. Statistical analyses were also conducted within references, the parameter values were then of 0.78, 8.8 % and 1.02 for MO, 0.89, 6.1 % and 1.24 for CO and 0.90, 6.0 % and 0.71 for LE. Generally, variations in starch digestibility were poorly predicted by MO but were predicted satisfactorily in LE and CO. LE, which is based on *in situ* values, appeared to be the most accurate model, especially when the experiments with large normalized residuals were removed. This result supports our current work dealing with the development of another model of ruminal starch digestion based on *in situ* data and adjusted with *in vivo* observations.

Key Words: Rumen, Modeling, Starch digestion

Ruminant Nutrition Transition Cow

736 Metabolic nutrients for transition dairy cows. D. P. Casper*¹, G. Wernet², and G. B. Ayangbile, ¹*Agri-King, Inc., Fulton, IL, ²Purdue University, West Lafayette, IN.*

Deficiencies in critical nutrients required for metabolic pathways can lead to metabolic complications during the transition period. The high nutrient requirements for the initiation of lactation, in combination with a reduction in dry matter intake prior to calving, could lead to several possible nutrients becoming deficient. These nutrients were formulated into a pack (PK) consisting of niacin, methionine, rumen protected choline, and several B-vitamins along with yucca. This PK was evaluated during the transition period (3 wk prior and 4 wk after calving) using 26 dry pregnant Holstein cows randomly assigned to one of two treatments. All cows were fed a TMR, prior to calving, consisting of (DM basis) 22.9% corn silage, 9.8% haylage, 18.1% alfalfa hay, 14.9% high moisture corn and 34.3% protein supplement, minerals, and vitamins. After calving, a TMR was fed consisting of 9.8% corn silage, 16.6% haylage, 8.8% alfalfa hay, 29.8% high moisture corn and 35.0% protein supplement, minerals, and vitamins. The treatments were the control (C) TMR and TMR containing the PK at .11 kg/hd/d. During the Pre-Calving period, BW (681.2 and 718.1 kg), BW gain (10.0 and 12.7 kg), dry matter intake (10.1 and 10.5 kg/d), and concentrations of blood glucose (47.7 and 44.3 mg/dl) and non-esterified fatty acids (.53 and .69 meq/l) were similar ($P > .10$) for cows fed C and PK, respectively. During the Post-Calving period, BW (575.1 and 592.1 kg), BW loss (-42.9 and -27.4 kg), and dry matter intake (14.6 and 13.3 kg/d) were similar ($P > .10$) for cows fed both C and PK. Yields of milk (

29.2 and 27.4 kg/d), 4% FCM (32.2 and 29.0 kg/d) and solids-corrected milk (27.3 and 24.3 kg/d) were similar ($P > .10$) for cows fed both C and PK. Percentages of fat (4.71 and 4.62%), protein (2.91 and 2.74%), lactose (4.61 and 4.54%), and total solids (13.13 and 12.80%) were similar ($P > .10$) for cows fed C and PK. Concentrations of blood glucose (36.7 and 30.2 mg/dl) and non-esterified fatty acids (.51 and .75 meq/l) were similar ($P > .11$) for cows fed C and PK. Under the conditions of this study it was demonstrated additional nutrients supplied by the PK were not required for optimal performance during the transition period.

Key Words: Choline, Nutrients, Transition cows

737 Effect of timing of sample collection and sample handling on urine pH of close-up dry Holstein dairy cows. P. W. Jardon*, *West Central Soy.*

The objective of this study was to determine the effect of sample handling on urine pH of close-up dairy cows. Samples were collected from cows ($n=31$) in the close-up pen on a Wisconsin dairy at 0, 4, 8, and 16 hrs post-feeding for 2 days. Cows were fed a diet balanced for dietary cation-anion difference (DCAD = (Na + K - Cl - S) = -80 meq/kg). All cows had been on the close-up ration for at least 7 days. The TMR was fed once a day. The first few ml of urine were collected separately from the main stream. The pH was measured within one h of collection. The main stream samples from the 0 hr collection on the first day were then split and stored either at 20°C or at 5°C.

In all samples, the pH of the first few ml of urine were either equal to or higher than the main stream of urine. Mean values were 6.89 and 6.42, respectively ($p < .01$). The pH of samples stored at 5°C rose 0.10 units (range=0 to 0.22) after 24 hrs ($p < 0.01$) and 0.30 units (range of 0.04 to 0.58) after 48 hrs ($p < .01$). The pH of samples stored at 20°C dropped 0.02 units (range=#0.66 to +0.28) after 24 hrs ($p > .05$) and 0.14 units (range of #1.03 to 0.47) after 48 hrs ($p < .05$). Although the mean change was smaller for the samples stored at 20°C, the direction and size of the changes were less consistent.

The mean, SD, min., and max., of pH of urine samples collected 0, 4, 8, and 16 hrs post feeding were 6.34, 0.66, 5.16, 7.79 for 0 hours; 6.02, 0.70, 5.10, 7.42 for 4 hrs; 5.94, 0.61, 5.09, 7.14 for 8 hrs; 5.86, 0.65, 5.11, 7.97 ($p < 0.05$ for 0 hr compared to all others and $p > 0.05$ for all other comparisons).

These results indicate that the first few ml of urine should not be used to assess urine pH because it is more alkaline than later samples. Samples storage either at 0°C or at 20°C will not bias the results. Overnight storage of samples does not appear to bias results, but samples should not be stored for 48 hours. Although urine pH was highest at feeding compared to later times in the day this difference was relatively small and unlikely to bias interpretation. Collecting urine samples at feeding appears to be acceptable.

Key Words: Urine pH, Dietary cation-anion difference

738 Effects of dry cow grouping strategy and body condition score at dry off on performance of dairy cows during early lactation. L. L. Contreras*, C. M. Ryan, and T. R. Overton, *Cornell University, Ithaca, NY*.

One-group dry cow nutritional strategies would simplify management of dry cows on many commercial farms. Multiparous Holstein cows ($n=377$) on two commercial dairy farms were used to determine the effects of feeding a standard two-group dry cow system [three weeks (21 d) on the close-up (1.55 Mcal/kg NE_L, 16.1% CP, 34% non-fiber carbohydrate) diet (treatment S)] versus feeding the close-up diet for the entire dry period (62 d; treatment L) on subsequent milk production and composition, BCS, prepartum plasma NEFA, and postpartum plasma BHBA. Performance data were collected during the first five monthly test days of lactation. Milk yield (42.4 vs. 42.0 kg/d) for treatment S and L was not affected by treatment; however, cows fed treatment S tended ($P < 0.15$) to have higher milk fat percentage (3.66 vs. 3.56%) and had significantly ($P < 0.05$) higher milk true protein percentage (2.83 vs. 2.77%), resulting in trends ($P < .15$) for increased yields of milk fat (1.55 vs. 1.48 kg/d), 3.5% FCM (43.5 vs. 41.8 kg/d), and true protein (1.20 vs. 1.15 kg/d). Cows fed treatment L gained more BCS during the dry period (treatment by time; $P < 0.01$). Interestingly, cows with initial BCS of 3.0 or less (thin) tended ($P < 0.12$) to produce more milk (43.0 vs. 41.3 kg/d) during early lactation than cows with initial BCS of 3.25 or greater (fat). A trend ($P < 0.11$) for an interaction of treatment and initial BCS existed for milk yield such that thin cows fed S produced the most milk (44.1 kg/d) and fat cows fed S produced the least amount of milk (40.6 kg/d); cows fed L regardless of BCS produced an intermediate amount of milk (42.0 kg/d). Prepartum plasma NEFA concentrations and postpartum plasma BHBA concentrations were not affected by treatment. These data indicate that two-group nutritional strategies for dry cows are preferred, and that BCS at dry off should be considered when determining grouping and nutritional strategies for dry cows.

Key Words: Periparturient Cow, Body Condition Score

739 Peripartal changes in fatty acid profiles of blood, adipose tissue, and liver of dairy cows can be modulated by diet. G. N. Douglas¹, J. Rehage², A. D. Beaulieu¹, A. O. Bahaa¹, and J. K. Drackley^{*1}, ¹*University of Illinois, Urbana, IL*, ²*Clinic for Cattle, Hannover, Germany*.

The fatty acid (FA) composition of bovine tissues might impact metabolic regulation and adaptation during the peripartal period. Patterns of change during the peripartal period and the extent to which these might be altered by diet are unknown. Holstein cows ($n=25$) were fed a control diet (1.59 Mcal NE_L/kg) at ad libitum (CA) or restricted (CR) intake, or fat-supplemented (S or U; 1.73 Mcal/kg) diets for ad libitum intake during the last 40 d prepartum to provide 120% (CA, S, and U) or 80% (CR) of NE_L requirements. Fat was supplemented either as a dietary saturated FA mixture (S) or by abomasal infusion

of unsaturated FA (soy oil; U). A single lactation diet was fed postpartum. Groups CR and U had lower prepartum intakes of DM and NE_L. Cows fed S, U, and CR had higher NEFA in plasma prepartum ($P < 0.05$), but peripartal and postpartal NEFA and hepatic total lipid and glycogen contents were similar among treatments ($P > 0.15$). Cows fed U had greater 18:2 but decreased 20:4 and 22:0 in total plasma lipids ($P < 0.05$). In adipose tissue biopsied at d 1 postpartum, CR decreased 14:0 and increased 18:1 vs CA; U increased 18:2 and 18:3 but decreased 18:1, 20:0, and 20:3 vs S ($P < 0.05$). Liver was biopsied at -45 d (covariate), 1, 21, and 65 d postpartum. In hepatic phospholipids (PL), 16:0 and *trans*-18:1 were increased, and 18:0, 20:3, and 20:5 were decreased at d 1 ($P < 0.05$). Treatment \times day interactions ($P < 0.05$) showed that 18:2 was increased and 18:1, 20:3, 20:4, and 22:6 were decreased in PL at d 1 from cows fed U. The FA profile of PL was similar among diets by d 21 postpartum. In hepatic triglyceride (TG), 16:0, 18:1, and 22:0 were higher at d 1 and then decreased by d 21; 18:0, 20:3, 20:4, 20:5, 24:0, and 26:0 were lower at d 1 and then increased by d 21. Both 18:2 and 18:3 were higher at d 1 for U than for S ($P < 0.05$). Changes in blood and tissue FA profile occur during the peripartal period; the potential exists to modify FA profile via dietary manipulation, which in turn could alter metabolic responses.

Key Words: Transition Period, Liver Metabolism, Fatty Acid Profile

740 Rumen fermentation and fiber degradability in pre-fresh transition dairy cows as affected by different levels of dietary crude protein. S. G. Onetti* and R. R. Grummer, *University of Wisconsin - Madison*.

Twelve multiparous rumen-cannulated Holstein cows (758 kg BW) were used to evaluate the impact of dietary crude protein (CP) concentration on rumen fermentation and fiber degradability during the pre-fresh transition period. The diet consisted of 64% corn silage, 17% alfalfa silage, 5% straw and 14% concentrate mix (DM basis). Treatments were 10, 12 and 15% dietary CP (DM basis), and were achieved by replacing part of the straw with urea. Cows were randomly assigned to a CP treatment sequence, with diets going from low to high (10 to 12, 10 to 15, or 12 to 15), or high to low (15 to 10, 15 to 12, or 12 to 10) CP percentage. Diets were fed as a TMR for ad libitum intake. Cows started the experiment at 32 d prior to the expected calving date (ECD) and diets were switched at 18 d prior to ECD, with 10 d of adaptation to the experimental diets and 4 d of data collection. Dacron bags containing the forage portion of the TMR were incubated in the rumen for 0, 2, 4, 8, 12, 24, 48, and 72 h, and rumen samples were collected every 2 h from 0 to 12 h after feeding. Dry matter intake tended to decrease as the CP percentage in the diet was increased. Rumen ammonia concentration increased linearly with increased levels of dietary CP. No treatment effect was observed for ruminal pH and acetate to propionate ratio. Increasing dietary CP concentration had no effect on NDF fractional rate of degradation, NDF degradability, or the potentially degradable fraction. The results of this study suggest that feeding above 10% CP does not enhance NDF degradation in the rumen and may result in a decrease in DMI during the pre-fresh transition period.

	Treatment ¹		Linear effect		
	10	12	15	SE	P=
DMI, kg/d	14.3	13.0	11.3	1.2	.105
NH ₃ -N, mg/dl	3.6	10.1	13.3	1.2	<.0001
pH	6.6	6.5	6.5	.1	.799
A:P ²	3.3	4.3	3.7	.3	.358
Kd ³ , % per h	3.3	3.4	2.9	.7	.816
Degradability, %	36.7	33.9	35.6	2.6	.854
Fraction B ⁴ , %	61.3	50.1	59.5	5.6	.922

¹Dietary treatments were 10, 12, and 15% CP (DM basis).

²A:P=Acetate to propionate ratio. ³Kd=Fractional rate of degradation.

⁴Fraction B=Potentially degradable fraction.

Key Words: Transition period, Crude protein, Fiber degradability

741 Effects of prefresh diet and post parturition drenching on early lactation performance of multiparous holstein cows. B. M. Visser*, J. G. Linn, S. M. Godden, and M. L. Raeth-Knight, *University of Minnesota, St. Paul, MN.*

Forty-eight multiparous Holstein cows were assigned to one of four treatments starting 21d before parturition: control diet with water drench (CW), control diet with treatment drench (CT), supreme diet with water drench (SW), supreme diet with treatment drench (ST). Diet C was 73% forage and 27% corn, soybean meal, minerals and vitamins. Diet S was 59% forage and 41% corn and soybean meal with anionic salts, sugar, soluble fiber, yeast, and enhanced minerals and vitamins. Cows were drenched for three consecutive days postpartum with 37.84 liters/day of water or a treatment drench (T) that contained alfalfa meal, calcium propionate, electrolytes, yeast, probiotics, niacin and propylene glycol mixed into 37.84 liters of water. All cows received the same lactation diet through six weeks of lactation. Over the six week postpartum period, there was no effect of diet, drench or interaction between diet and drench on milk production (37.8 kg/d, 37.2 kg/d, 41.9 kg/d and 38.8 kg/d for CW, CT, SW and ST, respectively). However, there was a trend for a diet by week effect with cows fed the supreme diet producing more milk ($P < 0.10$) in week 3 (4.20 kg/d), week 4 (4.19 kg/d), week 5 (4.98 kg/d), and week 6 (4.41 kg/d) than control diet fed cows. Milk protein yield was greater ($P < 0.05$) for the supreme diet, (average 1.28 kg/d vs 1.15 kg/d) with the greatest differences occurring in week 3 to 5. No difference ($P < 0.05$) was seen between diet, drench, or interaction between diet and drench for milk fat yield, lactose yield, body weight change, body condition change, and udder edema measurements. Milk fever incidences were 18.2%, 9.1%, 0%, and 12.5% for CW, CT, SW, and ST, respectively. Retained placentas were 36.4%, 36.4%, 9.1% and 0% for CW, CT, SW, and ST, respectively. Cows with no metabolic disorders at parturition ($n=25$) were evaluated against those with any metabolic disorders ($n=16$). Cows without any metabolic disorders averaged 3.57 kg/d more milk over the six week lactation period, with the greatest significant increase in week 1 to 3 ($P < 0.05$).

Key Words: Transition cow, Metabolic disorder, Drench

742 Metabolic adaptations in dairy cows to changes in diet and lactational status. A.F. Park*, J.E. Shirley, E.C. Titgemeyer, R.C. Cochran, J.M. DeFrain, and E.E. Ferdinand, ¹*Kansas State University, Manhattan Kansas.*

Four-ru-minally fistulated, multiparous, pregnant Holstein cows were utilized in a randomized design to measure plasma metabolites as the cow transitioned from a non-lactational to lactational state. Plasma measurements were obtained on d 79 prior to calving and weekly thereafter until parturition and on d 1, 3, 5, 7, 15, 20, 25, 30, 60, and 90 postpartum. Calculated NEL (Mcal/kg) and measured crude protein (%) of the diets were 1.73, 18.7; 1.46, 11.5; 1.56, 15.6; 1.70, 18.4 for late lactation (-79, -72, -65 d), far-off dry (-58, -51, -44, -37, -30d), close-up dry (-23, -16, -9, -2d), and early lactation diets. Albumin was above 3 mg/dl during the last 3 wk of lactation (-79, -72, -65d) and the first 3 wk of the far-off period (-58, -51, -44d), decreased to less than 2 mg/dl until parturition, increased linearly ($P < 0.05$) to 4 mg/dl on d 25 postpartum and 4.5 mg/dl on d 60 postpartum, then declined to 3.0 mg/dl on d 90 postpartum. Plasma NEFA were relatively constant prepartum (200 uM), experienced a sharp increase at parturition, peaked on d 15 (440 uM), and returned to prepartum levels by d 30 postpartum. Insulin and glucagon decreased just prior to calving, but glucagon increased sharply during the first wk postpartum while insulin continued to decline. The insulin to glucagon molar ratio was relatively constant prepartum, declined sharply at parturition reaching nadir at d 5 after calving. Glucose and triacylglycerol were elevated prepartum and decreased significantly at parturition. Plasma urea varied with level of dietary protein and DM intake. Plasma total alpha amino nitrogen increased from 2 mM prepartum to 2.9 mM on d 25 postpartum. These data support the concept that plasma metabolites respond to diet and lactational status.

Key Words: Periparturient, Dairy cow, Plasma metabolite

743 Characterization of ruminal fermentation in transition dairy cows. A.F. Park*, J.E. Shirley, E.C. Titgemeyer, R.C. Cochran, J.M. DeFrain, E.E. Ferdinand, and T.G. Nagaraja, ¹*Kansas State University, Manhattan Kansas.*

Four-ru-minally fistulated, multiparous, pregnant Holstein cows were utilized in a randomized design to delineate ruminal fermentation adaptations as the cow transitions from a non-lactational to lactational state. Ruminal measurements were obtained 72 (late lactation), 51 (far-off dry), 23, and 9 d (close-up dry) prepartum and 6, 20, 34, 48, 62, 76, and 90 d postpartum. Calculated NEL (Mcal/kg), measured crude protein (%), and digestibilities (based on steers fed the same diets at 2 % of BW) of the diets were 1.73, 18.7, 74.1; 1.46, 11.5, 66.2; 1.56, 15.6, 71.0; 1.70, 18.4, 70.7 for late lactation, far-off dry, close-up dry, and early lactation. Ruminal samples were collected 0, 3, 6, 9, and 12 h after feeding. Ruminal pH increased (6.1 to 6.6) when cows were switched from the late lactation to the far-off, remained elevated during the close-up period, and then decreased (6.6 to 6.1) when cows were fed the early lactation diet. Total VFA concentration remained relatively stable (100 mM) when cows were fed the late lactation, far-off, and close-up diets then increased to a peak of 150 mM by d 48 of lactation. Ruminal ammonia decreased (9.0 versus 3.0 mM) when cows were switched to the far-off diet, then increased slightly (3.0 to 5.0 mM) when cows consumed the close-up diet, and increased (5.0 to 12.0 + mM) further when cows were fed the lactation diet. Ruminal peptides decreased (0.6 to 0 mM) when cows were switched to the far-off diet, remained relatively stable (0.25 mM) during the dry period, then increased to over 2 mM by d 48 postpartum. The trend for ruminal free amino acids was similar to that of ruminal peptides. These data indicate that significant fermentation adaptations occur as the cow transitions from non-lactational to lactational status: likely due to changes in diet composition and DMI.

Key Words: Transition, Dairy cow, Fermentation

744 Effect of sampling time and different commercial anionic products on urinary pH from pre-partum cows. L.M Rode*¹, K.A. Beauchemin², and G.R. Bowman², ¹*Rosebud Technology Development Ltd.,* ²*Agriculture and Agri-Food Canada.*

Twelve dry, pregnant Holstein cows were used to investigate the impact of commercial anionic products on diurnal changes in urinary pH. Cows were limit-fed (12.0 kg DMI/d) a TMR comprised of barley silage, grass hay and barley-based concentrate (55:22:23 DM basis). Cows were randomly assigned to one of four treatments and received 1.0 kg (as fed) of a treatment supplement. Treatments and corresponding supplements were: Control, canola meal; BC-M, Bio-Chlor MMTM; BC-F, Bio-Chlor FRTM; and SC, Soychlor 16-7TM. Cows were fed once daily and treatment supplements were hand-mixed within the TMR prior to feeding for five consecutive days. Cows were monitored from #2 to 16 h post-feeding for four days starting 22 h after the first feeding of the treatment supplements. During the observation time, urine spot samples were collected and pH measured. For each day, pH observations were grouped into three Time Groups (TG1, -2 to +4 h; TG2, +4 to +10 h; and TG3, +10 to +16 h relative to feeding). A repeated measures model was used with time within day as the repeated measure. For Day 1, there were differences due to treatment ($P < 0.01$) and Time Group ($P < 0.09$) where urine pH was 7.81, 7.33, 6.00 and 6.02 for Control, SC, BC-M and BC-F respectively and 6.90, 6.83 and 6.64 for TG1, TG2 and TG3 respectively. Urine pH for cows fed BC-M and BC-F were similar but different ($P < 0.013$) from Control and SC. TG3 was different ($P < 0.05$) from TG1 and TG2. By Day 4, urine pH was 7.90, 6.37, 5.72 and 5.52 for Control, SC, BC-M and BC-F respectively and 6.36, 6.40 and 6.39 for TG1, TG2 and TG3 respectively. Urine pH for cows fed BC-M, BC-F and SC were similar but different ($P < 0.001$) from Control. There were no differences among Time Groups. All commercial products acidified urinary pH. However it took longer for SC to achieve acidification. Once acidified, there was little change in urinary pH and nadir was not restricted to a narrow window around four hours post-feeding.

Key Words: transition, pH, DCAD

745 Periparturient responses of multiparous Holstein cows to varying prepartum dietary phosphorus. A. B. Peterson* and D. K. Beede, *The Michigan State University, East Lansing, Michigan/U.S.A.*

Objective was to compare periparturient responses of 42 pregnant, non-lactating multiparous Holstein cows fed 0.21, 0.31, or 0.44% dietary P (dry basis) for 28 d prepartum. Cows were assigned to prepartum P treatments in a randomized block (parity and expected calving date) design. Dietary P requirement for a cow (average prepartum BW = 764 kg in this experiment) equaled 31 g/d (NRC, 2001). Prepartum basal diet (0.21%P) contained 17.5% alfalfa silage, 27.0% corn silage, 27.0% beet pulp, 9.1% corn starch, 9.0% ground corn, 2.1% HCl-treated protein supplement, 1.8% rice hulls, 1.1% blood meal, 0.9% biuret, 0.8% urea, and 3.7% mineral-vitamin premix, dry basis. Graded inclusions of monoammonium phosphate increased P to achieve 0.31 and 0.44%P treatments. All diets were similar in energy, RDP, RUP, and other nutrients. Daily prepartum DMI was unaffected by P treatment (overall mean = 15.5 ± 0.7 kg/cow or $2.05 \pm 0.09\%$ of BW). Daily prepartum P intakes differed (34, 48, and 67 ± 2.0 g/cow for 0.21, 0.31, and 0.44%P; $P < 0.01$). Prepartum blood serum P was lower (5.06 mg/dl), but still within the normal range for 0.21%P compared with 6.41 and 6.60 mg/dl for 0.31 and 0.44%P (SEM = 0.24; $P < 0.01$). Prepartum serum Ca was unaffected by treatment ($P > 0.1$). Periparturient (± 7 d of calving) serum Ca was lower with 0.44%P compared with 0.21 and 0.31%P ($P < 0.05$). Pre- and postpartum serum osteocalcin and deoxyypyridinoline were unaffected by prepartum P, suggesting no effects on bone accretion or resorption. After parturition, cows were fed the same lactation diet (0.40%P). Daily DMI (19.5 ± 0.92 kg/cow) and energy-corrected milk yield (52.9 ± 1.49 kg/cow) through 28 DIM were unaffected by prepartum P. No clinical cases of hypophosphatemia and one case of hypocalcemia (cow on 0.31%P prepartum) were observed. We conclude that 34 g of P/cow per d prepartum is sufficient for multiparous Holstein cows without negative periparturient effects.

Key Words: Phosphorus, Dairy Cattle

746 Breed differences in ruminal fibre digestibility in cows receiving high concentrate diets. C.W. Cruywagen*¹, N. Bangani¹, and C.J. Muller², ¹University of Stellenbosch, ²Western Cape Department of Agriculture.

Eight non-lactating ruminally cannulated cows (four Holsteins and four Jerseys) were used to determine rumen digestibility values of oat silage (OS), oat hay (OH) and alfalfa hay (AH). To simulate lactation conditions, all cows received a TMR containing 65% concentrates at a rate of 25 kg/day for Holsteins and 17 kg/day for Jerseys. Cows were adapted to the diets for 14 days before the *in sacco* incubations. Samples of OS (wet, cut to 10mm lengths), OS and AH (both ground through a 2mm sieve) were incubated in the rumen in 230 x 100mm dacron bags (53µm pores) for 0, 2, 4, 8, 16, 24, 48 and 72 hours. Rumen liquor samples were collected at 10:00, 13:00 and 18:00 on the last day of the trial. For both breeds, rumen pH decreased between 2 and 5 hours after feeding, but Jerseys had a higher ($P < 0.05$) mean daily pH (6.45) than Holsteins (6.10). Also, pH never dropped below 6.1 in Jerseys, while values were 5.90 and 5.93 for Holsteins at 3 and 5h post-feeding, respectively. Differences in pH were probably responsible for differences observed between breeds regarding ruminal DM and NDF degradabilities. Effective DM degradability values (at $k = 0.05$) for Jerseys and Holsteins, respectively, were 30.4 and 26.0% (OS), 46.6 and 38.0% (OH) and 60.9 and 57.7% (AH). Effective NDF degradability values for Jerseys and Holsteins, respectively, were 23.0 and 17.3% (OS), 22.0 and 18.5% (OH) and 29.9 and 26.0% (AH). Regarding crude protein, Jerseys showed a lower ($P < 0.05$) effective degradability than Holsteins (40.4 and 36.0%, respectively), but for the other forages, the two breeds did not differ. It was concluded that Jerseys appear to be more efficient to digest forages than Holsteins when receiving a high concentrate diet, but that the difference is probably related to pH patterns that could again be affected by feeding behaviour and management.

Key Words: Rumen degradability, Fiber digestibility, NDF

747 Preliminary report on gas pressure sensors in the reticulorumen of sheep. W.M. Shaik Mossadeq* and W.L. Grovum, *University of Guelph, Guelph, Ontario, Canada.*

Most of the carbon dioxide and methane gases produced during microbial fermentation of food in the ruminant forestomach are eliminated by eructation. This involves special contractions of the dorsal and ventral sacs of the rumen, relaxation of the upper esophageal sphincter and, inhalation and expiration of the gases with normal breathing. Previous studies have shown that insufflations of the rumen with carbon dioxide, oxygen, nitrogen and air all evoked eructation via a vago-vagal reflex, whereas distension of the rumen with large bladders containing air or fluid did not. Thus, we hypothesized that as yet unidentified sensors in the reticulorumen detected the pressures of these gases and elicited eructation. The properties of these sensors/neuronal receptors were investigated in 14 anesthetized sheep by recording afferent activities from single-fibres in the left cervical vagus in response to first, 0, 5, 10, 15, 20, and 25 mm Hg air pressure in the emptied and washed reticulorumen and secondly, tactile stimulation and manual stretch of its wall. The impulses from single gas sensors were isolated from a mixed record of impulses from several fibres in a vagal strand connected to the reticulorumen using the Multi-Spike Detection software (MSD[®]) from Alpha Omega Engineering. Four sensors from four different sheep increased their firing rates between 6.3 ± 2.5 (threshold) and 19.6 ± 3.7 mm Hg air pressure but then, they decreased sharply at higher pressures. Two receptors were localized to the dorsomedial wall of the cranial sac because manual stretch of its wall in these sites inhibited the background activities of these two receptors. Furthermore, these two receptors did not respond to either graded manual stretch or to light tactile stimulation of the forestomach wall as is characteristic of in-series tension receptors and epithelial receptors respectively. The gas pressure sensors responded uniquely to gas pressure and hence, were considered a new receptor type in the reticulorumen.

Key Words: Eructation, Receptors, Sheep

748 Availability of phosphorus in dairy feeds. M.J. Aguerre*², S. Marcot¹, H. Henselmeyer¹, and L.D. Satter^{1,2}, ¹U.S. Dairy Forage Research Center USDA/ARS, ²Dairy Science Department, University of Wisconsin, Madison.

Three trials were conducted. In trial 1 and 2, 10 and 9 cows in mid to late lactation were fed for 3 wks a low P basal diet (BD) containing 0.17-0.19% P (dry basis). During the last 3-d of the third wk 12 fecal samples (dispersed through the 24-hr day) were collected. Ytterbium was used as an external marker for estimating DM digestibility. Following this three wk period, all cows were assigned to a trt diet where the test feed (soybean meal and corn gluten feed for trials 1 and 2) was inserted to provide a source of P. The test feed replaced P-free starch in the BD and increased P content of the test diets to approximately 0.3%. Fecal samples were again obtained during the last 3 days of the two-wk test period. This cycle was repeated in trial 1 and 2, this time with cottonseed and corn distillers grain. Dry matter digestibility estimates from the two BD periods were averaged for calculating P availability of the two test feeds for trial 1. Marker problems prevented DM digestibility estimates in trial 2, so values of 67 and 65% were assumed for BD and test diets. The incremental increase in fecal P excretion due to feeding of the test feed was considered as unavailable P. Trial 3, utilizing 10 cows, was conducted in the same way, except there was only one BD period sandwiched between two test feed periods (porcine meat and bone meal and dicalcium P). The availability of P in test feeds ranged between 64 to 85%. These values are slightly higher than availability values used by NRC (2001), suggesting that the NRC estimates of P requirement provide a moderate margin of safety.

	DMI	DM	P	P excreted	P avail-		
	kg/d	Digest-	intake	g/d	ability	SD	SD
		ibility	g/d	g/d	(%)		
Trial 1 (n=10)							
BD	19.2	64	33.0	19.8	2.4		
BD+soybean meal	20.7	63	51.3	26.0	3.4	74	24.0
BD	20.0	64	34.5	23.8	4.3		
BD+cottonseed	20.2	66	48.1	24.4	3.7	81	20.1
Trial 2 (n=9)							
BD	18.5	67	33.3	20.9	3.9		
BD+corn gluten feed	20.7	65	66.1	29.7	8.2	73	16.2
BD	17.0	67	30.6	19.0	3.0		
BD+corn distiller grain	17.0	65	49.2	22.4	3.9	83	17.1
Trial 3 (n=10)							
BD+meat and bone meal	21.2	70	61.4	31.0	6.9	64	22.9
BD	20.2	74	40.5	23.0	4.0		
BD+dicalcium phosphate	21.7	68	65.1	26.9	7.2	85	16.0

Key Words: Phosphorus availability, Milk production

749 Phosphorus balance in Holstein cows fed normal or low-phosphorus diets for 2 lactations. R. Kohn*, T. Oleas, K. French, C. Sutcliffe, L. Scott, and T. Moreland, *University of Maryland, College Park.*

The objective of this study was to determine phosphorus (P) balance and apparent P digestibility for Holstein cows in different stages of lactation

when fed normal or low dietary P. Twelve multiparous cows (mean body weight = 698 kg) were fed diets based on corn silage, timothy hay and corn cobs (dry period) or corn silage and beat pulp (lactation period). Six cows (normal treatment) were fed diets supplemented with P using calcium phosphate in place of calcium carbonate. Two cows from each treatment did not complete the second lactation. Diets averaged 0.23 or 0.27% P for dry period, and 0.30 or 0.35% P during lactation. P balance was determined by total collection of feces, urine and milk for 5-d periods during dry, early, peak, mid and late stages of two lactations. Differences were tested with the model: Y = mean + lactation + diet + stage of lactation + interactions + cow(diet) as a random effect. P balance (g P intake # g P excretion) was #1.5 (SE=2.6) and #9.7 (SE=2.7) for low and normal P diets respectively in the first lactation, but was 12.4 (SE=2.9) and 26.4 (SE=2.8) g/d for low and normal P diets in the second lactation. In the first lactation, P balance was most negative in early (-17.2 g/d) and peak (-12.5 g/d) lactation, and greatest in the dry period (8.2 g/d). Apparent P digestibility (g/100g) was 0.41 (SE=0.03) and 0.21 (SE=0.03) for low and normal P diets respectively in the first lactation, but both increased to 0.54 (SE=0.03) in the second lactation. Milk production and intake were unaffected by diet. Long-term feeding of low-P diets can increase apparent P digestibility and P retention in different stages of lactation.

	Dry- Low	Dry- Normal	Lac- Low	Lac- Normal	Effects
Intake	30.0	40.3	62.2	76.0	L,S,D,S*L
Fecal	20.5	32.5	35.2	58.9	L,S,D,L*D
Urine	0.2	0.4	0.3	0.6	L
Milk	0	0	31.1	30.5	S,L*D
Balance	9.3	7.4	-4.4	-14.0	L,S,D,L*S,L*D,L*S*D
Digestibility	0.34	0.21	0.43	0.22	L,D,L*D,S*L

Least square means for P balance (g/d) and apparent P digestibility (g/100g) for normal and low P diets for non-lactating (Dry) and lactating (Lac) cows. Effects (P<.05) are lactation (L), stage (S), diet (D).

Key Words: phosphorus feeding, dairy cattle

Beef Species
Status and Application of Genetic Technologies in the Beef Industry

750 Consumer attitudes toward biotechnology: Impact on animal related applications. Christine Bruhn*, *University of California, Davis.*

Concern about biotechnology continues to be low on consumer’s list of concerns. When asked to volunteer food-related concerns, only 2% express concerns about the safety of foods modified by biotechnology, and a minority selected biotechnology when asked to add one additional item to a food label. Most people are not aware that products modified by biotechnology are in the supermarket. People support applications that benefit the environment, with modifications that provide direct consumer benefits, such as increased nutritional value or better taste endorsed by slightly fewer people. Following the recall of products containing StarLink corn, a higher percentage of consumers believed foods containing modified products should be labeled. Most consumer research has focuses on plant applications of biotechnology; modification of animals is likely to be more emotionally charges. Since the majority of US consumers agree that animals have rights, just like people, it would be likely that applications of biotechnology that benefit the animal, such as increased disease resistance, would have greatest support. Environmentally friendly application would also be viewed positively. Changes that primarily benefit people would likely receive public support from a smaller percentage of consumers, at least as recorded on consumer surveys. Frequent and effective communication that addresses public concern is a prerequisite for increasing public acceptance.

Key Words: biotechnology, consumer attitudes, consumer acceptance

751 Genomic and computing strategies in optimizing the genetic component of specification beef. J.W. Wilton*, *University of Guelph, Guelph, Ontario, Canada.*

Genomics and computing are closely inter-related in beef cattle improvement. Both require the prior definition of breeding objectives, both can

be used together to carry out genetic evaluations of economically important traits and both can be used in the development of selection tools for sires and dams. Effective use of both requires accurate specification of the desired product, optimum production program, and cross-breeding structure. Optimizing the genetic component of production requires information on traits of economic importance, identification and relationships of animals, information on candidate and marker genes, and information on economics. Genomic information can be used for strategies involving identified gene deletions, identified gene introgressions, marker assisted introgression, and marker assisted selection. Techniques are being developed for combining genotypic data and quantitative data into genetic evaluations, although more developments are needed to optimize the use of these techniques across the range of beef traits varying in economic importance and cost of measurement. The genetic component of economical production of specified products can be optimized with customized selection programs. An example is presented in which performance levels are predicted from genetic evaluations based on quantitative and genomic information. The implications for selection within a seedstock population are also discussed.

Key Words: Genetic improvement, Sire selection, Beef production

752 Status of bovine sperm sexing technology. J.L. Schenk*¹ and G.E. Seidel, Jr.², ¹XY, Inc., ²Colorado State University.

XY, Inc., a biotechnology company, is developing and marketing flow-sorting expertise for sexing sperm for global livestock applications. Mammalian X-chromosome-bearing sperm contain more DNA than Y-chromosome-bearing sperm (bulls; 3.8%), which is the basis of the flow-sorting procedure. Sperm stained with Hoechst 33342, a specific DNA-binding dye, fluoresce when excited with light from an argon laser. Sperm are transported past sensors at a rate of 25,000 sperm/s by a pressurized fluid stream. Properly positioned sperm sorter sensors

detect fluorescence intensity. The sperm-transporting stream is transformed into droplets that are electrically charged differently for X- and Y-chromosome-bearing sperm. Two electro-magnetically charged fields draw oppositely charged droplets towards separate collection vessels. Not all of the sperm can be sorted for a variety of reasons, for example, improper orientation of the flat surface of the sperm toward one of the sensors. Also, dead sperm are discarded in the process. For most bulls, 3000 - 5000 live sperm of each sex can be sorted/s, but sorting rates may double in the near future as technology improves. Insemination of flow-sorted sperm in six species, primarily cattle has resulted in thou-

sands of live offspring, with an accuracy of 85 - 95% of the predicted sex. Insemination of virgin heifers with sorted frozen/thawed sperm at dosages ranging 1 - 6 x 10⁶ total sperm usually results in 60-d pregnancy rates of 70 - 100% of unsexed controls that contain 20 x 10⁶ total sperm. Rates of abortion and normality of offspring have been similar to those for unsexed controls. Bovine sex-sorted semen is currently available for purchase and commercial use in the United Kingdom, and soon will be available in other countries.

Key Words: DNA, Hoechst 33342, sex, sperm

Animal Health Transition Cow Health

753 Effects of nonesterified fatty acids on lymphocyte functions in dairy heifers. U. Bernabucci*, D. Scalia, O. Franci, B. Ronchi, A. Nardone, and N. Lacetera, *Dipartimento di Produzioni Animali, Viterbo, Italy.*

This in vitro study was carried out to assess the effects of nonesterified fatty acids (NEFA) on DNA synthesis, immunoglobulin M (IgM), and interferon gamma (IFN-gamma) secretion of cows peripheral blood mononuclear cells (PBMCs). Concentrations of NEFA were designed to mimic those in healthy cows and cows affected with subclinical or clinical ketosis. Nine pregnant, non lactating, and non ketotic Holstein heifers were utilized as blood donors. After isolation, the PBMCs were incubated with various concentrations of NEFA (0, 0.0625, 0.125, 0.250, 0.5, 1, and 2 mmol/l). The first three concentrations of NEFA were intended to mimic those of healthy cows, whereas the others were intended to mimic those of ketotic cows. The mixture of NEFA was represented by C16:0 (30%), C16:1 (5%), C18:0 (15%), C18:1 (45%), and C18:2 (5%). The DNA synthesis was measured after stimulation of PBMCs with phytohemagglutinin (PHA, 2.5 microg/ml), concanavalin A (Con-A, 2.5 microg/ml), or pokeweed mitogen (PWM, 1 microg/ml); the IgM secretion was measured after stimulation of PBMCs with PWM (0.2 microg/ml); the IFN-gamma secretion was measured after stimulation of PBMCs with Con-A (2.5 microg/ml). Under the present culture conditions, the addition of NEFA to cell cultures was responsible for significant impairment of PBMCs functions. The DNA synthesis in PHA-, Con-A-, and PWM-stimulated PBMCs was inhibited at concentrations of NEFA of 2, 1, and 0.5 mmol/l (P ranging from ≤ 0.0001 and ≤ 0.05). The IgM secretion in PWM-stimulated PBMCs was diminished at concentrations of NEFA of 2, 1, 0.5, and 0.25 mmol/l (P ≤ 0.05). Secretion of IFN-gamma in Con-A stimulated PMBCs was depressed at concentrations of NEFA of 2, 1, 0.5, 0.25, and 0.125 mmol/l (P ranging from ≤ 0.0001 and ≤ 0.005). Results of the present study indicate that the increases of plasma NEFA might contribute to explain the impairment of the immune response or higher incidence of infections reported for cows suffering from subclinical or clinical ketosis.

Key Words: Cows, Nonesterified fatty acids, Immunoresponse

754 Acute phase response indicates inflammatory conditions may play a role in the pathogenesis of fatty liver in dairy cows. B. N. Ametaj*, B. J. Bradford, G. Bobe, Y. Lu, R. Nafikov, R. N. Sonon, J. W. Young, and D. C. Beitz, *Iowa State University, Ames, IA.*

The goal of the present study was to search for the presence of acute phase response in normal and fatty liver cows. Liver and blood samples of multiparous Holstein cows with elevated (n=4) and normal (n=4) triacylglycerols (TAG) concentrations in liver were obtained at d -4, 3, 8, 12, 14, 22, 27, and 36 postpartum and analyzed for concentrations of total lipid in liver (TLL) and tumor necrosis factor-alpha (TNF-alpha), serum amyloid A (SAA), haptoglobin (Hp), calcitonin gene-related peptide (CGRP), prostaglandin E2 (PGE2), cortisol, total cholesterol (TC), triacylglycerols (TAG), lactate, non-esterified fatty acids (NEFA), glucose, and bilirubin in plasma. Fatty liver cows reached peak TLL concentrations at d 3, 8, and 12 postpartum with 11 % (wet weight), respectively, compared with 6 % in normal cows, respectively (P < 0.05). Cows with fatty liver had before parturition greater plasma TNF-alpha, NEFA, and lower lactate concentrations than did cows with normal liver (P < 0.1). Cows with fatty liver had at the time of peak TLL concentrations, at least at one time-point, higher plasma Hp, SAA, cortisol,

and NEFA concentrations and lower plasma lactate and TNF-alpha concentrations than did cows with normal liver (P < 0.1). Concentrations of TLL at d 12 postpartum were a) correlated positively with concentrations of plasma TNF-alpha and NEFA at 0.96 and 0.75, respectively, and negatively with plasma CGRP at -0.75 before calving, b) correlated positively with concentrations of plasma Hp, SAA, and NEFA at 0.71, 0.80, and 0.74, respectively, and negatively with plasma PGE2, CGRP, and TC at -0.70, -0.75, and -0.72, respectively, at d 3, 8, and 12 postpartum, and c) correlated positively with concentrations of plasma bilirubin and cortisol at 0.70 and negatively with plasma glucose and lactate at -0.69 and -0.75 after d 12 postpartum (P < 0.1). Results of this study indicate that inflammatory conditions may play a role in the pathogenesis of fatty liver. (Partly supported under CREES-USDA agreement 99-35005-8576).

Key Words: acute phase response, fatty liver, dairy cows

755 Titration of the proper dose of calcium propionate (NutroCAL) to be included in an oral drench for fresh cows. J.P. Goff¹, T.F. Brown², S.R. Stokes³, C.L. Brawley², and F.R. Valdez⁴, ¹USDA-Agricultural Research Service, ²Tarleton State University, ³Texas A&M University, ⁴Kemin Industries.

Periparturient cows typically suffer some degree of hypocalcemia and negative energy balance. Calcium propionate (CaProp) is a rapidly absorbed source of Ca and gluconeogenic precursors included in drenches for fresh cows. An effective dose will raise blood Ca and improve energy status. A safe dose will not excessively increase blood Ca. Seventeen cows were assigned to one of 4 treatments; 0, 0.68, 1.02, or 1.36 kg of CaProp (NutroCAL, Kemin, Des Moines, IA) in 9 L water administered using an esophageal pump at calving. Blood was collected 0, 1, 2, 3, 4, 5, 6, 12, and 24 h post-drench. Plasma Ca at time zero averaged 7.19 mg/dl. Plasma calcium levels were significantly affected (P<0.0001) by drench. Blood Ca concentration decreased in cows receiving water only reaching a nadir of 6.16 mg/dl 3 h post calving. Drenching cows with 0.68 kg CaProp at calving significantly increased blood Ca concentration above 8.0 mg/dl within 2 h and maintained this level through the next 24h. In cows receiving 1.02 or 1.36 kg CaProp, plasma Ca concentration exceeded 10 mg/dl within 12 h. In 2 of 4 cows receiving 1.36 kg CaProp, plasma Ca exceeded 11 mg/dl within 2 h and in 1 of those 2 cows blood Ca exceeded 15 mg/dl for more than 3 hrs, which should be considered toxic. Blood B-hydroxybutyrate (OH-butyrate) increased in cows not receiving CaProp, suggesting decreased energy balance. However, plasma OH-butyrate decreased in cows treated with any dose of CaProp (P=0.0025), an indication that energy status had improved in these cows. While no problems were observed with the 1.02 kg CaProp dose, there was no advantages in terms of blood OH-butyrate. Since the 1.36 kg dose of CaProp proved toxic to 1 cow, it would seem prudent to maintain at least a 2:1 toxic/therapeutic index when dosing cows. We propose that a safe and effective dose of Ca propionate is 0.68 kg in Holstein cows.

Key Words: Drench, Calcium propionate, Gluconeogenesis

756 Effects of oral drenching of glycerol on blood parameters and milk production in dairy cattle at parturition. S. R. Stokes¹, G. E. Kaiser^{*2}, J. P. Goff³, and C. L. Brawley², ¹Texas A&M University, Stephenville, TX, ²Tarleton State University, Stephenville, TX, ³USDA-ARS NADC, Ames, IA.

Several strategies are used to overcome the reduction in dry matter intake around calving because of the deleterious effects associated with negative energy balance at the onset of lactation. The objective of this study was to determine the effects of oral drenching glycerol for cows at parturition on energy status and milk production on a commercial dairy. One hundred and one animals (seventy one cows, thirty heifers) were assigned to one of two treatments. Treatments were: 9.5 L water (C) or 1.5 L glycerol added to 8.0 L water for a total volume of 9.5 L (GLY). Drenches were administered via esophageal pump (McGrath Pump) within 6 h post-calving and again at 24 h post-calving. Prior to each drench and on d 4 and 10, blood samples were obtained from the jugular vein. Plasma was separated and frozen for subsequent analysis of glucose, non-esterified fatty acids (NEFA), and beta-hydroxybutyrate (BOHB). Milk production records were collected monthly from DHIA test weights. Concentrations of plasma glucose and NEFA were unaffected by treatment ($P = 0.4495$ and 0.3332 for glucose and NEFA, respectively). Plasma BOHB averaged 4.549 and 5.820 mg/dl at parturition in heifers and cows, respectively. Animals receiving GLY had reduced BOHB levels at 24 h post-calving compared to concentrations at 0 h (26 and 9 % for heifers and cows receiving GLY, respectively); however, animals receiving C experienced increased BOHB levels at 24 h post-calving compared to concentrations at 0 h (26 and 17 % for heifers and cows receiving C, respectively). Milk production averaged 34.5 and 37.1 kg per day for animals receiving C and GLY, respectively, but failed to be statistically significant due to great variation among animals within each treatment ($P = 0.3455$).

Key Words: Glycerol, Parturition, Ketosis

757 Effect of 14-day subcutaneous injections of several dosages of glucagon on the health of lactating dairy cows. G. Bobe^{*1}, B. N. Ametaj², D. C. Beitz¹, and J. W. Young¹, ¹Iowa State University, Ames, IA, ²Purdue University, West Lafayette, IN.

Elevated triacylglycerol (TAG) concentrations in liver in the first weeks after calving have been associated with increased incidences of several infectious and metabolic diseases in dairy cows. Liver TAG concentrations can be decreased by continuous intravenous infusions of glucagon. We tested whether 14-day subcutaneous injections of several dosages of glucagon decrease the incidence of diseases in dairy cows. Multiparous Holstein cows ($n=32$) were grouped on the basis of their liver TAG concentration at d 4 postpartum into "Normal" ($n=8$; <10 mg TAG/g wet weight) and "Susceptible" ($n=24$; >10 mg TAG/g wet weight). "Susceptible" cows were assigned randomly to 3 groups and received beginning at d 8 postpartum 0 (Saline Susceptible), 2.5 (7.5 mg/d Glucagon), or 5 mg (15 mg/d Glucagon) glucagon in 60 ml saline (pH 10.25) by subcutaneous injections of glucagon every 8 h for 14 d. "Normal" cows (Saline Normal) received the same treatment as "Saline Susceptible" cows. Health was determined by measuring twice daily body temperature and flake occurrence in milk, once daily stool consistency, urinary ketones, and vaginal discharge, and twice weekly somatic cell count. "Saline Normal" cows had less mastitis than did "Saline Susceptible" cows ($P \leq 0.1$). Glucagon-treated cows had less mastitis during the subsequent lactation than did "Saline Susceptible" cows ($P \leq 0.01$). During the injection period, glucagon-treated cows had more days with elevated but not "subclinical ketotic" urinary ketone concentrations than did "Saline Susceptible" cows ($P \leq 0.05$). Body temperature, vaginal discharge, and stool was not affected by liver TAG concentrations or glucagon treatment ($P \geq 0.1$). We conclude that 2.5 and 5 mg subcutaneous glucagon injections every 8 h for 14 d beginning at d 8 postpartum improve the mammary health in dairy cows and, therefore, improve the overall health of dairy cows. (Partly supported under CREES-USDA agreement 99-35005-8576).

Key Words: Fatty Liver, Glucagon, Health

758 Effect of 14-day subcutaneous injections of several dosages of glucagon on reproductive success in lactating dairy cows. G. Bobe^{*1}, B. N. Ametaj², D. C. Beitz¹, and J. W. Young¹, ¹Iowa State University, Ames, IA, ²Purdue University, West Lafayette, IN.

Elevated triacylglycerol (TAG) concentrations in liver in the first weeks after calving decrease reproductive success in dairy cows. Liver TAG concentrations can be decreased by continuous intravenous infusions of glucagon. We tested whether 14-day subcutaneous injections of several dosages of glucagon improve reproductive success in dairy cows. Multiparous Holstein cows ($n=32$) were grouped on the basis of their liver TAG concentration at d 4 postpartum into "Normal" ($n=8$; <10 mg TAG/g wet weight) and "Susceptible" ($n=24$; >10 mg TAG/g wet weight) cows. "Susceptible" cows were assigned randomly to 3 groups and received beginning at d 8 postpartum 0 (Saline Susceptible), 2.5 (7.5 mg/d Glucagon), or 5 mg (15 mg/d Glucagon) glucagon in 60 ml saline (pH 10.25) by subcutaneous injections of glucagon every 8 h for 14 d. "Normal" cows (Saline Normal) received the same treatment as "Saline Susceptible" cows. Reproductive success was determined by measuring number of services, pregnancy rates, days to first heat, days to first insemination, days open, and days to conception resulting in a calf. "Saline Normal" cows had greater reproductive success in all measured parameters than did "Saline Susceptible" cows ($P \leq 0.1$). Glucagon injections, irrespective of dosage, had no effect on reproductive success of any measured parameter ($P \geq 0.1$), except that "15 mg/d Glucagon" cows were earlier in heat than did "7.5 mg/d Glucagon" cows ($P \leq 0.1$). Changes in liver TAG concentrations during the experimental period were similar in glucagon-treated and "Saline Susceptible" cows ($P \geq 0.1$). We conclude that even a slight liver TAG accumulation (>10 mg TAG/g wet weight) in the early postpartal period can be detrimental for reproductive success. Therefore, improved reproductive success can be attained by prevention/treatment of liver TAG accumulation; however, 2.5 and 5 mg subcutaneous glucagon injections every 8 h for 14 d beginning at d 8 postpartum are both not sufficient to improve reproductive success. (Partly supported under CREES-USDA agreement 99-35005-8576).

Key Words: Fatty Liver, Glucagon, Reproduction

759 The relationship of postpartum endometrial cytology and reproductive performance in dairy cows. R. Kasimanickam^{*}, R. Foster, T. Duffield, C. Gartley, K. Leslie, J. Walton, and W.H. Johnson, University of Guelph, Guelph, Ontario, Canada.

Postpartum uterine disease is characterized by uterine inflammation and infection resulting in poor reproductive performance. Phagocytosis by neutrophils is the predominant uterine defense mechanism. The purpose of this study was to examine the association of endometrial cytology (EC) with reproductive performance in subclinical endometritis cows. Clinically normal cows ($n=228$), based on vaginoscope, at 20-33 DIM from 2 commercial dairy farms were enrolled. A thorough reproductive exam included per-rectal palpation, ultrasonography and EC. EC samples were collected from the base of the larger uterine horn using a cytobrush (Fisher Scientific Ltd.). Cytology slides were prepared by rolling the cytobrush on a microscopic slide, fixing with cytofixative (Cytoprep[®], Fisher Scientific Ltd.), and staining with modified Giemsa stain (Protocol Hema-3[®], Biochemical Sciences Inc.). The percentage of neutrophils (%PMN) was determined by counting a minimum of 100 cells at 400X magnification. Uterine and cervical size, %PMN, calving season, parity, peripartum diseases were included in the analysis. The analysis was performed using PHREG and LIFETEST procedure of SAS 6.12. Based on reproductive performance of cows, 18%PMN was selected as the threshold. Cows with $>18\%$ PMN had a 41% reduced risk of pregnancy over cows with $<18\%$ PMN ($p=0.001$). The risk of first service pregnancy was not different between $>18\%$ PMN and $<18\%$ PMN cows ($p=0.2$). Median days open for $>18\%$ PMN cows were 50 days more than $<18\%$ PMN cows ($p<0.001$). When EC was included in the model, all other variables were insignificant for the risk of pregnancy. EC at 20-33 DIM by the cytobrush technique may be a valuable predictor of the reproductive performance of postpartum dairy cows. EC should be interpreted differently if performed later as reproductive performance should be lower in cows with prolonged uterine infection.

Key Words: cytology, uterus, postpartum

760 Strategic herd selection to maximize the benefit of a Rumensin® controlled release capsule in transition dairy cows. T. Duffield^{*1}, R. Bagg², and P. Dick², ¹*Department of Population Medicine, University of Guelph, Guelph, Ontario, Canada,* ²*Provel, Division of Eli Lilly, Inc, Guelph, Ontario, Canada.*

Targetted use of a Rumensin® controlled release capsule (CRC) in individual cows based on body condition score (BCS) precalving is a legitimate approach to prevention of subclinical ketosis. However, selecting individual cows for prevention within high risk herds may limit potential benefit. The purpose of this study was to compare the impact of Rumensin® CRC between herds identified to be at high risk for subclinical ketosis (SCK) and those herds at normal risk on dairy herd improvement (DHI) milk production obtained at second test day post-calving. Data from a trial conducted in 1995 in 1010 Holstein dairy cows from 25 herds was used for this retrospective analysis. These cows were randomly assigned to receive either a Rumensin® CRC or placebo CRC at 3 weeks prior to expected calving. Four criteria for identifying herds at increased risk of SCK were used: incidence of displaced abomasum > 5% (DA, 9 herds), prevalence of fat cows (BCS ≥4.0) precalving > 10% (Fat cows, 13 herds), > 40% of cows at first DHI test with a protein to fat ratio < 0.75 (Low PFR >40%, 10 herds), > 20% of cows with serum beta-hydroxybutyrate ≥1400 µmol/L in week 1 or 2 postcalving (SCK >20%, 13 herds). Least squares means of milk production at second DHI test were generated to compare between treated cows within high and normal risk herds using the mixed procedure in SAS and controlling for days in milk, parity, season of calving and the random effects of herd. The table below illustrates the milk production (kg/d) response to Rumensin® CRC in normal and high risk herds using these 4 criteria. The data indicates that any of these 4 criteria could be used to assign risk of subclinical ketosis at the herd level. A significant increase in milk production at second DHI test is observed with whole herd use of Rumensin® CRC in transition cows in high risk herds. Within low risk herds, individual cow selection for Rumensin® CRC based on BCS might be more cost-effective.

Criteria	High Risk Herds			Low Risk Herds		
	Rumensin®	Control	P	Rumensin®	Control	P
DA >5%	37.6	35.5	0.002	36.5	36.4	0.73
SCK >20%	37.3	35.8	0.01	36.6	36.4	0.82
Low PFR						
>40%	38.2	36.8	0.03	36.0	35.6	0.41
Fat Cows						
>10%	37.3	36.1	0.03	36.2	35.8	0.50

Key Words: Rumensin, Subclinical ketosis, Controlled release capsule

761 Effect of method of delivery of Rumensin® on metabolic parameters in the periparturient dairy cow. T.M. Osborne^{*1}, K.E. Leslie¹, T. Duffield¹, B. McBride¹, T. Geishauser¹, R. Bagg², and G. Vessie², ¹*University of Guelph,* ²*Elanco Animal Health, Division of Eli Lilly Canada Inc.*

Subclinical ketosis causes significant economic losses for dairy producers by decreasing milk production and increasing periparturient disease. In previous studies, Rumensin® Controlled-Release Capsule (CRC) has been shown to decrease the incidence of subclinical ketosis and periparturient disease. The objective of this study was to compare the efficacy of Rumensin® CRC to Rumensin® Premix in reducing the incidence of subclinical ketosis. A total of 136 multiparous and primiparous periparturient cows from the Elora Dairy Research Station, Elora, Ontario, Canada were enrolled at 3 weeks prior to their expected calving date. Animals were blocked based on parity and season and randomly assigned to one of three treatment groups (negative control, CRC or premix group) within each block. Rumensin® Premix was included in the diet at 22 ppm. Blood was collected at enrollment, one week prior to calving, on the day of calving, and at one and two weeks post-calving. Serum was analyzed at the Animal Health Laboratory, University of Guelph for beta-hydroxybutyrate (BHBA), glucose and non-esterified fatty acids (NEFA) concentrations. Results for BHBA, glucose and NEFA concentrations by treatment group and by time relative to calving are shown in Table 1. Over time, Rumensin® had a significant impact on BHBA and NEFA. There was a significant treatment by time interaction for BHBA. It appears that both Rumensin® CRC and Rumensin® Premix have a significant impact on reducing BHBA concentrations in the periparturient dairy cow.

Parameter	Time	Overall	p-value	Control	CRC	Premix	p-value
BHBA µmol/L	Pre	545	0.002	554	530	556	0.007
	Calving	633		678	608	602	
	Post	816		1023	718	720	
Glucose mmol/L	Pre	2.90	0.520	2.88	2.98	2.86	0.241
	Calving	3.30		3.44	3.02	3.44	
	Post	2.36		2.16	2.43	2.50	
NEFA mEq/L	Pre	0.32	0.050	0.32	0.30	0.33	0.160
	Calving	0.72		0.84	0.66	0.67	
	Post	0.44		0.48	0.40	0.45	

Key Words: Periparturient dairy cow, Ionophores, Metabolic parameters

762 Associations of serum vitamin A and E concentrations with health in peripartum dairy cows. S.J. LeBlanc^{*1}, T.H. Herdt², T.F. Duffield¹, and W.M. Seymour³, ¹*University of Guelph, Ontario, Canada,* ²*Michigan State University,* ³*E.Lansing, MI,* ³*Roche Vitamins, Parsippany, NJ.*

The objective of this field study was to measure the association of selected antioxidants in serum with risk of peripartum disease. Beginning 1 week before expected calving, samples were collected weekly until the first week postpartum for measurement of serum α-tocopherol (α-T), cholesterol, β-carotene (β-C), and retinol (RET) concentrations. The occurrence of retained placenta for > 24 hours (RP), toxic metritis, clinical mastitis, and displaced abomasum (DA) within 30 days of calving, was recorded. Data were available from 1073 cows in 19 herds. Thresholds representing the quartile values for each vitamin variable were screened for association with disease risk. Final models were generated using logistic regression, adjusted for the correlation of cows within herd, season of calving, and parity. Concentrations of α-T, β-C, and RET declined sharply from 10 days prepartum until 3-5 days postpartum, whereas α-T:cholesterol mass ratio (α-T:C) was stable until declining sharply 1-2 days postpartum. There was no consistent relationship between serum α-T or α-T:C and the risk of RP, metritis, mastitis or DA. The incidence of RP was 15%. In the last week prepartum, cows with β-C ≥ 1.0 mg/ml were 1.6 times (P = 0.01) more likely to have RP, whereas cows with serum RET ≥ 175 ng/ml were half as likely (P = 0.006) to have RP as cows below those thresholds. The incidence of mastitis was 9.7% with median time to diagnosis of 2 days postpartum. Cows with serum retinol concentration ≥ 175 ng/ml in the last week prepartum were less than half as likely (odds ratio (OR) = 0.42, P = 0.01) to have clinical mastitis as cows below that threshold. The incidence of DA was 4.7%. Accounting for the effects of RP and ketosis, cows with serum retinol concentration ≥ 175 ng/ml in the last week prepartum were one third as likely (OR = 0.34, P = 0.0002) to have DA. Antioxidant status is a critical factor in the pathogenesis of disease in peripartum dairy cows. The optimum level and means of supplementation of vitamins A and E remain to be clarified.

Key Words: Retinol, Disease, Tocopherol

763 Influence of days fed a close-up dry cow ration and heat stress on subsequent milk production in western dairy herds. R.B. Corbett^{*1}, ¹*Dairy Health Consultation.*

Dairycomp 305 records were analyzed to determine the impact the number of days cows were offered a close-up prepartum ration had upon subsequent milk production. Data were collected for one-year from five commercial dairies in the western US (total of 13,000 cow records). Cows were divided into four groups based on the number of days they received the close-up dry cow ration prior to calving. Group 1 = 1-7 days (736 cows), Group 2 = 8-14 days (1224 cows), Group 3 = 15-21 days (2260 cows) and Group 4 was more than 21 days (7648 cows). The close-up dry cow rations were formulated to have a negative dietary cation-anion difference using BioChlor (Biovance, Omaha, NE). Crude protein ranged from 16.8 to 17.4% and DCAD ranged from #147 meq/kg to #233 meq/kg of dry matter. The average projected 305 day milk production was 9,242 kg, 9,740 kg, 10,169 kg and 10,350 kg for Groups 1, 2, 3 and 4 respectively. This represented increases of 5.39% between Group 1 and Group 2; an increase of 4.53% from Group 2 to Group 3 and an increase of 10.03% from Group 1 to Group 3. A similar response was seen when evaluating first test day milk yield and peak milk production. The same animals were split into two groups to determine the effect of heat stress on the same parameters. Group A freshened between January 1st,

2000 and May 1st, 2000. Group B freshened between June 1 st, 2000 and August 1st,2000. Group A out-produced Group B consistently in all four groups according to the number of days on the close-up ration as follows: Group 1, 894 kg; Group 2, 759 kg; Group 3, 684 kg and group 4, 599 kg. The results emphasize the importance accurate pregnancy diagnosis has in generating lists for moving dry cows to ensure adequate time on the close-up prepartum ration. Cows freshening during periods of high heat stress also benefit from a longer time on the close-up ration , but produce an average of 734 kg less milk than cows calving during cooler periods.

Key Words: transition, DCAD, heat stress

764 Efficacy of two sustained-release intraruminal selenium supplements. B Renquist*¹, C Maas², J Oltjen¹, M Sween¹, and D Flavell¹, ¹University of California, Davis, ²Pacific Trace Minerals, Inc.

Our objective was to test the efficacy of sustained-release selenium (Se) boluses for beef cattle. Fifty-five English breed heifers (mean initial body weight = 245.84 kg) were randomly assigned to one of four treatment groups: D1- one Dura-Se# bolus (Schering-Plough Co.) on day 0; D2- one Dura-Se# bolus on day 0 and day 121; P- one Se-365 bolus (Pacific Trace Mineral, 30 g, 10% elemental Se) on day 0; and C- control no additional Se. Heifers grazed Se deficient native foothill range without any additional supplement. Body weights and blood samples were taken for Se analysis from animals in all 4 groups at days #28, 14, 28, 49, 63, 121, 183, 293, and 365. No evidence of excess Se intake was observed (lameness, alopecia, brittle hair, coronitis). Data were analyzed in a model with Se treatment as the main effect; a log transformation for blood Se was used to make variances among treatments similar. On day 14 blood Se levels were higher for the three supplemented groups than for the control group ($p < 0.05$). On day 28 group P had higher blood Se levels than either D1, D2, or C ($p < 0.05$). At days 183 and 293, the D2 had the highest blood Se levels (231.1 22.7 and 133.4 13.4 mg/L), with groups P (136.8 23.0 and 75.8 17.9 mg/L), D1 (114.3 16 and 34.8 8.8 mg/L), and C (21.26 2.8 and 15.53 2.7 mg/L) having descending Se blood levels, respectively. On day 365, groups D2 and P provided

blood Se levels above the 50 mg/L that is considered deficient. Groups D1, D2, and P gained 11.2, 23.2 and 11.7 kg more than the 100.0 kg gain of the control group ($p = 0.084, 0.0006$ and 0.022 , respectively). Se supplementation with the Se-365 pellet provided sufficient Se to raise the blood Se levels above deficient levels. When compared with 1 Dura-Se# bolus, the Se-365 pellet prevented blood Se levels from falling to deficient levels for a more extended period.

Key Words: Selenium, Supplement, Intraruminal

765 Evaluation of Mannan Oligosaccharide on the immune status of dairy cows and their calves. S.T. Franklin¹, K.E. Newman*², and M.C. Newman¹, ¹University of Kentucky, ²Venture Laboratories, Inc.

Because of legislation against subtherapeutic antibiotic use in livestock, producers are looking for alternative products that may demonstrate similar performance, health and economic benefits. Mannan oligosaccharide (MOS) has been shown to provide benefits in a number of livestock species that are similar to antibiotic growth promoters. Among the benefits documented are increased colostrum immunoglobulin levels in sows receiving MOS. Forty cows were divided into two treatment groups by parity to evaluate the effect of MOS (10-g/h/d) on serum and colostrum immunoglobulin levels, blood parameters and vaccine antibody titers to rotavirus and calf immune status and growth. No overt differences were noted in blood parameters. Antibody titers to rotavirus vaccination following calving were numerically greater in calves from cows receiving MOS than in calves from unsupplemented cows (24,381 vs. 22,345 in colostrum and 12,777 vs. 6,809 in calf serum). Serum immunoglobulin levels were also numerically greater 24-h post-calving in calves whose dams received MOS than calves from unsupplemented cows (IgG 1902 vs. 1718 mg/dl; IgM 278 vs. 243 mg/dl). The exact mechanism of the effect of MOS on immune function is not fully understood, but improved immune status of the calf may provide an aid in performance and a reduction in the use of antibiotic use in milk replacer formulations.

Key Words: oligosaccharide, colostrum, calf

Goat Species

766 Feed intake and efficiency measurements in goats. J.M. Dzakuma* and E. Risch, *Prairie View A&M University, Prairie View, TX. USA.*

Two breeds of goats, the Spanish (SP) and the Tennessee Stiff-legged (TS), were fed three levels (100% or *ad libitum*, 85% and 70% of *ad lib*) of the same ration containing, approximately, 18%CP and 65% TDN. These goats were classified as intermediate (SP=47.5 kg) and small (TS=36.8 kg) mature sizes. They were individually penned and fed. Feed intake, orts, excreta, and bi-weekly weights were collected until yearling age. After weaning at, approximately, 70 d, 48 goats (24M and 24F) from each breed were divided into three groups of 8, by sex, and placed on the ration. Twenty-four goats (4M and 4F from each dietary level) were slaughtered at 6 mo of age. The other 24 goats were slaughtered at 13 mo and carcass data collected. The objective of this study is to understand nutrition, genotype and management interactions. Adjusted weaning(WN) wt, WNWT = BRWT + 70(ADG birth to weaning). Average Daily Gain, ADG = Wt gain/Interval in days. Feed Efficiency, FE = Wt gain/Feed consumed. ADG post-weaning and FE were calculated between WN and 6 mo and between 9 and 13 mo, corresponding to when data were collected. Analyses of all variables were performed using the GLM procedure in SAS (1998), with dietary level, breed and sex as main effects, and their secondary effects. No statistically significant differences were observed in feed intake amounts between the SP and the TS breeds throughout the duration of the study. Cumulative amount of feed intake for the SP and the TS goats, respectively, from WN to 6 mo were, 51.3 and 50.5 kg, and from 6 to 13 mo were, 67.7 and 66.7 kg. The TS, being a smaller size breed, ate the same amount of feed ($P > .05$) as the SP, an intermediate sized breed. Calculated FE were: (SP_{wn-6mo}=.122 kg per kilogram of feed consumed vs TS_{wn-6mo}=.167 kg per kilogram of feed consumed ($P < .01$) and SP_{6-13mo}=.088 kg per kilogram of feed consumed vs TS_{6-13mo}=.104 kg per kilogram of feed consumed) and ADG: (SP_{wn-6mo}=.058 kg vs TS_{wn-6mo}=.083 kg ($P < .01$) and SP_{9-13mo}=.034 kg vs TS_{9-13mo}=.038 kg). It would appear the TS is growing more efficiently than the SP.

The project has been repeated with the addition of Boer, a large mature breed size, and will be reported. Knowledge of the interactions of feed intake, genotype and body composition changes will help characterize growth curves in goats.

Key Words: Spanish, Tennessee Stiff-legged, Goats, Feed Intake, Feed Efficiency

767 Prediction of energy requirements for maintenance and gain of growing goats. J. Luo, A. L. Goetsch, and T. Sahlu, *E (Kika) de la Garza Institute for Goat Research, Langston University, OK.*

Literature data were compiled and a database was constructed to estimate ME requirements for maintenance (ME_m) and BW gain (ME_g) for three different biotypes of growing goats (i.e., $\geq 50\%$ Boer or meat, dairy, and indigenous) by regressing ME intake (MEI, kJ/kg BW^{0.75}) against ADG (g/kg BW^{0.75}). Because of differences among biotypes in intercepts and slopes ($P < 0.05$), data subsets for the different biotypes were used. The meat subset included 60 observations from 11 publications, representing 548 goats; the dairy subset had 116 observations from 25 publications with 1,851 goats; and there were 157 observations from 34 publications and 1,024 goats in the indigenous subset. Dairy and indigenous subsets were split into two groups-one for equation development and a second for evaluation. Observations with residuals greater than 1.5 times the residual SD from initial regressions were deleted. Equations were meat: MEI = 457.0 (SE = 22.3) + (25.23 (SE = 1.74) \times ADG) ($n = 57$; $R^2 = 0.79$); dairy goats (development subset, $n = 63$): MEI = 573.7 (SE = 46.2) + (23.56 (SE = 3.10) \times ADG) ($n = 56$; $R^2 = 0.52$); and indigenous (development subset, $n = 87$): MEI = 500.0 (SE = 11.9) + (18.59 (SE = 1.64) \times ADG) ($n = 76$; $R^2 = 0.63$). Intercepts and slopes from regressions of observed against predicted MEI with evaluation subsets based on dairy and indigenous equations were not different from 0 and 1, respectively. Prediction equations for the three biotypes

had similar slopes, but the intercept for dairy differed ($P < 0.05$) from those for meat and indigenous. A common slope equation with a dummy variable (D; dairy = 1 and others = 0) was: $MEI = 480.0$ ($SE = 13.5$) + $(103.2$ ($SE = 17.4$) $\times D$) + $(22.85$ ($SE = 1.23$) $\times ADG$) ($n = 189$; $R^2 = 0.74$). In conclusion, based on a compiled database from publications with growing goats, ME_m was 583.2 kJ/BW^{0.75} (139 kcal/kg BW^{0.75}) for dairy goats and 480.0 kJ/BW^{0.75} (115 kcal/kg BW^{0.75}) for meat and indigenous goats, and ME_g was 22.85 kJ/g (5.46 kcal/g). Supported by USDA project No. 9803092.

Key Words: Goats, Energy

768 Influence of nutrition on ovarian activity in goats. I. Effect of fat by-pass supplementation. C. A. Meza H.*¹, D. Lopez A.¹, J. G. Chavez P.², H. Salinas³, M. Valencia⁴, and M. Mellado⁵, ¹Universidad Autonoma Chapingo, ²Gabinete de Radiodiagnostico y Ultrasonografia, ³Instituto Nacional de Investigaciones Agricolas Forestales y Pecuarias, ⁴Universidad Juarez del Estado de Durango, ⁵Universidad Autonoma Agraria Antonio Narro.

Aim of this study was to evaluate, in puberal goats, the effect of by-pass fat supplementation (FAT) on ovarian activity and serum growth hormone (GH) concentration. Goats ($n=21$) with 21.3×0.45 kg body weight (BW) and 7 months old, received either low (LFAT, 0 g/hd per day) or high (HFAT, 40 g/hd of a Ca fatty acid salt per day; equivalent to 0.256 Mcal NE) during a 28-d pre and 14-d post-ovulation period. Goats had access to water, shade, mineral salts and a basal diet of alfalfa hay (2.0% BW, 14.6% CP), under natural photoperiod (25 NL). Upon estrous synchronization (PGF2 α , 2x 11d apart), blood samples were collected 36h later at 15-min intervals during a 6-h period to evaluate GH area under the curve (AUC) and pulsatility (PULSE). On d-15 post-ovulation, both follicular and corpus luteum number were determined by transrectal ultrasonographic scanning. Overall averages for total follicles (TF), corpus luteum (CL) and total ovarian activity (OA) were 2.28, 0.9, and 3.14, respectively. Neither TF, nor CL or OA were affected ($P>0.05$) by fat supplementation level. Overall GH average was 18.6 ng mL⁻¹; neither AUC nor PULSE were affected ($P>0.05$) by FAT level. Results suggest that nutrient partitioning could have privileged body growth processes in puberal goats, instead of optimizing the activity of the hypothalamic-hypophyseal-ovarian axis. The last scenario seems to delineate an effective metabolic strategy exerted by puberal goats which assures that energetic resources would not be diverted toward reproductive functions that depict a low probability to be physiologically successful in this growing phase.

Key Words: Goats, Energy supplementation, Ovarian activity

769 Influence of nutrition on ovarian activity in goats. II. Interactions among body condition, by-pass protein supplementation and endocrine profile. C. A. Meza H.*¹, J. A. Ortiz¹, R. A. Cuevas¹, J. G. Chavez P.², H. Salinas³, M. Valencia⁴, and M. Mellado⁵, ¹Universidad Autonoma Chapingo, ²Gabinete de Radiodiagnostico y Ultrasonografia, ³Instituto Nacional de Investigaciones Agricolas Forestales y Pecuarias, ⁴Universidad Juarez del Estado de Durango, ⁵Universidad Autonoma Agraria Antonio Narro.

Aim of this study was to evaluate the possible relationship among by-pass protein supplementation and ovarian activity in goats with divergent body condition (BC). Goats in low (LBC, $n = 16$; BW = 28.71 ± 0.02 kg) or high (HBC, $n = 16$; 38.461 ± 0.02 kg) received one of two levels of by-pass protein (blood meal): Low (LP, 0 g goat per day) or High (HP, 125 g goat per day) during 40 d pre- and 15 d post-ovulation. Goats had access to water, shade, mineral salts, and a basal diet of alfalfa hay (2.0% BW, 14.8% CP). Upon estrous synchronization (PGF2 α 2x 11d apart), blood samples were collected 36h later at 15 min intervals during a 6-h period to evaluate GH and LH area under the curve (AUC) and pulsatility (PULSE). On d-15 post-ovulation, ovarian activity was evaluated by transrectal ultrasonographic scanning. Overall means for total follicles (TF), corpus luteum number (CL), and total ovarian activity (OA) were 2.31, 2.34 and 4.65, respectively. While TF was not affected ($P=0.1$) by BC, both CL ($P=0.003$) and OA ($P=0.01$) differed between BC groups, with the largest values depicted by the HBC-goats. Similarly, the HP-goats showed the best values for TF ($P=0.04$), CL ($P=0.06$) and OA ($P=0.01$), when compared with the LP-group. Overall GH and LH averages were 8.47 and 2.52 ng mL⁻¹, respectively. However, neither AUC nor PULSE differed ($P>0.1$) among treatments. These results suggest that both by-pass protein supplementation and a good

body condition are able to increase the activity and(or) sensibility of the hypothalamic-hypophyseal-gonadal axis. The last resulted, in turn, in an increased ovarian activity in goats, without differences between treatments in serum LH or GH concentrations.

Key Words: Goats, By-pass protein supplementation, Ovarian activity

770 Effect of pasture feeding and lactation stage on the biochemical composition of goat milk and cheese flavor. K.A. Soryal*, S. Zeng, B. Min, S. Hart, K. Tesfai, and T. Sahl, E (kika de la Garza Institute for Goat Research, Langston Univ., OK.

This study examined the effect of pasture feeding with different levels of concentrate and lactation stage on milk fatty acids and cheese characteristics. Twenty lactating Alpine goats were randomly assigned to four groups. Group A was confined, fed alfalfa hay and supplemented with 0.66 kg concentrate (per 1 kg of milk over 1.5 kg/day) (Control). The three pasture groups with different levels of concentrate were B (0.66 kg/d); C (0.33 kg/d) and D (no supplementation). Two batches of milk (10 kg) were collected monthly for processing into a soft cheese, Egyptian Domiat, from April through September 2001. Milk samples were analyzed for fat, protein, lactose and TS, and cheese samples were organoleptically scored. Results indicated that the overall mean values of short chain (C₆, C₈, C₁₀; SCFA) and long chain (C₁₂, C₁₄, C₁₆, C₁₈, C_{18:1}, C_{18:2} and C_{18:3}; LCFA) fatty acids in milk were 0.98 and 6.79 mg/g, respectively. Both SCFA and LCFA contents in goat milk were affected ($P < 0.001$) by stage of lactation. SCFA concentration for D was lower, 0.83 mg/g than for A, B and C (1.04, 1.02 and 1.04 mg/g, respectively). However, LCFA content in B (7.34 mg/g) was significantly higher ($P < 0.05$) than for D (6.28 mg/g). SCFA (1.7 mg/g) and LCFA (9.2 mg/g) in the early lactation were greater ($P < 0.001$) than in mid to late lactation (0.7-1.2 and 6.0-8.1 mg/g, respectively). Milk fat content was positively correlated with milk protein ($r = 0.42$, $P < 0.01$), TS ($r = 0.87$, $P < 0.001$), and cheese yield ($r = 0.60$; $P < 0.001$) but was negatively correlated with flavor score ($r = -0.33$; $P < 0.01$). Milk protein was positively correlated with TS ($r = 0.68$, $P < 0.001$) and cheese yield ($r = 0.38$; $P < 0.05$). SCFA and LCFA concentrations in milk were positively correlated ($r = 0.7$; $P < 0.001$). In conclusion, the best cheese flavor was obtained with milk from groups receiving little or no supplemented concentrate (C and D) in mid-lactation when LCFA and TS contents in milk were low.

Key Words: Fatty acids, Domiat cheese, Pasture feeding

771 Rotational grazing as a parasite management tool for goats. W.E. Pomroy^{1,2}, S.P. Hart*¹, and B.R. Min¹, ¹E (Kika) dela Garza Institute for Goat Research, Langston University, OK, ²Institute of Veterinary, Animal and Biomedical Sciences, Massey University, NZ.

This study investigated the use of a short-duration, long-rest-period rotational grazing system as a method for controlling internal parasites in goats. Pastures (in central Oklahoma) were blocked by presence (15% cover) or absence of trees with two 2.0-ha pastures of degraded tallgrass native prairie per block. Two pastures were each divided with electric fence into 14 strips for rotational grazing beginning in May. Goats grazed each strip for 5 d and were moved to the next strip for two rotations, resulting in a 65-d rest period. Two pastures were set-stocked. Non-lactating, mature goats were used, six Angora and six Spanish does per pasture. Does were dewormed at the start of the study and fecal egg counts were used to confirm the efficacy of deworming. Initial and final weights of goats were taken. Tracer animals (11.5 kg BW Alpine wethers) were dewormed effectively (confirmed by fecal egg counts) and allowed to graze with animals in each pasture (three tracers per pasture) for 17 d near the end of the study to measure pasture contamination. Tracers were euthanized after an additional 11 d and worms in the abomasum and small intestine were identified and counted. Goats were sampled every 3 wk for fecal egg counts (modified McMaster procedure) and hematocrit. Fecal egg counts (FEC) were log transformed prior to statistical analysis. The FEC were reduced by rotational grazing ($P<0.05$; 309 vs 121 eggs/g). There was a significant treatment by block effect ($P<0.005$) in that pastures with trees had higher FEC, presumably due to animals congregating under trees and feces being shaded from the sun. Hematocrit and BW gain were not affected by treatment ($P>0.10$). Pasture contamination with *Haemonchus contortus* larvae, (74.4% of worms identified) as determined by tracer animals, was lower ($P<0.001$; 630 vs 40 worms per animal) for rotationally grazed

animals than for set-stocked animals with a block by pasture interaction ($P<0.001$) due to trees as previously discussed. Contamination by other species (*Ostertagia circumcincta*, 8.2% and *Trichostrongylus colubriformis*, 17.4%) of larvae followed a similar pattern. A short-duration, long-rest-period, rotational grazing system on tallgrass native range can effectively control internal parasites in goats, but the presence of trees in pastures can increase parasite infestation.

Key Words: Internal parasite, Pasture rotation, Goat

772 In situ degradability kinetics of the diet consumed by grazing goats in a semiarid region of north Mexico. A.S. Juarez-Reyes¹, R.A. Alvarez-Gamboa¹, G. Nevarez-Carrasco¹, and M.A. Cerrillo-Soto^{*1}, ¹Universidad Juarez del Estado de Durango. Durango, Dgo. Mexico.

The objective of this study was to determine the *in situ* degradability of forage consumed by grazing goats in a thorn scrubland in the north of Mexico. Three goats fitted with rumen and esophageal cannulae belonging to a herd 360 animals were used to obtain diet samples for a period of 24 months. Two seasons were considered; dry season from January to June and rainy season from July to December. The extrusa samples collected from the previous month were placed in nylon bags (5 g DM) and incubated in the rumen of the same animals for 0, 3, 7, 12, 24, 48, 72 and 96 h. The course of DM degradation of the samples was described by using the equation $p = a + b (1 - e^{-ct})$. The fractions a, b, a + b, c and ED were analyzed by ANOVA according to a randomized block design. The values obtained for the soluble fraction (a), insoluble but fermentable fraction (b), potential degradability (a + b), degradation rate constant (c) and effective degradability (ED) were higher for the rainy season. The rate of DM degradation (c, %/h) registered in the dry season for both years suggest supplementation practices may be necessary.

Season			
Fraction	Dry	Wet	sem
a (%)	30.2 _a	37.8 _b	0.85
b (%)	35.0 _a	39.3 _b	0.92
c (%)	4.1 _a	5.2 _b	0.20
a + b (%)	65.2 _a	75.1 _b	1.20
ED (%)	50.4 _a	60.5 _b	1.26

**Growth and Development
Somatotropic Axis and Leptin in Cows**

774 Correlation of circulating IGF-I with IGF-I mRNA and growth hormone receptor (GHR) 1A mRNA expression in calves exposed to long or short day photoperiod. P.E. Kendall*, T.L. Auchtung, and G.E. Dahl, *University of Illinois, Urbana.*

The galactopoietic effect of a long day photoperiod (LDPP) is well known in lactating cattle and is associated with a concomitant rise in circulating IGF-I concentration. However, LDPP has no effect on GH concentrations or hepatic GHR 1A mRNA expression. This study looked at the relationship between blood IGF-I concentration, IGF-I mRNA and GHR 1A mRNA expression in the liver in response to photoperiod. Two groups of Holstein steer calves were maintained indoors and exposed to either a LDPP (16L:8D; n=6) or short day photoperiod (SDPP) (8L:16D; n=6) for 9 weeks. Jugular blood samples were collected at weekly intervals to determine changes in serum IGF-I by radioimmunoassay. Liver biopsies were obtained at 3-week intervals to quantify changes in hepatic GHR 1A mRNA and IGF-I mRNA using real time PCR. IGF-I concentrations displayed a temporal increase in both treatments, with levels being consistently higher ($P<0.05$) in LDPP calves compared to SDPP calves. Both hepatic IGF-I mRNA expression and the amount of GHR 1A mRNA were positively ($P<0.01$) correlated with circulating IGF-I concentrations. Therefore, changes in circulating IGF-I are associated with altered expression of hepatic IGF system genes, and while IGF-I increases in response to LDPP, IGF system gene expression is not affected by photoperiod. It remains possible

ab values with the same letter within rows do not differ ($P_{i.05}$) sem standard error of the mean

Key Words: Grazing goats, *in situ* degradability, Diet

773 In vitro maturation of caprine oocytes in different sera. P. Tajik*¹ and M. Hashemi², ¹Faculty of Veterinary medicine, Islamic Azad University, Science and Research Branch, ²Islamic Azad University, Tehran North Branch.

Different protein supplements such as fetal calf serum (FCS) (Martin-Lunas et al, 1996), calf serum (CS) (Crozet et al, 1993), estrus goat serum (EGS) (Keskitape et al, 1994) and bovine serum albumin + EGS (Rajikin et al, 1994), have been used for in vitro maturation of caprine oocytes. However, in nearly all experiments, hormones have been added to the tissue culture media. On the other hand, the experiments on in vitro maturation of caprine oocytes using TCM-199 supplemented with 20% estrus goat serum, FSH, LH and estradiol 17 β , showed no significant difference between prepubertal and adult goats (Mogas et al, 1997). In a different study we found no significant difference in maturation in vitro of caprine oocytes among different concentrations of EGS in non-breeding season (Tajik and Shams, 1998). In the present study, three different sera, including estrus sheep serum (ESS), have been added to maturation medium and their effect have been reported. Oocytes were aspirated from caprine ovaries, washed and cultured in TCM-199 containing penicillin, streptomycin and 0, 10, 15 or 20% of FCS, ESS or EGS. After 24-26h culture, oocytes were freed from cumulus and corona cells by hyaluronidase and passing through a fine pipette, fixed in aceto alcohol, stained with aceto orcein and observed under a phase-contrast microscope for evidence of maturation. High maturation rates (74% - 94%) were observed in all concentrations of the 3 different sera examined. No significant difference was observed between different concentrations and among different sera. Almost no maturation observed in the medium lacking serum. In conclusion, these sera with the concentration examined can be substituted for one another for in vitro maturation of caprine oocytes.

Sera examind Concentrations	FBS (%)	EGS (%)	ESS (%)	Significance
0 (Control)	2/24 (4)	-	-	
10%	49/59 (83)	35/38(86)	34/36 (94)	-
15%	23/29 (79)	14/18 (77)	34/41 (83)	-
20%	26/31 (84)	17/20 (85)	28/38 974)	-

Key Words: In vitro maturation, Caprine oocytes, Different sera

that net increases of IGFs into circulation in cattle exposed to a LDPP are related to shifts in IGF-binding proteins (IGF-BPs) in circulation. We are currently quantifying the relative abundance of IGF-BP-2, BP-3 and BP-5 to resolve this issue. In summary, galactopoietic effects of LDPP are associated with higher concentrations of IGF-I in circulation, yet the mechanism producing this response remains unknown.

Key Words: Cattle, Photoperiod, IGF system

775 Plasma IGF-I does not reflect growth rate and fattening in finishing-fed dry dairy cows. M Vestergaard*¹, KF Jorgensen¹, HR Andersen¹, HB Bligaard², and K Sejrsen¹, ¹Danish Institute of Agricultural Sciences, Tjele, Denmark, ²Danish Meat Research Institute, Roskilde, Denmark.

The purpose was to investigate the growth and fattening potential of various categories of culled dairy cows. A total of 126 Danish Friesian cows (60 first and 66 later parity) were purchased from commercial dairy herds. Cows were culled for various typical reasons at different stages of lactation (22 to 395 days post partum). All cows were non-pregnant and milk yield ranged from 1 to 25 kg/d (14.4 \pm 0.6 kg). LW varied from 330 to 770 kg (562 \pm 6.4 kg). Cows were allocated to 3 treatment groups based on parity, LW, BCS, and culling reason. Cows were housed in tie-stalls. All cows had free access to barley straw and water during a 7-d drying off period in which cows lost 1.3 kg/d of LW on average. A

control group (C) was slaughtered after drying off (n=43), a group (F2) was finishing-fed for 63 days (n=42), and a group (F4) was finishing-fed for 126 days (n=41). In the finishing period, cows had free access to a TMR (10.6 MJ ME/kg and 130 g CP/kg of DM). At drying off and at slaughter, blood was sampled and analysed for IGF-I, and loin eye area (LDA) and backfat thickness (BT) was evaluated by ultrasound. Cows on treatment F2 and F4 consumed 15.5 kg DM/d and gained 1.16±0.65 kg/d in the finishing period. Compared to C-cows, F2- and F4-cows had 10 and 21% larger LDA and 14 and 70% larger BT, respectively. Plasma IGF-I was not different at drying off (135±4.6 ng/mL) but was 25 and 34% higher (P<0.001) after 2- and 4- months of finishing, respectively. However, IGF-I at 2- and 4-months of finishing was not correlated to ADG in the comparable periods. In first compared with later parity cows, IGF-I was 25% higher (P<0.001) and BT 12% lower (P<0.05), but ADG and LDA was similar despite cows were smaller (583 vs 665 kg, P<0.001). The results show that it is possible to dry-off and finish culled dairy cows with overall ADG of 1.0 kg resulting in larger muscles and improved fatness. However, IGF-I seems to be a weak indicator of daily gain, muscle development, and fatness in growing cows.

Key Words: finishing feeding, dry cows, IGF-I

776 Evaluation of the Use of a Human cDNA Microarray to Profile Hepatic Gene Expression in Transition Dairy Cows. J.R. Townsend*, D.E. Moody, and S.S. Donkin, *Purdue University, West Lafayette, IN.*

DNA microarrays provide a tool to profile the expression of thousands of genes in a single experiment. Bovine specific microarrays are not widely available commercially. The GF211 microarray filter containing 4,000 named human cDNAs or targets (Research Genetics, Huntsville, AL) was tested for suitability in profiling gene expression in liver from transition dairy cows. RNA was extracted from liver samples from 10 Holstein dairy cows on day -28, +1, and +28 relative to calving and pooled within day of calving. A total of 8 ug of each pool was reverse transcribed and labeled with ³³P-dCTP. Labeled cDNA was hybridized with one of three microarrays. Pooled samples were hybridized with three microarray filters in a 3 x 3 factorial arrangement of filter x sample combinations. This approach was used to minimize filter and day of hybridization effects. Hybridization was performed at 42C for 15 hours. Microarrays were washed then imaged on phosphor imaging screens. Intensity of target spots was determined using Pathways 3.0 (Research Genetics, Huntsville, AL) and normalized using the mean background intensity of binding to the microarray. A two-fold difference in intensity was used as the criteria for determining differences between sample pools. Using this criteria a total of 56 genes were identified as differentially expressed among liver samples obtained during the transition to lactation. These included: apolipoprotein-C III (ApoCIII), fatty acid binding protein (FABP), phosphoenolpyruvate carboxykinase (PEPCK), glutamate dehydrogenase-1 (GDH-1), and phosphoglycerate kinase-1 (PGK-1). The expression of FABP and Apo-CIII were greater on day +28 vs. day +1. Expression of PEPCK was greater on day -28 than day +28. GDH-1 was more highly expressed on day -28 compared with either day +1 or day +28. Expression of PGK-1 increased on day -28 relative to day +1. The data demonstrate that human gene filter microarrays can be used successfully to identify genes that respond to physiological changes, such as the transition to lactation, in dairy cows.

Key Words: Microarray, Bovine, Liver

777 Effect of insulin on the GH-IGF-I axis in the periparturient dairy cow. R. P. Rhoads*, B. J. Leury², L. H. Baumgard¹, S. S. Block¹, D. A. Dwyer¹, A. W. Bell¹, D. E. Bauman¹, and Y. R. Boisclair¹, ¹*Cornell University, Ithaca, NY*, ²*University of Melbourne, Victoria, Australia.*

In transition dairy cows, plasma IGF-I declines rapidly near parturition and remains depressed during the first few weeks of lactation. Reduction in plasma IGF-I parallels exactly the deteriorating energy balance (EB) and is maximal around parturition when abundance of the liver specific mRNA of the growth hormone receptor (GHR1A mRNA) reaches its nadir. Mechanisms responsible for mediating the effects of negative EB on plasma IGF-I, and perhaps on GHR1A mRNA, are not completely understood. In this study, we tested whether insulin is involved by performing hyperinsulinemic-euglycemic clamps on six Holstein cows in late pregnancy (LP, 25 days prepartum) and again in early lactation (EL, 10

days postpartum). Expected changes were observed during the transition from LP to EL: Cows were in positive EB in LP (+12.3 Mcal/d) and in negative EB in EL (-12.2 Mcal/d); EL cows had lower plasma concentrations of glucose (39 vs 49 mg/dL, P<0.001), insulin (0.6 vs 2.0 ng/mL, P<0.001) and IGF-I (79.7 vs 171.8 ng/mL, P<0.001) than LP cows. Reduced plasma IGF-I in EL occurred despite absence of difference in the hepatic levels of IGF-I mRNA between EL and LP cows; EL cows however, had lower hepatic levels of GHR1A mRNA than LP cows. During the clamp, plasma insulin rose 2.3 fold during LP and 3.7 fold during EL. Hyperinsulinemia increased the plasma concentration of IGF-I 2-fold in both physiological states, but the absolute increment was lower in EL than in LP (Δ IGF-I = 78.9 vs 157.3 ng/mL, P<0.001). Insulin increased the levels of IGF-I and GHR1A mRNAs to a similar extent in EL and LP cows. We conclude that insulin mediates a portion of the effects of negative EB on plasma IGF-I by regulating expression of the growth hormone receptor in liver. However, our data indicate that post-transcriptional mechanisms are also involved, and could include cellular (i.e. translational effects) as well as intravascular phenomena (i.e. changes in binary and ternary IGF-containing complexes).

Key Words: GH receptor, Liver, Energy balance

778 Leptin Binding Moieties in Bovine Serum. R. A. Hill*, S. Margetic², and N. Hughes¹, ¹*University of Idaho*, ²*Central Queensland University, Australia.*

Leptin has a wide range of roles including direct, peripheral interactions. These are likely to be affected by leptin binding proteins. Previously, leptin has been shown to bind to an abundant site in rat plasma, forming a 66 kDa complex, and similarly in humans forming a 450 kDa complex. The present study characterized bovine serum leptin-binding activity by incubating serum with ¹²⁵I-labeled leptin, and resolved using Sephadex S300 column chromatography (Table 1). Within 2 h, 220 kDa and 66 kDa complexes had come to equilibrium. However, the 66 kDa complex was more abundant (proportion of radioactivity bound). After addition of excess unlabelled leptin, the first three peaks were reduced (p<0.01), showing that interactions with ¹²⁵I-leptin were reversible. Peak III, showed the greatest binding reduction, 5-fold (p<0.01). Radioactivity was displaced to the elution position of free ¹²⁵I-leptin, (17 kDa) which was increased about 2-fold. We speculate that 50, 200 and 650 kDa proteins, represent the bovine leptin binding proteins. Peak II may represent homodimers of the soluble leptin receptor. Peak I may provide evidence of leptin complexed with alpha2-macroglobulin. Thus, there appears to be considerable species variation in plasma leptin binding proteins which are both quantitative and qualitative. Variations in the leptin binding profile and the abundance and affinities of these moieties are likely to account for species differences in leptin pharmacokinetics and leptin interaction in peripheral tissues. Table 1. Percent of total radioactivity in areas under the peaks from Sephacryl S-300 chromatography of bovine serum, in the absence or presence of unlabeled leptin. Values are means + SEM (n= 3).

Incubation period (h)	Peak I (670 kDa)	Peak II (220- kDa)	Peak III (66 kDa)	Free leptin (17 kDa)
0	-	-	-	93.88±1.92
2	1.86±0.08	5.58±0.51	11.81±0.88	71.26±0.87
4	3.33±0.52	4.06±1.21	15.27±3.21	60.80±2.15
8	4.45±1.59	7.17±1.12	15.70±1.63	57.23±2.19
12	6.18±0.93	6.33±1.39	25.72±2.13	47.66±3.21
+ unlabelled leptin				
12	4.51±0.52	2.52±0.32	4.83±1.34	79.27±3.91

779 Role of insulin and growth hormone in regulating the concentration of plasma leptin in lactating dairy cows. S. S. Block*, R. P. Rhoads¹, D. E. Bauman¹, R. A. Ehrhardt¹, M. M. McGuire¹, B. A. Crooker², J. M. Griinari¹, T. R. Mackle¹, M. E. Van Amburgh¹, and Y. R. Boisclair¹, ¹*Cornell University, Ithaca, NY*, ²*University of Minnesota, St. Paul, MN.*

In lactating dairy cows, the onset of negative energy balance (EB) at parturition causes a reduction in plasma leptin and is also associated with increased concentration of growth hormone (GH) and decreased concentration of insulin. These observations raise the possibility that opposite changes in plasma insulin and GH are partly responsible for

reduced leptin synthesis in adipose tissue. To test this hypothesis without the confounding influence of parturition, we first examined the effects of undernutrition by using late lactating dairy cows fed 120 % of their nutrient requirements or restricted to 33 % of maintenance energy requirements. Plasma leptin was reduced within 24 h of feed restriction (fed vs restricted, 2.8 vs 2.2 ng/ml, $P < 0.001$), and was associated with increased plasma GH and decreased plasma insulin; complete food deprivation for a period of 48 h did not accentuate the reduction in the plasma concentration of leptin (fed vs fasted, 2.7 vs 2.0 ng/ml, $P < 0.05$). To determine if an elevation in GH is responsible for the fall in plasma leptin, late lactating cows in positive EB were treated for 4 consecutive days with excipient or recombinant bovine somatotropin (rbST, 40 mg/d), rbST treatment increased milk yield by 26 % ($P < 0.01$) but had no effect on plasma leptin. rbST also failed to alter plasma leptin when a similar experiment was performed during the third week of lactation when EB was negative. Finally, the effects of insulin were studied by performing euglycemic hyperinsulinemic clamps in mid-lactating dairy cows in positive EB. After 96 h of hyperinsulinemia, plasma leptin was increased significantly (basal vs hyperinsulinemia, 2.5 vs 3.4 ng/ml, $P < 0.001$). These data indicate that, in undernourished lactating dairy cows, reduced plasma insulin is partly responsible for the fall in plasma leptin, and that elevated plasma GH plays no role in this effect.

Key Words: Leptin, Growth Hormone, Insulin

780 Effect of sunflower seed inclusion on conjugated linoleic acid concentrations in milk fat of Holstein cows. D. B. Carlson^{*1}, M. S. Laubach¹, W. L. Keller¹, J. W. Schroeder¹, J. H. Herbein², and C. S. Park¹, ¹North Dakota State University, Fargo, ND, ²Virginia Polytechnic and State University, Blacksburg, VA.

The objectives of this study were to investigate the effect of sunflower seed supplementation on conjugated linoleic acid (CLA) concentration

in milk fat and to determine the level of sunflower seed supplementation that maximizes CLA concentration without negatively impacting milk yield. Lactating Holstein cows ($n = 4$) were stratified by parity, milk yield, and days in milk, and assigned to one of three dietary treatments in a completely randomized design. Treatments were: 1) 1% of dry matter (DM) as sunflower seeds (CON), 2) 6.5% of DM as sunflower seeds (MID), and 3) 11.4% of DM as sunflower seeds (HIGH). Sunflower seeds were rolled and directly blended into total mixed rations. The predominant fatty acids present in sunflower seeds were linoleic acid (74.04% of total oil) and oleic acid (15.45% of total oil). Cows were fed individually for a period of twelve wk following a one-wk adaptation period. Dry matter intake (DMI) and milk yield were measured daily. Milk and blood samples were collected, and body weight (BW) and a body condition score (BCS) were determined on d 0, 21, 42, 63, and 84. Data were analyzed using GLM procedures of SAS. Differences were considered significant at $P < 0.05$. DMI, milk yield, BW, BCS, and serum non-esterified fatty acids were not altered by treatment ($P > 0.05$). Serum glucose was higher ($P < 0.01$) in cows fed CON compared to those consuming MID and HIGH. *Cis-9, trans-11* CLA concentration in milk fat was significantly increased ($P < 0.01$) in cows consuming MID and HIGH (8.0 and 7.0 mg/g of milk fat, respectively) compared to CON (4.3 mg/g of milk fat). Sunflower seed supplementation can increase CLA concentration in milk fat without affecting milk components and yield.

Key Words: Conjugated linoleic acid, Sunflower, Oilseed

Nonruminant Nutrition Young Pig Nutrition and Management

781 Baby pig nutrition and management. V. W. Hays*, University of Kentucky, Lexington.

Producers and researchers knew about feeding young pigs before early weaning was introduced as a part of the management system. Death of the sow shortly after farrowing or failure to produce milk necessitated transfer of pigs to another sow or finding an alternative food supply. If the pigs did not receive colostrum milk, mortality was very high. Those producers that had access to milk cows had found that cow's milk is a quite adequate diet for very young pigs. "Harris On the Pig" (1985) includes a trial by Miles of the Michigan Station in which pigs 2 weeks of age and 4.0 lb. body weight did very well on cow's milk. They gained 3.5 lb/pig during the first week. In the mid to late 1940s, researchers began using early weaned pigs (1 day of age and older) to study vitamin and other nutrient requirements. Serious interest in weaning at a very young age as a management system began in the early 1950s. In early studies, liquid or dry diets were based on the composition of sow's or cow's milk based on our knowledge of the performance of pigs on those diets. Much of the early work was published in Station publications, producer magazines or applied journals. "Baby Pigs Don't Need Their Mommies Any More", "Baby Pigs Have A Sweet Tooth" and "Pre-Starter 75" were among the titles. The age or weight at weaning still varies and should be determined by the degree of sanitation, the control of the environment, the complexity of the diet and the desired productivity level of the sow. As we changed the diets for economic reasons (less dependent on milk), we learned more and more about the quality and nutrient limitations of feed ingredients and the development of the pig's digestive system. Our knowledge of the nutrient requirements and utilization of various feedstuffs has been expanded greatly through the use of younger pigs.

Key Words: Baby pigs, Early weaning, Management

782 Dipeptide transport in the small intestinal brush border membrane vesicles of the weaned pigs. J.G. Dai¹, D.F. Li^{*1}, X.S. Piao¹, J.R. Pan¹, H.L. Chen¹, and G.F. Yi², ¹China Agricultural University, ²University of Missouri-Columbia.

Six crossbred Landrace x Large White x Beijing Black weaned pigs (age = 35d) were used in a series of experiments to investigate the trans-

port of glycyl-L-proline (Gly-Pro) into brush border membrane vesicles (BBMV) of the small intestine. The BBMV were prepared from the small intestine using a magnesium chloride aggregation method. The membrane purity of the BBMV was determined routinely by assay of alkaline phosphatase, a marker enzyme for BBMV, and Na^+/K^+ -ATPase, a marker enzyme for the basolateral membrane used to monitor the contamination of this membrane in BBMV. Results from the seven experiments indicated the following: Gly-Pro was not hydrolyzed in the small intestinal BBMV ($P=0.25$); transport of Gly-Pro in BBMV was optimized at an external pH of 4.5-5.5; Gly-Pro transport (20 min period) was greater at an external pH of 5.0 compared to that of a pH of 7.5 ($P<0.05$); at an external pH of 5.0, the presence of an inward proton gradient stimulated Gly-Pro transport ($P<0.05$); in the absence of a transmembrane proton gradient Gly-Pro transport was not different at an external pH of 5.0 as compared to a pH of 7.5; the K^+ diffusion potential (interior-negative) produced by valinomycin resulted in an increase in Gly-Pro transport both in the presence and absence of Na^+ ($P<0.05$); the H^+ diffusion potential (interior-positive) generated by protonophore Carbonyl cyanide p-(Tri-fluoromethoxy) phenylhydrazone (FCCP) decreased Gly-Pro transport ($P<0.05$); and that the uptake of Gly-Pro was due to transport directly into the intravesicular space rather than binding to BBMV. Collectively, these results suggest that dipeptide transport into the weaned pig small intestine is different from the transport of amino acids and glucose, in that Gly-Pro transport may be proton gradient-dependent and Na^+ -independent.

Key Words: Pigs, Dipeptide, Small intestine

783 Effects of feeding supplemental milk replacer to piglets on pre- and post-weaning performance. M. E. Davis^{*1}, C. V. Maxwell¹, D. C. Brown¹, Z. B. Johnson¹, K. J. Touchette², and J. A. Coalson², ¹University of Arkansas, Fayetteville, ²Merrick's, Inc., Middleton, WI.

Nineteen litters from two farrowing groups were allotted to two milk replacer treatments to assess the effects of milk replacer supplementation on pre- and post-weaning piglet performance. Litters were allotted to

treatments beginning at farrowing: 1) no milk replacer, and 2) milk replacer containing 18% solids. Milk replacer was provided ad libitum via an in-line system using a cup dispenser for each litter. At weaning, pigs within each treatment group were blocked into 8 weight groups, and 6 pigs from each block were assigned to a nursery pen. Pigs were fed a phase 1 diet from d 0 to 14 and a phase 2 diet from d 14 to 28. Pigs from the two lightest weight blocks were offered milk replacer for an additional 5 d after weaning. Average daily gain was greater from d 5 after birth to weaning (227 g vs. 285 g; $P \leq 0.05$), d 10 to weaning (223 g vs. 314 g; $P \leq 0.01$), and from birth to weaning (205 g vs. 254 g; $P \leq 0.06$) when pigs were provided milk replacer. Pig BW was greater at weaning (5.5 kg vs. 6.4 kg; $P \leq 0.08$) when pigs were fed milk replacer compared to the control pigs. From d 0 to 5 and d 0 to 14 post-weaning, pigs previously fed milk replacer had lower ($P \leq 0.05$) ADG than control pigs. Light weight (LW) pigs fed milk replacer for an additional 5 d after weaning had greater ADG (341 g vs. 153 g; $P \leq 0.01$) than heavy weight (HW) pigs without milk replacer. However, ADG decreased (210 g vs. 32 g, HW vs. LW, respectively; $P \leq 0.01$) during the subsequent 5 d after LW pigs were removed from milk replacer. The improvement in ADG of LW pigs from d 0 to 5 after weaning brought BW of HW and LW pigs closer together on d 5 after weaning (2.2 kg difference at weaning vs. 1.2 kg on d 5); however, this difference was lost by d 10 after weaning (2.1 kg difference) when milk replacer was removed from LW pigs. Supplementing pigs with milk replacer during the pre-weaning period improves ADG and weaning weight, while milk replacer supplemented to LW pigs for the initial 5 d after weaning improves ADG.

Key Words: Swine, Growth, Milk Substitutes

784 Gut integrity of piglets fed a diet in liquid and dry form. J.M.A.J. Verdonk¹, M.A.M. Spreeuwenberg^{*2}, G.C.M. Bakker¹, Z. Mroz¹, and M.W.A. Verstegen³, ¹ID TNO Animal Nutrition, Lelystad, ²Nutreco, Boxmeer, ³Wageningen University, the Netherlands.

Effects of dietary form (liquid versus solid) on the gut integrity were studied with 30 weaned piglets (Yorkshire x [Dutch Landrace x Finnish Landrace]) of 7.3 kg initial BW. During 7-d postweaning period they were housed individually and fed a diet in two forms: 1) dry pelleted (group 1) and 2) liquid (group 2). The liquid diet was soaked with water (1:2.5, wt/vol). Daily rations were restricted to 0.5, 1.0 and 2.0 NE_m at weaning, d 2 and d 5, respectively. Gut samples were obtained from the proximal and mid jejunum of piglets euthanized at weaning ($n = 6$), on d 2 ($n = 12$) and on d 6 postweaning ($n = 12$) for comparing morphological parameters and permeability in Ussing chambers. Group 1 had significantly higher ($P < 0.05$) transcellular transport compared to group 2. Paracellular transport, the villous length and crypt depth were similar in both groups, although numerically longer villi (15%) and deeper crypts (7%) were in group 1. Crypt depth on d 2 was decreased and on d 6 increased numerically compared to d 0 (weaning). Crypt depth on d 6 was significantly increased compared to d 2 values. Villous length on d 2 decreased ($P < 0.05$) compared to d 0. On d 6 as compared to weaning, the liquid diet caused a further decrease of villous length, whereas in piglets fed the dry diet villi were partly restored to similar height as on d 0. Paracellular transport increased ($P < 0.05$) on d 2 and partially decreased on d 6 post weaning compared to d 0. The transcellular transport increased ($P < 0.05$) on d 2 and d 6 compared to day 0. These data imply that the mucosal integrity in weaned piglets fed restricted NE is affected by a weaning stress, as manifested by villous atrophy and increased paracellular permeability, irrespective of the dietary physical form.

Key Words: Piglets, Mucosal integrity, Physical form

785 Effect of segregated early weaning on growth performance and immune parameters of pigs. D. C. Brown^{*}, C. V. Maxwell, M. E. Davis, and S. Singh, University of Arkansas, Fayetteville.

Growth performance and immune parameters were compared between pigs reared in on-site and off-site facilities. Crossbred pigs ($N = 88$) were weaned at 19 ± 2 days of age, allotted to one of two facilities based on initial BW (5.94 ± 0.07 kg on-site; 5.87 ± 0.07 kg off-site). Pigs in each group were divided into four weight groups, allotted into equal subgroups (2 or 3 pigs/pen), and stratified based on sex and litter. All pigs received common diets and were managed similarly. On d 1, 3, 11, and 24 post-weaning, one pig from each weight block was randomly sacrificed

($n = 4$ per facility) and blood was collected for differential cell counts, lymphocyte blastogenesis assay and cytokine profiles. Bile was collected for quantification of immunoglobulin-A (IgA). During phase1, pigs reared in the off-site facility had greater ADG ($P \leq 0.01$) and ADFI ($P \leq 0.01$) and were heavier at 24 d post-weaning ($P \leq 0.05$) than pigs reared on-site (17.38 ± 0.35 kg vs. 15.85 ± 0.35 kg, respectively). Lymphocytes isolated from pigs from both facilities had a higher ($P \leq 0.01$) mitogen stimulation index on d 1 post-weaning compared to d 3, 11 and 24 post-weaning. Production of IgA and the percentage of eosophils from pigs at both locations were higher ($P \leq 0.05$) on 24 d post-weaning compared to other days sampled. On-site pigs had higher ($P \leq 0.05$) interleukin-4 (IL-4) production on d 1 post-weaning than on d 3, 11 and 24 post-weaning and higher IL-4 on d 1, 11 and 24 post-weaning than off-site pigs. Off-site pigs had higher ($P \leq 0.05$) IL-4 production on d 3 post-weaning than on d 1 and 11 post-weaning and higher IL-4 on d 11 and 24 post-weaning than on-site pigs; however, there were no differences in interleukin-2. The percentage of neutrophils increased ($P \leq 0.05$) in off-site pigs from d 1 through 3 post-weaning followed by an increase ($P \leq 0.05$) in lymphocytes on d 11. These data suggest that rearing weanling pigs in an off-site facility can improve growth performance, and that performance during the nursery period may be dependent on the immune status of the pig.

Key Words: Immune function, Nursery pigs, Growth

786 Pigs weaned from the sow at 10 d of age respond to dietary energy source. W. T. Oliver^{*1}, K. J. Touchette², J. A. Coalson², C. S. Whisnant¹, J. A. Brown¹, S. A. Mathews¹, J. Odle¹, and R. J. Harrell¹, ¹North Carolina State University, Raleigh, NC, ²Merrick's Inc., Union Center, WI.

Previous research suggests the young pig does not respond to the energy density of manufactured liquid diets and that the sow does not supply adequate amounts of nutrients for optimal growth of neonatal pigs. Our objectives were: 1) to determine the effect of a high (25%, HF) or low (2%, LF) fat liquid diet on pig performance, and 2) to determine if dietary energy source alters plasma leptin. Two replicates of 60 pigs ($n = 120$; 60 males, 60 females), with an initial body weight of 4210 ± 95 g, were weaned from the sow at 10 days of age and utilized in a randomized complete block design. Pigs were blocked by weight and gender, and then assigned to 1 of 6 pens (10 pigs/pen). Diets were formulated to provide a constant lysine:ME ratio and were fed for a duration of 9 days. Pigs gained 336 ± 9 g/d, which resulted in an ending body weight of 7228 ± 120 g, regardless of dietary treatment ($P > 0.15$). Pigs fed LF diet consumed approximately 17% greater dry feed/pen/day than the pigs fed the HF diet (2777 ± 67 vs 2376 ± 67 g/d, $P < 0.01$) throughout the 9-day experiment. Treatment differences in ADFI were not observed on d 5 or 6 of treatment ($P > 0.25$). Calculated ME intake did not differ between dietary treatments ($P > 0.20$), except on d 5 and 6 of treatment, where ME intake was higher in the pigs fed the HF diet ($P < 0.05$). Feed conversion (gain:feed) was 23% higher in HF compared to LF fed pigs ($P < 0.01$). Circulating leptin averaged 1.78 ± 0.06 ng/mL, regardless of dietary treatment. Plasma urea nitrogen concentration was higher in HF pigs (11.0 ± 0.6 mg/dL), compared to LF pigs (6.2 ± 0.6 mg/dL, $P < 0.01$). These results suggest that young pigs respond to a lower energy density liquid diet with increased feed intake, without altering growth performance, utilizing a mechanism other than circulating leptin. However, economic advantages of dietary energy source will depend on the availability and costs of dietary ingredients.

Key Words: Swine, Energy source, Leptin

787 Effect of menhaden fish oil supplementation and starter diet complexity on the performance and immune response of nursery pigs. A. M. Gaines^{*1}, G. L. Allee¹, J. A. Carroll², J. W. Frank¹, D. C. Kendall¹, J. D. Spencer¹, and G. F. Yi¹, ¹University of Missouri-Columbia, ²Animal Physiology Research Unit, ARS-USDA.

A trial using 64 weanling pigs (TR4 x PIC C22) was conducted to determine the effects of menhaden fish oil supplementation and diet complexity on performance and immune response of nursery pigs. Pigs (17 d and 6.27 ± 1.16 kg) were weaned into a SEW facility and given free access to a complex diet for 7 days postweaning. At d0 (d7 postweaning), pigs were blocked by weight and allotted to 64 pens. Treatments (Trt) were arranged as a $2 \times 2 \times 2$ factorial arrangement. Main effects included diet (complex vs. simple), oil (menhaden fish (MFO) vs. corn (CO)), and

immunogen (saline vs. lipopolysaccharide (LPS)). Experimental diets contained 6% oil (6% CO or 5% MFO + 1% CO) and were fed for 14 days. On d12, i.v. injections of either LPS (100 µg/kg) or saline were given, followed by blood collection at 30 min intervals for 6 hrs. After the immune challenge (d14), pigs were placed onto a common corn-soybean meal fortified diet and growth performance was evaluated until termination of the study (d28). Pigs were weighed and feed intakes recorded at 7, 14, and 28d. Prior to immune challenge (d12), there were differences in BW for pigs fed complex vs. simple diets ($P < 0.01$; 13.1 and 12.1 kg, respectively) and pigs fed CO vs. MFO diets ($P < 0.05$; 12.9 and 12.3 kg, respectively.) During the challenge period, for pigs treated with LPS there was a Time \times Immunogen \times Oil effect ($P < 0.04$) for serum cortisol with MFO fed pigs having lower serum cortisol as compared to CO fed pigs. Peak serum cortisol for LPS-treated pigs was 174.1 ng/ml at 3 hrs post-challenge for MFO fed pigs and 234.2 ng/ml at 4 hrs for CO fed pigs. At d14 & 28, there were no differences ($P > 0.05$) in BW, except for pigs challenged with LPS. This study suggests that by d7 postweaning, pigs can be placed on a simplified diet without affecting performance and that menhaden fish oil supplementation may provide immunological protection.

Key Words: Starter diet, Fish oil, Pigs

788 Effects of different fat sources in milk replacer on growth performance, body composition and plasma fatty acid profile in neonatal pigs. H. K. Kim*, Y. W. Shin, J. G. Kim, Y. H. Park, and K. Y. Whang, *Korea University, Seoul, Korea.*

An experiment was conducted to investigate the effects of various fat sources in milk replacer on growth performance, body composition and fatty acid profiles in plasma and whole body in neonatal pigs. A total of 58 neonatal crossbred pigs (Yorkshire \times Landrace \times Duroc) were assigned to six treatments at 5-day old. Pigs in each treatment were fed artificial milk replacers including six different fat sources. Milk intakes were the same among treatments and adjusted every day as pigs grew. Milk replacers were made of dried skim milk (62.8% DM), fat sources (35.5% DM), and emulsifiers (1.7% DM). Fat sources and inclusion rates in the milk replacer were 35.5% lard (LD), 17.8% lard (LLD), 35.5% palm oil (PAM), 35.5% canola oil (CAN), 35.5% coconut oil (CCN), and 35.5% olive oil (OLV). Pigs were weighed at day 0, day 10 and day 20 and average daily gain, average daily milk intake and milk efficiency were calculated. Four pigs were sacrificed for initial body and fatty acid compositions at day 0. Also, four or five pigs each treatment were sacrificed at day 10 and day 20 to measure body composition and plasma and body fatty acid compositions. Average daily gain, milk intake and milk efficiency in LLD were lower ($P < 0.05$) than other treatments for the entire experimental period. From day 0 to day 10, water, protein and ash gains were not different among treatments, but fat gain in LD (9.66 g/d) was higher ($P < 0.05$) than those in LLD (3.85 g/d), CAN (3.96 g/d), and OLV (5.49 g/d) but not different from those in PAM (6.23 g/d) and CCN (7.75 g/d). From day 10 to day 20, gains of all body components were not different among treatments. Fatty acid compositions in plasma and whole body were similar to fatty acid compositions of fat sources of milk replacer in each treatment. This experiment demonstrates that fat source in milk replacer does not alter the growth performance, but the absolute amount of fat consumption affects growth in suckling pigs. Also, the present study suggests that fat gain in the early stage of growth might be affected by fatty acid composition in milk.

Key Words: Pigs, Body composition, Fatty acids

789 Impact of glutamine, glutamate, and nucleotides on the growth performance and intestinal morphology of weaned piglets. G.F. Yi^{*1}, G.L. Allee¹, Y. Toride², J.L. Usry³, and A.M. Gaines¹, ¹*University of Missouri-Columbia*, ²*Ajinomoto Co., Inc.*, ³*Ajinomoto Heartland Lysine, Inc.*

A total of 210 weaned barrows (4.81 \pm 0.3kg) at 17 \pm 2 days of age were used to evaluate the effects of glutamine (GLN), glutamic acid (GLU), or nucleotides (RNA) supplementation, individually or in combination on the growth performance and intestinal morphology of weaned piglets. Pigs were randomly allotted to one of the seven dietary treatments in a complete randomized block design, with six replicate pens per trt and five pigs per pen. The nursery rooms were cleaned but not disinfected after the last trial. Each pen of pigs had 'nose to nose' contact with an

older pig (about 22 kg) in an attempt to increase endemic pathogenic load. A corn-soy-lactose-fishmeal diet with no spray-dried plasma (SDP) served as a negative control (Trt 1). Trt 2 was fed a 3.5% SDP diet and served as a positive control. Trt 3 to 7 contained GLN, GLU, GLU+GLN mixture, GLU+ RNA mixture, or RNA diet, respectively. BW, ADG, ADFI and G:F were used to evaluate the growth performance weekly. Villus height (VH), crypt depth (CD) and VH:CD ratio (VCR) of duodenum, jejunum and ileum were used to compare the intestinal morphology of pigs at 7 days postweaning. From d 0 to 7, feeding the 3.5% SDP diet and the GLU+RNA mixture diet improved ADG of piglets compared to those fed the negative control diet, and those fed the GLN and the GLU diet ($P \leq 0.05$). Pigs fed the 3.5% SDP diet and those fed the GLU+RNA mixture diet tended to increase ADFI compared to pigs fed the GLU diet or the GLU+GLN mixture diet ($P \leq 0.10$). The first wk after weaning, feeding the 3.5% SDP, GLU+RNA mixture and RNA diet increased the VH of jejunum compared with the negative control diet ($P \leq 0.05$). The improved intestinal morphology of the pigs fed the 3.5% SDP and the GLU+RNA diet was in agreement with the increased ADG, while the improved jejunum VH of the pigs fed the RNA diet did not bring about a corresponding increase in ADG.

Key Words: Pigs, Glutamine, Intestinal morphology

790 SoluteinTM supplementation and growth of nursery piglets in commercial farms. Michel Vignola*, *Shur-Gain, a member of Maple Leaf Foods Inc., Saint-Romuald, Quebec, Canada.*

Two controlled field trials have been conducted in commercial facilities to measure the impacts of SoluteinTM, a source of soluble globulins. The first trial was conducted with 24 pens, 17 pigs/pen. Piglets weaned at 14-18 days of age were co-mingled from different sow operations with non stable status for PRRS. Twelve pens on one side of the room received SoluteinTM through water delivery system from d 0-4, 5-7 and 14-17 at 16, 7.3 and 11 g/p/d respectively. The control pigs (12 pens) received standard feeding program based on corn, soybean meal, plasma and whey. Live weight and feed intake were measured weekly. After 6 weeks, all pigs were individually weighed to determine variation of body-weight by pen. Results were analysed as a randomised complete block design using StatistixTM. SoluteinTM improved ADG during the first week (125 vs 88 g/d, $P < 0.001$) and numerically for the overall 6 week period (391 vs 370 g/d, $P < 0.10$). Feed intake was also improved with SoluteinTM the first week (137 vs 106 g/d, $P < 0.001$) and remained numerically improved each week without being significantly better ($P < 0.10$). For the entire period, feed intake was better for SoluteinTM fed pigs (544 vs 508 g/d, $P < 0.01$). Feed efficiency was not affected by treatment. End-weight was similar (21.81 vs 21.14 kg, $P = 0.28$) as was variation (13.56 vs 12.63 %, $P = 0.33$). Total mortality and culls was numerically reduced with SoluteinTM (2.94 vs 4.90 %, $P = 0.43$). A second trial was conducted with healthier (PRRS+ but stable) co-mingled pigs in two rooms. One room (18 pens, 17 pigs/pen) received SoluteinTM for d 0-4: 16g/p/d and a second room received standard program. SoluteinTM had no impact on ADG, ADFI, liveweight average (27.4 kg after 46 days) and variation (10.8%) but total mortality and culls was numerically reduced with SoluteinTM (0.98 vs 2.94 %, $P = 0.12$). SoluteinTM appeared to improve growth performances in health challenged pigs (PPRS+ non-stable) by improving feed intake and reducing the frequency of culls and mortality. SoluteinTM impacts could be different according to the PRRS status of recipient pigs.

Key Words: Piglets, Globulin protein

791 Weaner feed efficiency is determined by lower small intestine morphology. R. D. Slade* and H. M. Miller, *University of Leeds, Leeds, UK.*

Alterations to small intestine (SI) morphology following weaning are thought to influence pig growth performance. However, little information is available on the effect these changes have on feed efficiency (G:F). The objective of this study was to investigate the relationship between SI development and the efficiency of weaner growth. Twenty-four piglets (62.5% Large White, 25% Landrace, 12.5% Duroc) were weaned into individual mesh floor pens at 22 \pm 0.25 days of age (SEM) and 6.0 \pm 0.13kg liveweight. Piglets received a starter ration for 7 days (17.5 MJ DE/kg, 1.75% lysine) followed by a second stage ration (16.5 MJ DE/kg, 1.65% lysine). Diets were fed *ad libitum*. Individual feed intake and liveweight gain were recorded. Twelve pigs were killed for analysis on d7 following

weaning and 12 on d14. Mean crypt depth, villus height and villus diameter 100mm above the crypt villus interface were determined at points 25, 50 and 75% along the small intestine and crypt villus area estimated geometrically. Mean feed intake, weight gain and G:F were 175.2 13.5 g/d, 138.3 16.8 g/d and 0.71 0.07, respectively. Morphological measurements were similar throughout the tract and did not differ between d7 and d14 ($P > 0.05$). G:F was independent of villus and crypt dimensions at 25 and 50% positions ($P > 0.05$) and was poorly correlated with estimated crypt villus area for the same sites (linear, $R^2 = 0.18$, $P < 0.05$ and $R^2 = 0.13$, $P < 0.1$ respectively). At 75% G:F increased linearly with villus height ($R^2 = 0.27$, $P < 0.01$), villus diameter ($R^2 = 0.49$, $P < 0.01$) and crypt depth ($R^2 = 0.26$, $P < 0.05$) and quadratically with crypt villus area ($R^2 = 0.59$, $P < 0.001$). The relationships between feed efficiency and positional morphology were unaffected by days post-weaning although regression coefficients and significances were improved at 14 compared to 7d. The results indicate that the distal SI plays a key role in determining piglet feed efficiency during the 2 weeks following weaning.

Key Words: Weaner, Gut morphology, Performance

792 Influence of litter size and creep feeding on preweaning gain and influence of preweaning growth on growth to slaughter in barrows. John Klindt*, *USDA, ARS, U.S. Meat Animal Research Center.*

It has been advised that heavier weaning weights (Wnwt) are desired because pigs heavier at weaning attain market weights sooner. However, weaning ages have decreased and slaughter wts have increased, thus, Wnwt is a smaller proportion of the final wt. Herein, birth-to-weaning ADG (B-WADG) as a determinant of weight at a final age and yield of marketable pork was examined. Newborn pigs from 54 birth litters were crossfostered to create 47 assigned litters of 4 through 14 pigs/litter to create differences in B-WADG. Creep feed was offered from 5 d of age or for 2 d before weaning at 13 to 20 d. Data were obtained from 195 barrows slaughtered at an avg age of 170 d. Carcass dissection data were recorded. Analyses revealed a linear effect of assigned litter size ($P < 0.01$), linear effect of birth wt, kg ($P < 0.01$), and effect of birth dam ($P < 0.01$) on B-WADG, kg and Wnwt, kg. B-WADG and Wnwt were not influenced ($P > 0.71$) by creep feeding treatment. The importance of birth wt (Brwt), B-WADG, Wnwt, and Brwt plus B-WADG in determination of measures of postweaning growth and yield of marketable pork (sum of trimmed picnic, butt, loin, and ham) were examined by regression analysis. The initial models included the linear and quadratic effects of the independent variables. The models for wt at 170 d are presented below. In general, the R2s for other models ranked as for wt at 170 d. The results indicate positive relationships between B-WADG and measures of post-weaning growth and carcass yield, suggesting management practices that increase B-WADG may be advantageous in pork production. However, these data do not allow evaluation of costs and benefits of management changes that would increase B-WADG, and thus, increase postweaning growth rate.

Dependent var	Intercept	β (Brwt)	β (Brwt) ²	β (B-WADG)	β (Wnwt)	R ²
170 d wt, kg	54.8 ±15.1	59.3 ±18.9	-15.2 ±2.8	—	—	0.11
170 d wt, kg	98.3 ± 3.4	—	—	93.8 ±15.7	—	0.15
170 d wt, kg	82.5 ± 4.1	—	—	—	5.1 ±0.1	0.18
170 d wt, kg	47.7 ±14.4	50.5 ±17.9	-13.5 ±15.5	78.2 ±16.0	—	0.20

Key Words: Pigs, Weaning weight, Growth

793 Impact of pig weight at weaning. I. subsequent growth rate, feed conversion, and carcass composition. R. Cabrera*¹, S. Jungst¹, R.D. Boyd¹, M.E. Johnston¹, E. Wilson¹, and J. Vignes², ¹PIC USA, Franklin, KY, ²ABN Inc., St. Louis Park, MN.

This study was conducted to determine the impact of high milk production on post-weaning growth of progeny. Three rearing strategies were used to produce piglet wean weights ranging from 4.1 to 8.6 kg. Litters of pigs were sow-reared until weaning (SR) (244), weaned at 2 d (2W)

(228) or 14 d (14W) (226) of age. PIC C22 sows were randomly allocated to treatments based on parity. 2W and 14W groups were allowed *ad libitum* consumption of an acidified, medicated milk replacer using a semi-automated milk delivery system. Birth weights did not differ among treatments ($P > .05$). Litters were weaned from the sow or milk system at 19.5 ± 0.3 d of age. Pigs from 14W and 2W groups were 1.0 and 2.2 kg heavier respectively at 20 d of age compared to pigs from the SR group ($P < .05$). Pigs from the 14W group grew 35 g/d faster during the nursery period compared to pigs from the 2W group ($P < .05$). The ADG of SR pigs did not differ from the other two groups ($P > .05$). 14W pigs required 3.0 fewer d (164.7 d) to reach 125 kg compared to SR pigs ($P < .05$). SR and 14W pigs gained 936 and 932 g/d, respectively, during the finish period, which was 24 and 20 g/d faster than 2W pigs ($P < .05$). Feed conversion of SR pigs was 0.03 kg gain/kg feed better than 14W pigs (0.40, $P < .05$). Lean percent was 0.7% higher in carcasses from SR pigs (55.0%) compared to carcasses from 2W pigs ($P < .05$). Carcasses from SR pigs had 1.7 and 2.0 mm more Fat-O-Meater loin depth than 14W and 2W pigs respectively ($P < .05$). Adjusted weaning-to-estrus intervals for sows were 6.1, 8.1, and 13.8 d for the sows weaned at 19 d, 14 d, and 2 d of lactation, respectively ($P < .001$). We observed that a 1 kg increase in wean weight resulted in 8 kg at 140 d of age and that the sow is important to post-weaning piglet growth beyond the period of colostrum (SR vs 2W). This may involve facilitated development of the immune system, digestive system, or both.

Key Words: Pig wean weight, Milk supplement, Growth rate

794 Impact of pig weight at weaning. II. post-weaning growth and economic assessment of weights ranging from 4.1 to 8.6 kg. R. Cabrera*¹, S. Jungst¹, R.D. Boyd¹, M.E. Johnston¹, E. Wilson¹, and J.L. Usry², ¹PIC USA, Franklin, KY, ²Ajinomoto Heartland, Chicago, IL.

Six groups of pigs with mean 20-d wean weights of 4.6 (n = 41), 5.5 (n = 77), 6.4 (n = 112), 7.3 (n = 109), 8.2 (n = 77), and 9.5 kg (n = 41) were derived from sow reared (SR) litters or the combination of SR and milk supplement (19.5 ± 0.3 d of age). Pigs were allocated to pens of 15 (blocked by gender and weight) and fed by computerized Feed Intake Recording Equipment. Birth weight (BWT) averaged 1.43, 1.43, 1.49, 1.60, 1.71, and 1.85 kg for 4.6, 5.5, 6.4, 7.3, 8.2, and 9.5 kg groups, respectively. The estimate of the linear effect for BWT was 0.043 kg ($P < .001$). Growth rates in the nursery period for the 4.6, 5.5, 6.4, 7.3, 8.2, and 9.5 kg groups were 507, 530, 549, 579, 593, and 607 g/d with a linear estimate of 10.3 g/d ($P < .001$). Growth rates for combined nursery-finish periods were 752, 796, 804, 815, 825, and 831 g/d, respectively, with a linear estimate of 7.06 g/d ($P < .001$). Nursery-finish gain:feed ratio was similar, (0.41). Age at 125 kg averaged 176.8, 168.8, 167.8, 164.8, 162.9, and 160.9 d respectively. The linear estimate was -1.432 d ($P < .001$). Fat-O-Meter loin depths were 57.4, 58.1, 57.6, 56.4, 56.1, and 55.4 mm for the 4.6, 5.5, 6.4, 7.3, 8.2, and 9.5 kg weaning groups, respectively. Estimates of the linear effect were -0.24 mm ($P < .05$) for loin depth. Lean percent did not differ among groups. Return over feed for each weaning weight group was calculated assuming \$0.12/kg cost of finisher feed, \$1.32/kg carcass weight market price, and a premium of \$2.75/100 kg carcass weight for pigs with 54 to 56% lean. This resulted in a lean premium of \$2.22/pig. Carcass yield was assumed constant, 73.6%. Marginal revenue per pig produced was \$83.67 for the 4.6 kg group. This was \$5.13, \$7.24, \$8.67, \$10.88, and \$9.83 per pig less compared to the 5.5, 6.4, 7.3, 8.2, and 9.5 kg groups, respectively. This study illustrates the financial benefit of improved wean weight and provides important information when assessing management and selection strategies.

Key Words: Pig wean weight, Milk supplement, Growth rate

795 Influence of type of heat-processed cereal and oat hulls inclusion in the diet on nutrient digestibility and productive performance of young pigs. G.G. Mateos*, M.A. Latorre, F. Martin, M.I. Gracia, and R. Lazaro, *Universidad Politécnica de Madrid.*

A trial was conducted to investigate the influence of substituting 30% of cooked corn by rice with or without the inclusion of 2.5% of cooked and expanded oat hulls on apparent fecal nutrient digestibility and performance of piglets weaned at 20 d. Each of the four treatments was replicated eight times. Diets were based on full-fat soybeans, fish meal, and milk products, and were fed from 20 to 40 d of age. Fecal nutrient

digestibility was determined at 33 d of age. At the end of the trial, piglets fed rice tended to grow faster (345 vs 315 g/d; $P=0.08$) but had same feed conversion than piglets fed corn. Adding oat hulls to the diet did not affect growth but improved feed conversion (1.51 vs 1.59 g/g; $P<0.05$). Apparent fecal digestibility of organic matter (76.0 vs 73.8%), crude protein (67.1 vs 62.8%), and gross energy (72.0 vs 69.0%) improved when oat hulls were included in the diet ($P<0.01$) but was not affected by the main cereal used. In a second trial we compared diets with 52% of heat-processed rice or corn and 0, 2, or 4% of cooked and expanded oat hulls. Each of the six treatments was replicated eight times and the trial lasted 20 d. At the end of the trial, average daily gain was greater for rice than for corn diets (315 vs 286 g/d; $P<0.01$) but feed conversion was not affected by the main cereal. Increasing the level of oat hulls did not affect performance from 20 to 29 d but improved feed conversion from 29 to 40 d of age ($P<0.01$). It is concluded that the inclusion of cooked rice in diets for piglets improves performance during the first 20 d after weaning. Also, the inclusion of a moderate amount of heat-processed oat hulls improves feed conversion from 29 to 40 d of age without modifying body weights at any age.

Key Words: Rice, Oat hulls, Piglets

796 The effect of the addition of a starter culture on the fermentation of liquid milled wheat. C. A. Moran^{*1} and R. H. J. Scholten², ¹*Alltech Inc., Nicholasville, KY*, ²*Beuker, Doetinchem, The Netherlands*.

A number of concerns have been raised about the fermentation of complete liquid feed diets as this may lead to protein fermentation products, palatability problems and reduced feed intake. An alternative strategy

would be to ferment the carbohydrate fraction of the diet separately and combine it with the remainder of the diet immediately before feeding. The aim of this study was to examine the effects of a lactic acid bacteria inoculum on chemical and microbial composition during fermentation of Liquid Milled Wheat (LMW). In this study, LMW (210g DM kg⁻¹) was defined as whole grain wheat, hammer-milled through a 3mm sieve, mixed with water and steeped for 48 hours with mixing every two hours. Two treatments were assigned in triplicate to 45 L PVC storage tanks housed in a temperature-controlled room set at 24°±1°C. The control treatment (Con) received no starter culture whilst the other (SC) was inoculated (6 log₁₀ cfu ml⁻¹) with a starter culture containing *Lactobacillus plantarum* and *Pediococcus pentosaceus*. Samples were removed at Time = 0, 24 and 48 h for chemical and microbiological analysis. Lactic and acetic acid concentrations were measured by capillary electrophoresis. Microbiological counts were determined from decimal dilutions of LMW samples in MRD and plated on MRS, MacConkey and Rose Bengal Chloramphenicol agar for lactic acid bacteria, coliforms and yeast, respectively. Data were analyzed by two-way ANOVA. The inclusion of the starter culture resulted in a lower coliform population (5.8 vs 6.7 log₁₀ cfu ml⁻¹, $P < 0.001$) at the end of the 48h steeping period. However, lactic acid concentration, LAB numbers and pH were not different in Con and SC treatments after 48 h. Coliform inhibition in the SC treatment may have been due to the slightly elevated acetic acid concentration or other unknown anti-microbial fermentation products resulting from starter culture addition. These results indicate that the use of the LAB starter culture combination may prove beneficial during fermentation of LMW for liquid feeding applications.

Key Words: Fermented liquid feed, Liquid milled wheat, Lactic acid bacteria

Physiology Reproduction

797 Evidence for uterine Effects on fetal Development in the Pig. S.C. Town^{*}, J.L. Patterson, and G.R. Foxcroft, *Swine Research & Technology Centre, University of Alberta, Edmonton, Alberta, Canada, T6G 2P5*.

Even in a proportion of gilts, uterine crowding in early pregnancy has detrimental effects on placental development, with implications for fetal development and postnatal growth capacity. To study this phenomenon further, pregnant gilts ($n = 23$) underwent midline laparotomy at d30 of gestation to record embryo number in utero and ovulation rate. Subsequently, during farrowing, each piglet born was matched with its placenta using an umbilical tagging procedure and piglet birth weight and placental weight were recorded. Representative day-old piglets from each litter ($n=45$) were necropsied and brain:liver weight ratio was determined as a measure of intra-uterine growth retardation. In this group of gilts, number of embryos at d30 of gestation was strongly correlated to litter size at term ($r^2 = 0.72$; $P < 0.0001$). Although there was a strong positive correlation between placental weight at term and birth weight ($r^2 = 0.76$, $P < 0.001$), neither showed a strong inverse relationship to litter size born ($r^2 = 0.12$; $P = 0.12$; $r^2 = 0.17$; $P = 0.05$), suggesting that uterine capacity had only a moderate effect on intra-uterine development. However, as brain:liver weight ratio, an indicator of IUGR, showed a negative correlation with mean piglet birth weight ($r^2 = -0.48$; $P < 0.001$), and a positive correlation with litter size at term ($r^2 = 0.35$; $P = 0.003$), intra-uterine growth retardation, measured by changes in brain:liver weight ratio, appears to have been influenced by the intra-uterine environment to a greater extent than birth weight. The results of the current study indicate that even in the absence of extreme uterine crowding, a "brain sparing" effect occurs in lower birth weight neonates. Therefore, other aspects of fetal growth such as muscle fibre development, may also be affected.

Key Words: Swine, Uterus, Development

798 Estradiol benzoate (EB) delays new follicular wave emergence in a dose dependent manner after ablation of the dominant follicle in the ovaries of cattle. C.R. Burke^{*1,2}, M.L. Mussard¹, and M.L. Day¹, ¹*The Ohio State University, Columbus OH*, ²*Dexcel Research Ltd, Hamilton, New Zealand*.

Estradiol benzoate (EB) induces atresia of the dominant follicle (DF) on the ovaries of cattle when progesterone is elevated. Reduction of estrogenic function in the DF occurs within 36 h, but emergence of the new follicular wave is typically observed 3 to 5 d after EB is administered. We tested the hypothesis that EB delays emergence of a new follicular wave in a dose dependent manner, independent of the status of the DF. At 6.4 ± .2 d after ovulation, all follicles ≥ 5 mm in diameter were aspirated in 26 postpartum cows, and animals immediately received 0, 1, 2 or 4 mg EB/500 kg BW by i.m. injection ($n=6$ or 7/group). Ovarian structures were monitored daily by ultrasonography from the d before aspiration to emergence of a new follicular wave. Blood samples were collected every 8 h to measure changes in concentrations of FSH. The time to peak FSH was defined as the interval from aspiration to the time of maximal FSH concentration. Time to peak FSH was 29.3 ± 4.0 h, 53.3 ± 4.5 h, 81.1 ± 15.5 h and 91.4 ± 8.2 h for the 0, 1, 2 or 4 mg EB treatments, respectively. Time to new follicular emergence was 1.5 ± .22 d, 3.3 ± .3 d, 4.0 ± .6 d and 4.4 ± .4 d, respectively. Peak FSH and new wave emergence occurred earlier ($P<.05$) in the 0 than in the 1, 2, or 4 mg EB treatments. These variables were similar among the 1 and 2 mg EB, and longer ($P<.05$) in the 4 mg EB when compared to the 0 or 1 mg EB treatments. The interval from peak FSH to new wave emergence was 15.7 ± 3.3 h and was not affected by treatment. Treatment with EB maintained the basal concentrations of FSH present during follicular dominance, and in a dose dependent manner, delayed the surge in FSH that stimulates new follicular development. These results show that the dose of EB, rather than the timing of atresia in the DF, determines the timing of new follicular emergence that follows treatment with EB.

Key Words: Estrous synchronization, Follicular development, Estradiol

799 Metabolic and endocrine risk factors for repeat breeder cows. N. Moss^{1,2}, I.J. Lean^{*1,2}, S.W.J. Reid³, and D.R. Hodgson², ¹*Bovine Research Australasia*, ²*University of Sydney*, ³*University of Glasgow*.

A prospective cohort study was used to investigate interactions between metabolic and endocrine factors at first insemination and conception requiring > 1 insemination (CONC>1). Holstein cows (n = 709, of which 224 were primiparous; 485 multiparous) from 7 non-seasonal calving herds in NSW and 3 seasonal calving herds in Victoria, Australia were enrolled. Herds were principally pasture-fed, supplemented with concentrates and conserved forages. Mean milk production at first service was 30.5 L (inter-herd range 24.5-36.5 L). Biographic and disease data were collected. Cows were body condition scored within 10 days before calving and again at first insemination. Cows were blood sampled at first insemination. Serum albumin, total protein, calcium, phosphorus, urea, NEFA, cholesterol and β -hydroxybutyrate (BHBA) and plasma concentrations of glucose, progesterone and LH were determined. Pregnancy was determined 45-75 days after last insemination.

First service conception rate was 53.6% and did not significantly differ between primipars and multipars, and seasonal and non-seasonal systems. Univariable logistic regression revealed increases in risk ($P < 0.05$) of CONC>1 with low serum cholesterol <4.2mM/L (n=149); low albumin <31g/L (n= 119); low glucose < 3.7mM/L (n=500); higher BHBA concentrations; shorter calving to first service interval, conception requiring >2 inseminations in the previous lactation (n=127); higher BCS at calving; dry period >99 days (n=53); post partum disease (n=87); and progesterone >1ng/mL (n=40). Multivariable logistic regression with herd fitted as random effect, revealed relationships ($P < 0.05$) between CONC>1 and low cholesterol (odds ratio(OR)=1.60 (95%CI 1.1-2.4)); low albumin (OR=1.91 (95%CI 1.3-2.9)); rising BHBA (β =0.1592); shorter calving to first service interval (β =-0.01); dry period >99 days (OR=2.0 (1.0-3.8)); post partum disease (OR=1.71(1.1-2.8)) and progesterone >1ng/mL (OR=2.4 (1.2-4.8)). This study supports associations between negative nutrient balance during early lactation and CONC>1, the negative effects of disease and previous poor fertility on risk of repeat breeding.

Key Words: Repeat Breeder, Nutrient Balance, Epidemiology

800 Use of quantitative milk progesterone testing in lactating dairy cows for determination of post calving cyclicity, estrus detection, and pregnancy diagnosis. J.D. Ferguson¹, D.T. Galligan¹, J.W. Brooks^{*2}, G. Azzaro², S. Ventura², and G. Licitra³, ¹*University of Pennsylvania*, ²*Consorzio Ricerca Filiera Lattiero-Casearia, Ragusa, Italy*, ³*University of Catania, Italy*.

The objective was to evaluate the use of a quantitative milk serum progesterone (P4) test in determining post partum cyclicity, accuracy of estrus detection, and pregnancy diagnosis. Milk samples from 11 farms were analyzed for serum P4 concentration by ELISA over a 4 month period. Samples were collected at weekly intervals from lactating dairy cows from 4 to 7 weeks after calving. A threshold value of 300 pg/ml was used for segregation of samples into "low" or "high" P4 concentration. Cycling status was determined by analysis of P4 profiles of 611 samples from 166 cows. Profiles that corresponded to the presence of a functional CL were considered to indicate cyclicity. Among all post partum cows 56.6% (94/166) were cyclic by 7 wks and 19.9% (33/166) acyclic with the remaining 23.5% (39/166) undetermined. Upon insemination a second series of samples was collected at each insemination, and at 21 d and 42 d after the most recent insemination. Rectal palpation for pregnancy was performed twice for each cow not returning to estrus at 35-41 d and 56-62 d after insemination. At insemination (n = 684) the test, when correlated with pregnancy status, had a sensitivity for detection of estrus (≤ 300 pg/ml) leading to pregnancy of 93.2% and a specificity of 13.5%. As a pregnancy test at 21 d and 42 d (n = 448 and 185) the test had a sensitivity for detection of a functional CL (> 300 pg/ml) of 95.4% and 98.0% and a specificity of 49.5% and 49.1% respectively. Thus, for determination of estrus and pregnancy the test functions well given a negative result, that is high P4 at insemination or low P4 at 21 d or 42 d post insemination. However, a positive result has very little predictive value (28.8% and 51.7% at 0 d and 21 d) until 42 d (77.4%) requiring that all animals be presented for manual pregnancy diagnosis after testing positive. The test functions well for determining post calving cycling status.

Key Words: P4, Cycling status, Pregnancy test

801 The Effect of Dexamethasone to Prevent Induced Luteolysis in Holstein Heifers . M Mohammadsadegh^{*1}, P Hovareshti², M Bolourchi², and I Noroozian², ¹*Faculty Of Vet. Med., Azad Univ. of Garmsar*, ²*Faculty of Vet. Med., Tehran Univ.*

To study the effect of dexamethasone to inhibit corpus luteum regression in Holstein heifers, 17 animals, at 15 to 17 month of age and 340 kg mean body weight were synchronized for estrus by two intramuscular injections of a naturally occurring PGF2a (25 mg PGF2a - Tham. salt, Lutalyse, Upjohn Co.USA) at 14 days interval and were studied in consecutive cycle, first as a control and then as a test group. Heifers were treated by 15 mg of a placebo and 25 mg of PGF2a on days 8 and 9 of the induced estrous cycle respectively and served as a control group. All the heifers showed estrous 2 to 6 days later and then treated by 15 mg dexamethasone sodium-phosphate (Colvasone, Norbroke Co.England) and 25 mg PGF2a on days 8 and 9 of the second estrous cycle respectively and served as a test group. Blood samples were collected on days 8 and 13 of the cycle to assay serum progesterone levels. Estrous detection and rectal palpation of the corpora lutea were established from days 8 to 13 of the cycle. The results showed that in the control group active corpora lutea were present and progesterone levels were high (> 1 ng/ml) on day 8 of the cycle. However, the corpora lutea regressed and the progesterone levels decreased (< 0.5 ng/ml) on day 13. In the test group, corpora lutea regressed in 11 heifers but the active corpora lutea were palpated in 6 heifers on day 13 with high progesterone levels (> 1 ng/ml). It was concluded that the injection of dexamethasone, 24 h before the injection of PGF2a on day 9 of the estrous cycle did not inhibit luteolysis in 64.7 % of treated heifers and failure of luteolysis was encountered only in 35.3% of the heifers. Dexamethasone inhibited significantly luteolytic activity of Dinaprost ($p < 0.01$).

Key Words: Dinaprost, Dexamethasone, Luteolysis

802 Repeated exposure to novel females enhances sexual behavior of bulls. J.D. Bailey^{*}, J.D. Rhinehart, L.H. Anderson, and K.K. Schillo, *University of Kentucky, Lexington, KY*.

The objective of this experiment was to determine the effect of novel females on sexual behavior of beef bulls. According to a latin square design, 4 Angus bulls (BW=557 \pm 17 kg) were exposed to 4 treatments over 4 test periods, each consisting of 4, 1-hour behavior tests. Treatments included: 1) consecutive exposure to 4 estrual heifers, 2) alternating exposure to 2 estrual heifers, 3) continuous exposure to 1 estrual heifer, and 4) continuous exposure to 1 diestrus heifer. During each test, heifers were unrestrained. Before the experiment, 10 heifers (BW=441 \pm 11 kg) received melengestrol acetate (7d) and 25 mg (i.m.) of PG (d 7). Forty-eight and 24 hours before each period, respectively, 7 heifers received 25 mg (i.m.) of PG and 1 mg (i.m.) of estradiol cypionate. Heifers designated as estrual were observed to participate in homosexual mounting and bulls were allowed to observe this behavior for 4-6 hours before testing. Behavior was recorded and quantified using 4 surveillance cameras interfaced with a duplex-multiplexer and a 24-hour, real-time videocassette recorder. Mounts with intromission averaged 3.3, 2.6, 1, and 0 \cdot hr⁻¹ for bulls in treatment 1, 2, 3, and 4, respectively. Bulls exposed to 4 different estrual heifers exhibited more mounts with intromission ($P < 0.01$) and more flehmen responses ($P < 0.02$) compared to other treatments. Bulls that were paired with a diestrus female for 4 hours had fewer mounts with intromission ($P < 0.01$) and tended ($P = 0.06$) to have fewer flehmen responses than other treatments. Bulls receiving alternating exposure to 2 estrual heifers exhibited more ($P < 0.01$) mounts with intromission compared to bulls continually exposed to 1 estrual heifer. Aborted mounts tended ($P = 0.07$) to decrease linearly ($P = 0.05$) over time, independent of treatments and test period. These data demonstrate that bull sexual behavior is enhanced by novel females when bulls are allowed to interact with unrestrained females.

Key Words: Sexual behavior, Mounting, Intromission

803 Effect of Hormone Addition to Semen on Backflow, Sperm Reservoir, Uterine Contractions and Fertility following AI in Pigs. K.L. Willenburg^{*}, G.M. Miller, and R.V. Knox, *University of Illinois*.

Hormone addition to semen has been used to minimize situations of low fertility. Therefore, the following experiment utilized a low fertility model to evaluate its mode of action. Twenty-four hours after the onset of estrus a low dose (0.5x10⁹ sperm/ 80 ml) single AI containing

no hormone, estrogens (5 mg 17-beta estradiol, 4.5 mg estrone sulphate, and 2 mg estrone), 5 mg PGF_{2alpha} (Lutalyse®), or 4 I.U. of oxytocin was evaluated on backflow, the sperm reservoir, uterine contractions, litter size (LS) and pregnancy rate (PR) in gilts. In experiment 1-3 all hormone treatments and AI procedures were identical. In experiment 1, backflow of semen from the uterus was collected continuously for 8 h after AI. Pregnancy rate and litter size were assessed at 25 d. In experiment 2, backflow was collected as in experiment 1 and the tracts were also flushed to determine sperm numbers in the distal part of uteri and oviduct. In experiment 3, sows were monitored for uterine contractions 1 h before AI and for 2 h after AI. In experiment 1, the average volume of semen (70 ± 1.0 ml) and number of sperm ($2.1 \pm 0.1 \times 10^8$) expelled from the uterus were not different for any of the treatments. The average PR (60%) and LS (10.8) were also not influenced by hormone addition. There was a trend for the increased number of sperm in the uteri of hormone treated animals ($6.0 \pm 1.3 \times 10^4$) compared to the controls ($2.2 \pm 1.3 \times 10^4$, $P = 0.1$) but there was no difference in sperm in the oviducts ($3.2 \pm 1.3 \times 10^4$). Within 0.5 h of AI, there was an increase in the frequency of contractions for the PGF_{2alpha} treatment compared to the other treatments (14.2 vs 6.3 contractions/ 0.5 h, $P < 0.05$), however there was no difference in amplitude (55 mmHg) or duration (34 sec) of contractions. Overall, hormone addition to semen did not improve fertility compared to the controls despite a situation of low fertility. Therefore, hormone addition may not be an efficient or cost effective strategy to improve reproductive parameters in swine.

Key Words: AI, Hormone supplementation, Pigs

804 A comparison of the determination of bull sperm concentration and motility using IVOS®, Optibreed® and traditional techniques. Alana Cent^{*1}, Peter Chenoweth¹, Alice Lee², and Duane Steffey², ¹Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University, ²Statistical Consulting Center, San Diego State University.

Traditional microscopic estimations of sperm motility and concentration lack objectivity, repeatability, and standardization. This work compared newer technologies for semen analysis which promise greater objectivity, namely CASA (IVOS®) and Optibreed®, with more traditional microscopic, hemocytometric and spectrophotometric techniques. Here, the hemocytometer was the gold standard for sperm concentration (4 readings for each aliquot by 2+ technicians) and IVOS for sperm motility (5 scans/aliquot). Fresh bull semen ejaculates (n=3) were pooled on two occasions, incubated at 37°C and centrifuged (600 x g for 10 minutes). Seminal plasma was added or removed to create known semen concentrations from 10 million to 2.5 billion sperm/ml. Each semen aliquot of pre-determined sperm concentration (n=52) was evaluated for sperm concentration using IVOS® and Optibreed® as well as by spectrophotometer using established protocols. Each was also evaluated for sperm motility employing IVOS®, Optibreed® and phase-contrast microscopy. Significant relationships occurred between hemocytometric sperm concentration and IVOS® estimations ($R^2=.96$; $P<0.001$), Optibreed® ($R^2=.97$; $P<0.001$) and spectrophotometer absorbances ($R^2=.95$; $P<0.001$). Overall motility was significantly correlated between IVOS® readings and Optibreed® average channel counts ($R^2=.58$; $P<0.001$), being strongest for 0-40% motility ($R^2=.65$, $P<0.001$). These findings suggest acceptable relationships between the hemocytometric IVOS® and Optibreed® determinations of sperm concentration. Good relationships occurred between IVOS® motility readings and Optibreed® average channel counts, particularly for lower motility (0-40%) samples. Supported in part by NIH Short Term Training Grant and Alpha Animal Health Division.

Key Words: CASA, Optibreed®, IVOS®

805 Effects of osmotic stress and bovine serum albumin on sperm motion characteristics and plasma membrane integrity in boars. H. D. Guthrie^{*1}, G. R. Welch¹, and J. R. Critser², ¹Germplasm and Gamete Physiology Lab, ARS, USDA, Beltsville, MD 20705, ²Comp. Med. Ctr, Res Anim Diagnostic Lab, College of Vet. Med., Univ Missouri, Columbia, MO 65211.

The cell volume excursion associated with exposure to hypo- and hyperosmotic environments causes irreversible loss of motility and substantial increased death among porcine spermatozoa. The purpose of this experiment was to determine the effects of osmotic stress and bovine serum

albumin (BSA) treatments on sperm viability and motion characteristics. Semen from ten boars, extended in Beltsville Thawing Solution, was incubated at 38°C for five min in phosphate-buffered saline (PBS) with or without 0.3% BSA at final osmolalities ranging from 80 to 1170 mOsm/kg (mOsm) and then returned to isosmotic conditions. The percent motile sperm (MOT) and measures of sperm motion were determined using a Hobson Sperm Tracker, and the proportion of sperm cells with plasma membrane integrity (PMI) was determined by flow cytometric analysis of the fluorescence of the nuclear stains SYBR-14 and propidium iodide. MOT decreased significantly ($P \leq 0.05$) as osmolality of sperm treatments decreased or increased outside of a range of 290 to 340 mOsm. PMI and motion parameters were more osmotically tolerant than MOT showing a low incidence of statistically significant change in the range of 290-430 mOsm. The presence of BSA in the anisosmotic PBS solutions was capable of reducing the loss of motility increasing MOT by 13-14 percentage points to 75.3% and at 290 mOsm and 78.2% at 340 mOsm, and increased the following sperm motion parameters: curvilinear velocity (15%), average path velocity (26%), straight line velocity (60%), beat cross frequency (33%), and percent straight line distance (33%) in the range of 215-430 mOsm. The presence of BSA had no significant effect on PMI or amplitude of lateral head displacement. While hypo- and hyperosmotic stress kills many boar spermatozoa, a subpopulation in each ejaculate was capable of maintaining viability and normal motion characteristics.

Key Words: Sperm Motility, Osmotic Stress, Plasma Membrane Integrity

806 The effects of winter photoperiod and rate of body weight gain on serum prolactin, puberty and first service pregnancy in spring-born beef heifers. J. A. Small^{*1}, N. D. Glover¹, and A. D. Kennedy², ¹Agriculture & Agri-Food Canada, ²University of Manitoba.

Gelbvieh sired crossbred heifers (n=143) were assigned on the basis of age (192 ± 16 d) and body weight (235 ± 20 kg) at fall weaning to one of four treatment groups (NC, NS, EC, ES) in a 2*2 factorial layout of natural (N) and extended (E) winter photoperiod (P) and constant (C) and stepped (S) body weight gain (G) treatments that were initiated 36 d after weaning (Day 0). One of two similar winter housing facilities consisting of a south facing shed and drylot was equipped with high-pressure sodium lamps to provide pens with supplemental light (320 lux 1 m above ground). The other facility had no lighting or exposure to spill over light. From December 21 to March 21 (Days 28 to 112), when natural photoperiod increased from 7 to 12 h, the lights were programmed to turn on 1/2 h before sunset and turn off after completion of a 16 h photoperiod which included a 1/2 h simulated twilight. Rations were formulated for heifers to achieve 60% of mature weight at first service; however constant (0.9 kg/d; Days 0 to 168) and stepped (0.6, 0.9 and 1.2 kg/d Days 0 to 56; 56 to 112 and 112 to 168, respectively) rates of body weight gain were achieved by adjusting the amount of barley silage and chopped grass hay in a total mixed ration that was offered once daily. Estrus detection was conducted twice daily and ovulation confirmed by serum progesterone. Body weight, backfat thickness and prolactin were measured every 28 d. On Day 168 estrus synchronization was initiated for timing insemination (AI) after Lutalyse. Prolactin, body weight, backfat and confirmed estrus showed significant ($P<0.05$) interaction among P, G and Day primarily because of differences among treatment groups that occurred between Days 56 and 112, especially at the midpoint on Day 84. At this time prolactin was higher for E than N (19.6 vs 3.3 ng/mL), especially ES; body weight and backfat were lower for S than C (320 vs 333 kg and 1.7 vs 2.2 mm), especially for ES, and confirmed estrus was higher for E than N (33.3 vs 22.2%). Although by Day 168, body weight, backfat and confirmed estrus did not differ among treatment groups, AI pregnancy rate was higher for E than N (51.4 vs. 30.9%; $P < 0.05$). Photoperiod can be used to facilitate puberty in heifers at a lower body weight and fatness.

Key Words: Photoperiod, Puberty, Heifer development

807 Evidence Against Lamprey GnRH-III as the Mammalian FSH-Releasing Hormone. M. Amstalden^{*1,2}, D.A. Zieba^{1,2}, M.R. Garcia^{1,2}, P.J. Bridges³, R.L. Stanko^{1,4}, T.H. Welsh, Jr.², J.E. Fortune³, Hansel W.H.⁵, and G.L. Williams^{1,2}, ¹Texas A&M University Agricultural Research Station, Beeville, TX, ²Texas A&M University, College Station, TX, ³Cornell University, Ithaca, NY, ⁴Texas A&M University-Kingsville, Kingsville, TX, ⁵Pennington Biomedical Research Center, Baton Rouge, LA.

It is generally accepted that both mammalian gonadotropins, FSH and LH, are regulated by the hypothalamic peptide, GnRH. However, FSH secretion is less dependent upon GnRH and, in addition to the regulatory influence of ovarian hormones, has been postulated to be controlled by a separate FSH-releasing hormone (FSHRH). Since several reports in rodents and one in cattle suggest that lamprey GnRH-III (lGnRH-III) can selectively stimulate the release of FSH, it has been proposed as a putative mammalian FSHRH. To test the hypothesis that lGnRH-III can selectively stimulate the release of FSH in cattle, we performed 3 experiments. In experiment I, anterior pituitaries from two steers were collected at slaughter and cells were dispersed, plated, and cultured for 5 d. Cells in three independent replications were treated for 4 h with either media alone (control), media containing GnRH (10^{-9} , 10^{-8} , 10^{-7} , and 10^{-6} M), or media containing lGnRH-III (10^{-9} , 10^{-8} , 10^{-7} , and 10^{-6} M). All doses of GnRH increased ($P<.001$) release of LH and FSH. However, only the two highest doses of lGnRH-III stimulated ($P<.001$) a non-selective release of FSH and LH. In experiment II, seven ovariectomized, mature cows, each bearing an estradiol implant to maintain serum estradiol concentrations at 2-4 pg/ml, were injected i.v. with each of the following treatments in a Latin Square design: Saline Control; GnRH (0.055, 0.11, and 0.165 $\mu\text{g/kg}$); lGnRH-III (0.055, 0.11, and 0.165 $\mu\text{g/kg}$). All doses of GnRH induced ($P<.001$) release of both LH and FSH. However, none of the lGnRH-III doses tested stimulated release of LH or FSH. To determine whether higher doses of lGnRH-III would stimulate release of gonadotropins in vivo, two mature heifers were injected i.v. with either 1 or 5 mg of lGnRH-III during the follicular phase of a synchronized estrous cycle. Lamprey GnRH-III induced a surge release of LH in both heifers, which resulted in ovulation of the largest follicle in the absence of a detectable increase in plasma FSH. In summary, we found no evidence for selective release of FSH by lGnRH-III under the experimental conditions tested and the potency of lGnRH-III to release both gonadotropins was lower than that of GnRH.

Key Words: Lamprey GnRH-III, FSH, LH

808 Serum estradiol and FSH concentrations in lactating sows before and after ovariectomy. C. J. Bracken^{*}, B. L. McCormack, R. P. Radcliff, T. C. Cantley, and M. C. Lucy, *University of Missouri, Columbia MO.*

The factors affecting follicular growth and the variation in weaning to estrus and weaning to ovulation intervals in sows are poorly understood. The objective was to measure serum concentrations of estradiol and FSH in lactating sows before and after ovariectomy and to correlate estradiol and FSH concentrations with ovarian follicular development. The posterior vena cava anterior to the ovarian vein was cannulated via the saphenous vein in 20 sows at 8.9 ± 0.4 d post-farrowing. Blood samples were taken thrice daily (0700, 1500, and 2300 h) beginning on the day of cannulation and continuing for 48 h after ovariectomy (16.6 ± 0.7 d post-farrowing). Serum concentrations of estradiol and FSH were measured by validated radioimmunoassay. Transrectal ovarian ultrasonography was performed once daily for follicle measurement and continued until ovariectomy. Ovariectomies were performed based upon stage of follicular development (2 to 5 mm follicle diameter). There was an effect of time ($P<.001$) relative to ovariectomy on serum FSH because serum FSH increased after ovariectomy (4.5 ± 0.2 ng/ml to 6.7 ± 0.4 ng/ml). A sow by time interaction was also detected for FSH ($P<.001$) because 4 of 20 sows did not have greater FSH after ovariectomy. Serum FSH concentrations before ovariectomy were not correlated with average follicular diameter or serum estradiol concentrations. There was an effect of sow ($P<.001$) on serum estradiol concentrations but serum estradiol concentrations before (4.1 ± 0.3 pg/ml) and after (3.5 ± 0.6 pg/ml) ovariectomy were similar and the sow by time interaction was not significant. Serum estradiol concentrations before ovariectomy tended to be positively correlated with follicular diameter ($r^2=0.13$; $P<.10$). We conclude that FSH secretion in most lactating sows is controlled by an ovarian negative feedback loop. The estradiol in serum of lactating sows

arises from both ovarian and nonovarian sources and changes in FSH after ovariectomy are not dependent on a change in serum estradiol.

Key Words: FSH, estradiol, sow, ovariectomy

809 Effects of Treatment With LH or FSH Between 4 To 8 Weeks of Age on The Attainment of Puberty In Bull Calves. ET Bagu^{*1}, S Madgwick², R Duggavathi¹, PM Bartlewski³, DMW Barrett¹, S Huchowsky¹, S Cook¹, and NC Rawlings¹, ¹Department of Veterinary Biomedical Sciences, University of Saskatchewan., ²Department of Agriculture, University of Newcastle., ³Department of Obstetrics, Gynecology and Reproductive Sciences, University of Saskatchewan.

In bull calves increase in gonadotropin secretion between 6 and 20 wks of age is probably critical for the onset of puberty. In this study, to try and hasten the onset of puberty, calves were injected (sc) 3 mg of bLH (n=6) or 4 mg of FSH (n=6) once every 2 d, from 4 to 8 wks after birth, and control calves received saline (n=12). Scrotal circumference (SC) and body weights were measured bi-weekly from birth to puberty ($SC \geq 28$ cm) and blood samples were collected every 15 min for 10 h, at 4 and 8 wks of age and then every 6 wks until puberty. Mean serum FSH concentrations, at 4 and 8 wks of age were significantly higher ($P<.001$), in the FSH treated (1.94 ± 0.06 and 1.08 ± 0.04 ng/ml) as compared to LH treated (0.74 ± 0.01 and 0.62 ± 0.01 ng/ml) and control calves (0.53 ± 0.10 and 0.46 ± 0.01 ng/ml, respectively). Mean LH concentrations were significantly higher ($P<.001$) in the LH- (2.28 ± 0.32 ng/ml) as compared to FSH- (0.82 ± 0.07 ng/ml) treated and control calves (0.60 ± 0.07 ng/ml) at 4 wks of age. There was no significant difference ($P>.05$) in the mean weight gain among the groups but SC was greater ($P<.05$). Calves were electroejaculated every 2 wks at $SC \pm 26.5$ cm, ejaculates of ± 50 million sperms/ml with progressive linear motility $> 10\%$ were obtained earlier ($P<.05$) in FSH treated (44.3 ± 2.7 wks) compared to control calves (48.2 ± 3.9 wks of age). In conclusion, treatment of bull calves with FSH, starting before the early postnatal increase in gonadotropin secretion, hastened the onset of puberty.

Key Words: Puberty, Luteinising Hormone (LH), Follicle Stimulating Hormone (FSH)

810 Luteinizing hormone (LH) release during the pre-ovulatory period, in two strains of Holstein-Friesian cows being fed two different diets. S Meier^{*1}, S Morgan¹, J Fahey², E Kolver¹, and G Verkerk¹, ¹Dexcel Limited, Hamilton, New Zealand, ²VIAS, Werribee, Victoria, Australia.

This study examined the release of luteinizing hormone, during the pre-ovulatory period of the oestrous cycle, of 2 strains of Holstein-Friesian (HF) cows fed different diets. Two strains of HF cows, New Zealand (NZ) Friesian ($>77.5\%$ NZ genetics) and international (100% non-NZ genetics; OS) were fed either ryegrass and white clover pasture system (Grass) or total mixed ration (TMR; 1). The size of ovarian structures was estimated by daily transrectal ultrasound during one oestrous cycle. Four hourly blood sampling began when the CL declined in the presence of a pre-ovulatory follicle and continued until ovulation. Samples were collected using a jugular catheter. Samples were assayed for LH with the inter- and intra-assay coefficient of variations of $<12\%$ and $<19\%$ for reference samples. The sensitivity of the assay was 0.1 ng/ml. The time from the start of the 4 hourly sampling to ovulation was 4.0 ± 0.3 days, with a range of 3 to 8 days. Average size of CL prior to the 4 hourly sampling was 23.1 ± 0.6 (range 28 to 18 mm). The 4 hourly sampling started when the CL decline to 18.5 ± 0.6 mm (range 25 to 14 mm). Peak LH did not differ between strain and feeding regimes (NZ 11.6 ± 1.6 ng/ml, OS 9.9 ± 1.3 ng/ml, $P=0.28$; Grass 12.4 ± 1.8 ng/ml, TMR 9.4 ± 1.0 ng/ml, $P=0.13$). However, within the NZ strain the LH peak was as higher in NZG than NZT (15.0 ± 3.0 ng/ml; n=6; and 9.3 ± 1.3 ng/ml; n=7; respectively, $P<.05$). The OS groups were similar (OSG: 10.2 ± 2.0 ng/ml; n=7, and OST: 9.6 ± 1.7 ng/ml; n=6). The area under the curve (AUC) across the 12 hours before and after the LH peak, did not differ between breed or diet. These results suggest that LH concentrations around ovulation be influenced by diet.

1. Kolver et al., 2000. Pages 265-269 in Proc. New Zealand Soc. Anim. Prod. Hamilton, New Zealand.

Key Words: LH, pre-ovulatory, bovine

811 Endosperm type and kernel processing of corn silage: effects on short-term lactational performance in dairy cows. R. A. Longuski^{*1}, K. C. Fanning², M. S. Allen¹, R. J. Grant², and J. F. Beck³, ¹Michigan State University, East Lansing, ²University of Nebraska, Lincoln, ³Syngenta Seeds, Golden Valley, MN.

Effects of kernel processing (rolling) and endosperm type (floury, vitreous) of corn silage on short-term lactational performance in dairy cows were evaluated at two sites (MI and NE). At each site, vitreous and floury corn silages were harvested just prior to black layer, and half of each hybrid was chopped at ~1 cm TLC (not rolled) or ~2 cm TLC with kernel processor (1-mm clearance). A replicated 4 x 4 Latin square with 28-d periods and a 2 x 2 factorial arrangement of treatments were used at both sites. Diets contained 42.6 to 45.9% and 32.0 to 35.1% corn silage at NE and MI, respectively. At NE, 12 Holstein cows (8 multiparous and ruminally fistulated) were used, and at MI eight ruminally fistulated, multiparous cows were used. Dry matter intake (DMI) decreased by rolling ($P < 0.01$) with a tendency ($P < 0.12$) for a greater reduction for floury (26.1 vs. 27.6 kg/d) than for vitreous (27.0 vs. 27.4 kg/d). This response was consistent across locations. There was a significant ($P < 0.01$) location by rolling interaction for milk yield and fat-corrected milk (FCM) yield; rolling increased milk yield by 3.4 kg/d and FCM by 2.7 kg/d at NE but had no effect on either at MI. Rolling decreased milk fat % for vitreous (3.44 vs. 3.68%) but not for floury across location. Body weight and body condition score were not affected by treatment. Efficiency of FCM production (FCM/DMI) increased ($P < 0.04$) by 4.6% for floury versus vitreous and by 6% ($P < 0.01$) for rolled versus unrolled corn silage. No effect of endosperm type and no interaction between endosperm type and rolling was observed on yield of milk or milk components across locations. When formulating diets for lactating dairy cows, endosperm type and silage processing will affect efficiency of FCM production.

Key Words: Silage processing, Corn endosperm type, Lactational performance

812 Endosperm type and kernel processing of corn silage: effect on starch and fiber digestion and ruminal turnover in lactating dairy cows. K. C. Fanning^{*1}, R. A. Longuski², R. J. Grant¹, M. S. Allen², and J. F. Beck³, ¹University of Nebraska, Lincoln, ²Michigan State University, East Lansing, ³Syngenta Seeds, Golden Valley, MN.

Effects of kernel processing (rolling) and endosperm type (floury, vitreous) of corn silage on starch and fiber digestion and ruminal turnover in lactating dairy cows were evaluated at two sites (MI and NE). At each site, vitreous and floury corn silages were harvested just prior to black layer, and half of each hybrid was chopped at ~1 cm TLC (not rolled) or ~2 cm TLC with kernel processor (1-mm clearance). A replicated 4 x 4 Latin square with 28-d periods and a 2 x 2 factorial arrangement of treatments were used at both sites. At NE, 12 Holstein cows (8 multiparous and ruminally fistulated) were used, and at MI eight ruminally fistulated, multiparous cows were used. At both sites, floury endosperm corn silage increased total tract digestibility of OM and starch ($P < 0.01$), and tended to increase NDF digestion ($P = 0.09$). Rolling increased starch digestion ($P < 0.01$) but reduced digestibility of NDF and OM ($P < 0.01$). There was no interaction of endosperm and rolling on total tract digestibility of OM, starch or fiber. Average ruminal pH, total VFA, and acetate to propionate ratio were unaffected by rolling or endosperm. Rolling increased ruminal digesta volume for the vitreous hybrid, but decreased volume for the floury hybrid. Ruminal turnover rates for OM, NDF, and starch were unaffected by treatment. Rumination and total chewing times were reduced ($P < 0.03$) for cows fed the vitreous compared with the floury hybrid but eating time was not affected by treatment. Total tract starch digestibility in lactating dairy cows can be improved by use of floury endosperm silages and silage processing. Greater ruminal starch digestion from rolling might decrease NDF digestibility. The modest response to endosperm type likely reflected the fact that <15% of the dietary DM was comprised of treatment starch.

Key Words: Silage processing, Corn endosperm type, Digestibility

813 The effect of corn silage particle size and cottonseed hulls on cows in early lactation. P.J. Kononoff^{*1} and A.J. Heinrichs, ¹The Pennsylvania State University.

The objective of this study was to evaluate the effects of reducing corn silage particle length (PL) and the inclusion of cottonseed hulls (CSH) on intake, digestion, chewing activities and milk production. Sixteen cannulated, multiparous cows averaging 17 DIM and 677 kg BW were assigned to one of four 4X4 Latin Squares. One square contained rumen cannulated cows to evaluate effects of treatment on rumen fermentation and function. During each of the 23 d periods animals were offered one of four TMRs that differed in forage PL (long or short corn silage) and CSH inclusion rate (0 or 8% DM). Dietary treatments were as follows: long no CSH (LGNH), long with CSH (LGH), short no CSH (SHNH), and short with CSH (SHH). Total physically effective NDF, measured as percent of NDF greater than 1.18 mm, was similar across diets (31.3, 32.4, 32.0, 30.6 for LGNH, LGH, SHNH, and SHH respectively) but mean particle length decreased with reducing PL and inclusion of CSH (7.9, 6.8, 6.8, 6.1 mm). Dry matter intake was not significantly affected by PL but was significantly increased with the inclusion of CSH. Decreasing PL and the inclusion of CSH significantly increased neutral detergent fiber intake (NDFI). Total chewing activity expressed as minutes per day was unaffected by PL and the inclusion of CSH. Both eating and ruminating efficiency expressed as minutes per kilogram of NDFI increased with increasing PL and decreased with the inclusion of CSH. Milk production did not differ across treatments; but the inclusion of CSH significantly increased percent protein. Reducing forage PL tended to reduce percent milk fat. Mean ruminal pH was not affected by PL but was highest on diets containing CSH even though no treatment effects were observed on total VFA, acetate, or propionate concentration. These results indicate that corn silage PL is a poor predictor of total chewing time and rumen pH but is useful in understanding factors affecting feeding behavior. Additionally, the inclusion of CSH resulted in increased rumination and mean rumen pH even though effects of VFA concentration were not observed.

Key Words: forage particle length, cottonseed hulls, chewing activity

814 Effects of brown midrib 3 mutation of corn silage on feed intake and ruminal adaptation of Holstein cows during the peri-parturient period. Y. Ying^{*} and M. S. Allen, Michigan State University, East Lansing.

Thirty-one cows were alternately assigned to treatment diets containing either brown midrib (bm3) corn silage or its isogenic normal control silage at 28 ± 3 d prior to estimated calving date. Diets were formulated to 33% NDF and 14% crude protein with corn silage at approximately 57% of dietary DM. Twenty-three cows received treatment diets at least 21 d and were used for analysis. All cows were switched to a common diet formulated to 28% NDF and 19% CP at calving for 56 ± 3 d. Ruminal capacity, pH, papillae size and digestibility were measured weekly until 7 \pm 3 DIM. DMI and milk yield were measured daily until 56 DIM and milk components were measured weekly. Bm3 significantly increased digestibility of NDF (43.0 vs. 33.9%, $P < 0.01$), decreased digestibility of starch (91.6 vs. 94.1%, $P < 0.01$) but did not affect digestibility of DM or OM before calving. Treatments did not affect DMI, digestible DMI or change in BW or BCS before or after calving. Rumen pool sizes were not affected by treatment. Ruminal turnover time for NDF tended ($P = 0.11$) to be reduced for bm3 treatment one week prior to calving but DMI was not affected. Ruminal pH averaged 6.48 before calving and was not affected by bm3 treatment or by week on treatment. Ruminal papillae surface area increased during the treatment period and rate of growth was greater for bm3 treatment relative to control. Although papillae surface area was greater for bm3 compared to control at 7 DIM, no treatment effects were observed for ruminal pH or rate of valerate absorption from the rumen, and total VFA concentration tended to be greater for bm3 treatment (127.1 vs. 113.8 mM, $P = 0.06$). Treatments before calving did not affect digestibility of DM, OM, NDF, or starch, at 7 DIM or DMI or yield of milk or FCM through 56 DIM. Results of this experiment suggest that feed intake was not limited by ruminal fill before calving and that rate of VFA absorption immediately after calving was not affected by adaptation of ruminal papillae.

Key Words: bm3 corn silage, peri-parturient period, feed intake

815 Influence of non-fibrous carbohydrates on milk production and composition of cows fed fescue silage. D.J.R. Cherney*, J.H. Cherney, and L.E. Chase, *Cornell University, Ithaca, NY.*

There is interest in knowing if source of non-fibrous carbohydrates (NFC) influences milk production and composition. Our objective was to determine the effects of source (starch or sugar) and level of NFC in the diet on these parameters. A 4x4 Latin square replicated five times using early-lactation (56 ± 9 days in milk) Holstein cows was used, cows being offered one of two levels of NFC and either no added sugar or sugar substituting for 10% of the corn. Diets were balanced to meet NRC requirements for total protein, energy, and minerals. Tall fescue silage was included at one of two levels (0.95% or 1.25% of body weight as forage neutral detergent fiber (NDF)), resulting in diets with 40% and 30% NFC. Remaining ingredients consisted of high-moisture corn, soybean meal, SoyPlus #, minerals and vitamins. By-pass fat (0.45 kg/d) was used in the low NFC diets. High NFC diets were lower ($P<0.01$) in NDF (31.5%) and crude protein (CP; 19.6%) than the low NFC diet (35.8% NDF and 21.0% CP). Sugar containing diets were somewhat lower ($P<0.01$) in NDF (33.1%) than the no sugar added diets (34.3%), but diets did not differ in CP%. Cows offered the high NFC level produced more milk (40.1 kg/d; $P<0.05$) than those offered the low level (37.9 kg/d). Cows consuming the high NFC diet also had lower ($P<0.05$) milk fat (3.25%) and milk urea nitrogen (MUN; 13.68 mg/dl), and higher ($P<0.05$) milk protein (2.58%) and milk lactose (4.81%) concentrations than cows offered the low NFC level (3.46% milk fat, 17.47 mg/dl MUN, 2.51% milk protein, and 4.74% milk lactose). The NFC source did not influence DM intake or milk production ($P<0.05$). Milk lactose (4.79%) and MUN (16.0 mg/dl) concentrations were higher ($P<0.05$) for cows offered sugar as a portion of the NFC compared with those not offered sugar (4.76% milk lactose and 15.13 mg/dl MUN). Results suggest that cows fed sugar may utilize diet nitrogen less efficiently than those not fed sugar.

Key Words: Grass, Non-structural carbohydrates

816 Incorporating risk in dairy cattle nutrition . T.P. Tylutki* and D.G. Fox, *Cornell University, Ithaca NY USA.*

Data from extensive feed sampling and chemical analyses collected over a two-year period on a 600 cow dairy farm were used to evaluate the effect of variation in individual feed chemical components on milk production and income over feed costs. The composition variances (and correlations among feed components) were used in a modified version of the Cornell Net Carbohydrate and Protein System (mCNCPS). The mCNCPS was used with @Risk version 4.0 to simulate milk production variance using Monte Carlo sampling techniques. The diet had IOFC of \$10.31 as formulated. The example diet was formulated using the observed feed chemical composition means (assumes perfect information) for 45.4 kg milk valued at \$14 per 45.4 kg and simulated over 50,000 iterations (run 1). A second simulation was made locking silage DM, and a third simulation was made where locking silage chemical composition (run 3). Results from run one indicate that hay crop dry matter and lignin content are highly correlated with energy and protein allowable milk. Five percent of the eNDF distribution was below 22%, the breakpoint where the CNCPS begins depressing fiber digestion. Standard deviations were high for energy balance (SD of 1.78 Mcal ME), ME allowable milk (SD of 1.62 kg), and MP allowable milk (SD of 2.16 kg), while mean income over feed cost (IOFC) was \$10.19. Run two (DM locked) increased IOFC to \$10.22, decreased the variation in ME balance (SD of 1.44 Mcal), ME milk (SD of 1.31 kg), and MP milk (SD of 1.66 kg), yet 5% of the simulations remained below 22% eNDF. Controlling forage DM and composition (run 3) further decreased variation in ME balance (SD of 0.84 Mcal ME), ME milk (SD of 0.76 kg), and MP milk (SD of 1.02 kg) while increasing mean IOFC to \$10.28 and all were above 22% eNDF. Comparing this to run 1 suggests that failure to analyze feeds results in \$4,380 foregone annual income per 100 cows of which \$1,095 is related to DM analysis (difference in IOFC between runs 1 and 2); \$2,190 is related to silage analysis (difference in IOFC between runs 2 and 3); and \$1,095 is related to concentrates varying (difference in IOFC between run 3 and base). This study suggests that producers can improve IOFC by controlling feedstuff variation via increased forage analysis.

Key Words: Risk, Models, Monte Carlo

817 Effectiveness of strategic ration balancing on efficiency of milk protein production and environmental impact. J. H. Harrison*¹, L. Johnson¹, D. Davidson¹, J. Werkhoven², A. Werkhoven², S. Werkhoven², M. Vazquez-Anon³, G. Winter³, N. Barney⁴, and W. Chalupa⁵, ¹Washington State University, ²Werkhoven Dairy, Monroe, WA, ³Novus Int., St. Louis, ⁴LignoTech USA, Prairie Village, KS, ⁵University of Pennsylvania, Kennett Square.

The standard herd diet for a commercial herd producing 13,600 kg milk annually was reformulated with the use of CPM Dairy model. The primary goal was to reduce CP in the diet and therefore reduce nitrogen imported to the farm. Ration CP was effectively reduced by ~ 0.8% CP (17.8% CP vs 17.0% CP) with inclusion of Alimet[®] (Novus International, St. Louis, MO), lysine-HCL, and a commercially available bypass protein source (SoyPass[®] - LignoTech USA, Prairie Village, KS). Respective diets were fed in a 4-1/2 month switch back design trial with two periods. Cows were fed as groups of ~90 cows each and were paired for parity and milk production prior to initiation of the study. Cows were milked 4x/day and were provided Posilac[®]. Diet reformulation was successful in reducing nitrogen imported by 7.5%, increasing milk yield, increased milk yield, increased milk protein yield, reducing MUN, and improving efficiency of milk protein yield. This study illustrates the benefits of reducing dietary CP and improving efficiency of milk protein production. Detailed data are summarized below.

Item	Control	Treated	SE	P≤
DMI, kg	25.77	25.10	—	—
CP Intake, kg	4.59	4.25	—	—
Milk, kg	45.41	46.32	0.24	.007
3.5% FCM,kg	43.62	43.92	0.21	.32
Milk Fat, kg	1.48	1.47	0.008	.63
Milk Protein, kg	1.31	1.34	0.007	.0004
MUN, mg/dl	17.5	14.5	—	—
Ratio Mik True Protein:				
Intake Protein Ratio	.285	.316	—	—

818 Balancing diets for cows grazing pasture post-peak lactation using forage mixed rations. A.V. Chaves*^{1,2}, S.L. Woodward³, G.C. Waghorn¹, I.M. Brookes², C. Holmes², and W. McNabb¹, ¹AgResearch, ²Massey University, ³Dexcel, Ltd.

New Zealand dairy cows are grazed on ryegrass (*Lolium perenne*) dominant pasture (P) as a sole diet but dry summers limit P availability so supplementation is needed to maintain productivity. The supplements evaluated here were either maize silage (M) or sulla (*Hedysarum coronarium*) silage (S), which is a low fibre legume containing condensed tannin, fed with pasture or in combination as a forage mixed ration (FMR) over 4 week period. Sixty Friesian cows (10 rumen fistulated); 483 kg live weight (LW); 14.3 kg milk/day; 156 days in milk were allocated to six treatments (%DM basis): normal pasture (P); excess pasture (EP); 60P, 40M (PM); 60P, 40S (PS); 60P, 25M, 15S (PMS); 60P, 25S, 15M (PSM). Normal P allowance (25 kg DM/cow/day) was available for all cows except EP which had 50 kg DM/day. Silage was available to cows during grazing. P, M and S had 17.6%, 6.9% and 17.8% CP; 47%, 38% and 43% NDF, respectively. The normal pasture allowance (P) resulted in an unacceptable LW loss which was overcome by a high allowance (EP) or silage supplementation. Although the EP treatment resulted in highest milk yield, high allowances resulted in higher pasture residuals after grazing and cows lost more weight than those given 6 kg silage DM in PMS, PM and PS treatments. Milk production was similar for cows given all silage supplements, but the PMS prevented weight loss and resulted in highest milk yields. Choice of supplements have resulted from *in sacco* evaluations and will be used to develop balanced diets based on pasture at different times of the year.

	P	EP	PMS	PSM	PM	PS	SEM
Milk, kg/d	13.15 ^c	17.18 ^a	14.28 ^b	13.71 ^{bc}	13.70 ^{bc}	13.68 ^{bc}	0.57
Pasture DMI, kg/d	10.38 ^b	15.71 ^a	8.75 ^c	8.96 ^{bc}	8.82 ^{bc}	8.72 ^c	0.77
Silage DMI, kg/d			5.78 ^a	5.38 ^b	5.48 ^{ab}	5.16 ^b	0.24
Total DMI, kg/d	10.38 ^c	15.71 ^a	14.54 ^{ab}	14.34 ^{ab}	14.30 ^{ab}	13.89 ^b	0.90
Change in LW, kg	-12.4 ^a	-3.8 ^{bc}	+1.0 ^d	-4.5 ^b	-0.8 ^{cd}	-1.4 ^{bcd}	3.96
FE, kg Milk/kg DMI	1.27 ^a	1.09 ^b	0.98 ^{bc}	0.96 ^c	0.96 ^c	0.98 ^{bc}	0.08

^{a,b,c,d}Least square means with different superscripts differ $P < 0.05$. FE = feed efficiency

Key Words: cow, pasture, silage

819 Effects of simultaneous evaluation of cooling strategies on production responses and intake behavior during heat challenge in dairy cattle. K. M. Spurlin*, D. E. Spiers, M. Ellersieck, and J. N. Spain, *University of Missouri - Columbia*.

Six fistulated, lactating cows were used to compare production and intake behavior when exposed to 4 cooling treatments including 24 h (24H), 12 h nighttime (12N; fans on between 1900 - 0700), 12 h daytime (12D; fans on between 0700 - 1900), and no fan cooling (NO). Treatments were administered during consecutive 14 d periods arranged as a 4x4 Latin Square. Periods were comprised of a 6 d thermoneutral (TN; constant 20C) period, 3 d step-up, and a 5 d heat challenge (HC). During HC, maximum ambient temperature was held at 33C from 1400 - 1800 and lowered to 23C from 0200 - 0600. Feeding occurred at 0600, 1400, and 2200 h daily with refusals and water consumption measured before each feeding to monitor intake patterns. Milk yield was recorded daily. Rumen temperatures were measured continuously via telemetric transmitters located in the ventral rumen. Cooling treatment effects were not different, and reflected the adequate nighttime cooling independent of treatment. Effects of day were significant ($P < 0.05$) for daily yield and intake with milk yield increasing during TN and then declining during HC. Dry matter intake followed a similar pattern, except during HC when feed intake was reduced between 1400 and 2200. Lower feed intake during this time was partially offset by increased intake between 2200 and 0600 ($P < 0.05$). Total water intake increased throughout TN until day 11 of HC, followed by a reduction due primarily to reduce water intake between 1400 and 2200 on the final days of HC. Both DMI and total water consumption were highest between 1400 and 2200, validating the relationship between drinking and feeding behavior. Milk yield peaked on day 10, the first day of HC, while DMI had significantly declined. Rumen temperatures indicated water intake bouts. The difference between maximum and minimum hourly rumen temperatures peaked during times of scheduled human-cow interactions such as milking and feeding, indicating the cows were stimulated to drink upon standing. The heat challenge imposed was not sufficient to simultaneously evaluate the effects of cooling method on productive and intake responses, yet behavioral responses were observed. Rumen temperature differences indicate that management scheme rumen microenvironment.

Key Words: heat stress, feeding behavior, dairy cows

820 Methane and manure production in cattle with different net feed intakes. E. Okine*, J.A. Basarab², V. Baron², and M.A. Price¹, ¹AFNS, *University of Alberta, Edmonton, AB T6G 2P5*, ²Western Forage Beef Group, *Lacombe Res. Centre, 6000 C & E Trail, Lacombe, AB T4L 1W1*.

Our hypothesis was that methane emissions and manure production would differ among feeder steers with varying net feed intakes (NFI). One hundred and thirty-three spring born steer calves (331 kg; SD=40 kg) from the M1, M2, M3, M4 and TX BeefBooster strains, were adjusted to a high-barley diet and monitored for individual animal DMI. Steers from each genetic strain were selected at random on day 1, 71, 99, 127, 155 and 183 and harvested at the Lacombe Research Centre abattoir. Retained energy and heat production were determined from individual animal gain, intake and body compositional data. Based on NFI calculations 43, 47 and 43 steers were classified as High-NFI (> 0.05 SD above the mean); Medium-NFI (0.05 SD above and below the mean) and Low-NFI (< 0.5 SD below the mean), respectively. Methane production was calculated from the steers requirement for ME, in vivo diet DE and DMI above that required for maintenance. There was no difference in methane production as percent of GE (5.59 1.16; $P > 0.05$) among NFI groups. However, daily methane emissions (g d^{-1} and g kg gain^{-1}) for Low-NFI steers were 9.0 and 12.6% lower ($P < 0.02$) than for High-NFI steers, with no difference between High- and Medium-NFI steers. Yearly manure, N, P and K production were all low, medium and high ($P < 0.0001$) for Low, Medium and High-NFI steers, respectively. Low-NFI steers with above average ADG ($\geq 1.48 \text{ kg d}^{-1}$) produced 53 compared to 67.9 kg kg gain^{-1} methane ($P < 0.001$) than the High-NFI steers with below average ADG. We conclude that selection for Low-NFI in beef cattle is in theory accompanied by a significant reduction in methane, manure and N, P, K, output due to reduction in daily feed intake and more efficient use of feed without any compromise in growth performance.

Key Words: Key words: Beef cattle, Net feed intake, Manure, Methane

821 The interaction between plane of nutrition and success of estrus synchronization using two methods. E. Charmley*, J. Wichtel², G. Richardson², and R. Lofstedt², ¹AAFC, *Crops and Livestock Research Centre*, ²Atlantic Veterinary College.

Plane of energy nutrition has a major impact on reproductive efficiency. In a study with 57 winter-calving beef cows, grass/legume silage was fed at one of three levels of intake; 1.5, 1.7 and 2.0% of body weight (BW). Equal numbers of cows on each plane of nutrition were assigned, according to calving date and parity, to one of two estrus synchronization methods: Ovsynch and CIDR. The Ovsynch method involved an injection of GnRH followed 7 d later by an injection of prostaglandin and a second GnRH injection 48 h after that. Cows were bred 16 h following the second GnRH injection. The CIDR method involved the insertion of an intravaginal device containing 1.9 g progesterone for 7 d. An intramuscular injection of 1 mg estradiol benzoate and 100 mg progesterone was given at the time of device insertion. Twenty-four h after CIDR withdrawal, cows received an additional injection of 1 mg estradiol benzoate and were bred 28 h after this injection. Although calculated ME intakes were 86, 97 and 115 MJ d^{-1} for the low, medium and high intakes, respectively, there was no effect on cow BW change, body condition score, rump fat or back fat. However, there was a direct linear response to plane of nutrition in calf BW gain ($P = 0.02$) and calf weights at turn-out to pasture ($P = 0.04$). This was attributed to a quadratic increase in milk fat % ($P = 0.04$) and a similar trend in milk protein % ($P = 0.09$) as plane of nutrition increased. Overall first service pregnancy rates were acceptable being 61 and 83% for the Ovsynch and CIDR methods respectively ($P = 0.13$). However there was a marked diet by synchronization method interaction. First service pregnancy rates for cows on the Ovsynch method were 29, 57 and 89 % for low, medium and high planes of nutrition, respectively ($P = 0.04$). Corresponding pregnancy rates for cows synchronized with CIDR's were 80, 80 and 89% ($P = 0.83$). It is concluded that the success of CIDR synchronization method may be less sensitive to plane of nutrition than more traditional methods of estrus synchronization.

Key Words: Estrus synchronization, Plane of nutrition, Beef cow

822 Effects of the forage source on feeding behavior and selectivity of dairy cows. G.M. Burato*¹, G. Cozzi¹, F. Gottardo¹, E. Ragno¹, and I. Andrighetto¹, ¹Dipartimento di Scienze Zootecniche, University of Padova, Italy.

The inclusion of a specific forage source in dairy cow TMR, depends upon its ability to stimulate chewing activity and to reduce feeding selectivity. The study compared 2 TMR differing only for sources of roughage: grass hay (H) vs corn silage (CS). The diets had similar chemical composition (DM basis: 16.0% CP; 33.6% NDF; 39.3% NFC) and particle size distribution measured by Penn State particle separator (6.2% top; 26.6% middle; 67.2% bottom as fed basis). Twelve Holstein cows (34.2 ± 4.5 kg/d milk yield; 139 ± 79 DIM) were divided in 2 groups according to a cross-over experimental design with 14 d periods. Each group of cows was housed in a separate pen and it had free access to 6 weighing manger stations. Individual cows feeding behavior was measured by an automatic system which recorded the duration of all visits at the manger and the intake per visit. Rumination activity was measured by direct observation for 24 h. Time spent eating was similar between diets but DMI was lower for H (18.6 vs 20.0 kg/d, P < 0.05) which instead increased rumination (499 vs 457 min/d, P < 0.05) and total chewing time (785 vs 737 min/d, P < 0.05). To evaluate feed selection activity, diets were sampled at each weighing station at the time of their administration and 4, 12 and 23h post-feeding (pf). Diets had similar chemical composition at the administration, however samples collected at 4h pf showed a higher NDF (35.7 vs 33.4%, P < 0.001) and a lower NFC content (36.8 vs 40.7, P < 0.001) for H. These differences remained still significant at 12h pf (NDF: 37.6 vs 34.3%, P < 0.01; NFC: 34.8 vs 40.1%, P < 0.001) and at 23h pf (NDF: 39.5 vs 35.3%, P < 0.05; NFC: 32.8 vs 39.8%, P < 0.001). These composition variations indicate a selection activity operated by the cows when fed H TMR. This feeding selectivity towards concentrates was confirmed by a progressive increase of the fraction retained by the top screen and by the reduction of the fraction gathered on the bottom pan of the Penn State particle separator. The different chemical composition of the ingesta of the 2 diets had no effect on milk yield, and composition.

Key Words: dairy cow, forage source, feeding behavior

823 Methane emission from lactating Holstein Friesian cows from the northern Hemisphere and New Zealand grazing pasture or fed TMR over one lactation. G.C. Waghorn*¹, K.R. Lassey², E.S. Kolver³, G. Molano¹, and L. Robertson⁴, ¹AgResearch, ²NIWA, ³Dexel, ⁴Dairy Research Institute, New Zealand.

Enteric methane production was measured in 20 cows over three 5 day periods at 60, 150 and 240 days of lactation. Ten cows were of a New Zealand Holstein-Friesian (NZ HF) origin selected over 30+ generations from intensive (primarily ryegrass; *Lolium perenne*) grazing systems, and ten were from the Northern Hemisphere (United States/Netherlands) (NH HF) genotype selected from TMR feeding systems. Five cows from each genetic origin were fed *ad libitum* ryegrass pasture and the remainder a TMR. Principal measurements included methane production using the SF₆ tracer procedure, intakes using an alkane digesta marker, milk production and composition. Predicted annual methane production (kg/cow) were NZ HF, P 113.1; NZ HF, TMR 142.5; NH HF, P 112.1; NH HF, TMR 151.3. Cows fed TMR produced more (P<0.001) methane (438 g/day) than cows fed pasture (338 g/day) but had higher DM intakes (22.1 vs. 16.8 kg/day; P<0.001) and milk production (35.4 vs. 20.8 kg/day; P<0.001). Cows fed TMR increased (P=0.016) methane production from 18.2 to 21.9 g/kg DMI from day

60 to 240 of lactation (5.0 to 6.3% of gross energy (GE)). Corresponding values for pasture were an increase (P<0.001) from 16.6 to 23.6 g methane/kg DMI, representing 4.9 to 6.9% of GE. These changes were associated with an increase in fibre content of pasture (35.5 to 38.3% NDF) and increased forage content of the TMR (48 to 56%) over the lactation. When methane is expressed in terms of milk production there appears to be lower green house gas (GHG) emissions per unit product with TMR, but cultivation of annual crops used in TMR results in high GHG emissions relative to permanent pasture. Cow genotype had a significant effect upon methane production, with NH HF producing less methane (g/kg DMI) than NZ HF at day 60 of lactation (15.1 vs. 18.0, P=0.007) and at day 150 (16.0 vs. 20.3, P=0.067). These patterns disappeared by day 240. Genotypic origins of cows appear to influence rumen methanogenesis.

Key Words: cow, methane

824 Fractional synthesis rates in lambs infected with *Trichostrongylus colubriformis*. E.N. Bermingham*^{1,2}, N.C. Roy¹, G.W. Reynolds², G. C. Waghorn¹, I.A. Sutherland¹, D.K. Revell³, and W.C. McNabb¹, ¹AgResearch Limited, Palmerston North, New Zealand, ²Massey University, Palmerston North, New Zealand, ³University of Adelaide, Adelaide, Australia.

The aim of the experiment was to investigate the effects of *T. colubriformis* infection on the protein fractional synthesis rate (FSR) in the small intestine (SI), liver and muscle of 10 lambs (38 kg (SE 1.4) fed fresh lucerne (*Medicago sativa*). Five lambs were infected with *T. colubriformis* L3 larvae (P; 6000/d for 6 d; Day 0), whilst the remaining were kept as parasite-free controls (C). On day 48 of infection, [3,4-³H]-valine (10.2 MBq/h) was infused for 8 h into the jugular vein. The lambs were euthanased while the infusion was still running and tissue samples collected from the duodenum, ileum, liver and muscle (*biceps femoris*). The duodenum and ileum samples were stripped of their mucosa. All tissues were quickly rinsed in cold saline and frozen in liquid N. Tissue samples (2 g) were homogenised and processed in order to determine the specific radioactivity of the protein-bound and free-pool valine. Protein FSR (%/day) were calculated according to the equation described by Wykes *et al.* (1996; J. Nutr. 126: 1481). Total intestinal worm counts were 353 (SE 116.7) and 22050 (SE 991.1) in the C and P groups, respectively (P=0.001). The presence of parasites had no effect on feed intake (777 g DM/d (SE 7.69) but reduced liveweight gain (C: 168 vs. P: #108 g/d; P<0.10). The presence of parasites in the SI tended to reduce FSR in the ileum of the lambs (P<0.10) and tended to increase FSR in the liver (P<0.10). The increase in liver FSR is possibly related to more export protein being synthesised in the liver for meeting the demands of the immune response in lambs infected with *T. colubriformis*.

		FSR (%/d)					
		C		P			
Tissue		Mean	SE	Mean	SE	P=	
Duodenum	Whole	43	9.8	32	8.5	0.45	
	Stripped	11	1.9	12	1.1	0.59	
	Mucosa	31	9.2	21	11.3	0.51	
Ileum	Whole	25	4.1	19	3.7	0.36	
	Stripped	11	1.8	5	1.6	0.06	
	Mucosa	15	4.3	14	2.5	0.89	
Liver		24	1.9	34	0.7	0.07	
Muscle		1	0.6	2	0.8	0.64	

Key Words: fractional synthesis rates, intestinal parasites, lambs

Extension Education

825 2001 results from Ohio's beef quality assurance program. S. Boyles*¹, W. Shulaw¹, D. Glauer², A. Henry³, H. Zerby¹, F. Fluharty¹, and G. Fike¹, ¹The Ohio State University, Columbus, OH, ²Ohio Department of Agriculture, Reynoldsburg, OH, ³Ohio Cattlemen's Association, Marysville, OH.

Beef Quality Assurance (BQA) is a program to ensure that beef and dairy cattle are maintained in a manner that will result in a safe and wholesome beef product for the consumer. The objectives of Ohio's BQA effort are to 1) set production standards in beef and dairy operations which meet or exceed the National Cattlemen's Beef Association guide-

lines and 2) provide technical assistance through Ohio State University, Ohio Department of Agriculture, Ohio Beef Council, and the Ohio Cattlemen's Association. The program is free to beef and dairy producers due to a grant from the U.S. Food Safety Inspection Service. Teachers for the BQA program are certified by attending a training workshop. Trainers receive an Ohio BQA manual and more are available upon request. They also receive a compact disc with presentations that follow the manual, a checklist for planning a BQA event, a training request form, a participant list form, and a list of other Ohio BQA certified trainers. Six hundred and thirty-seven people have gone through the program in 2001 with 329 filling out the post-program evaluation form.

BQA was considered by participants to be an important consideration for the future (Mean = 1.4, SD = .81). Participants felt that the program helped them increase their understanding of BQA (Mean = 1.6, SD = .78), and provided relevant information to their work (Mean 1.6, SD = .84). A major emphasis of the program was to encourage producers to place all injections in the neck region. When given the choice of indicating where injections should be placed, all respondents indicated the neck, versus the rump or round. Eighty-five percent of respondents correctly indicated that "Extra-label" drug use could only be done with a valid veterinarian-client-patient relationship. However, 33% incorrectly indicated that "Extra-label" drug use in the mixing of drugs in animal feeds is permitted while there is a valid veterinarian-client-patient relationship.

Key Words: Beef, Quality, Assurance

826 Uniformity of mixing and delivery of total mixed rations. A. Predgen* and L. E. Chase, *Cornell University, Ithaca, NY.*

Total mixed rations (TMR's) are being increasingly implemented on dairy farms. One concern is the uniformity of mixing of the TMR on both a within and between day basis. This trial was conducted to evaluate the uniformity of the feed mixing and delivery process on 5 New York dairy herds. Observations were obtained on 3 different days for each farm. Samples were obtained from 5 locations in the feedbunk immediately after the TMR was delivered by the mixer wagon. Samples were analyzed for dry matter, particle size, density, pH, chloride, crude protein (CP) and acid detergent fiber (ADF). The coefficient of variation (CV) was calculated as an index of uniformity. A CV >10% was observed in 14 out of 15 observations for coarse particle distribution. This result indicates the difficulty of incorporating coarse particles uniformly into TMR's. The percent of coarse particles in samples 1 through 5 for 1 day on 1 farm was 24.0, 26.4, 26.5, 21.6 and 28.5%. Analysis of variance was used to examine differences between days or sample location within day. Significant differences (P<.05) were found for sample location within day in only 3 comparisons out of the 45 conducted. There were 14 significant differences (P<.05) detected for between day observations. These included 4 for particle size, 3 for dry matter, 1 for density, 1 for chloride, 3 for pH and 2 for CP. No significant differences were found for ADF for either within or between day determinations. The results of this study indicate that greater differences in TMR uniformity existed between days than within days on these farms. This variation between days could be related to factors including variations in feeds, operator differences, loading procedure, mixing time or scale errors. The technique of analyzing samples from a number of locations in the feedbunk provides a method to assess the uniformity of TMR mixing and delivery on dairy farms.

Key Words: Total mixed rations, Feedbunk management

827 A heifer development system emphasizing genetics - The Virginia Premium Assured Heifer Program: program development and requirements. J. B. Hall*, S. P. Greiner*, B. R. McKinnon, and W. D. Whittier, *Virginia Tech, Blacksburg, VA.*

Several extension sponsored beef heifer development and marketing programs exist in the US, but they give minimum consideration to genetic merit of the heifers. In 1999, the Virginia Premium Assured Heifer (VAPAH) Program was designed as an elite beef replacement heifer program which would emphasize genetic merit of service sires and heifers. The VAPAH Program was designed to produce, for home use or sale, replacement heifers that are healthy, reproductively sound and of known

genetic value. Extension professionals and veterinarians provide nutritional, genetic, phenotypic, and health guidelines and recommendations. Physical requirements include maximum age at calving, frame score 4.5 to 6.5, body condition score 5 to 7, proper weight for age and frame and muscling scores of 1 to 2.5 (USDA feeder calf grades). A committee evaluates heifers for structural soundness and freedom from defects (e.g. horns, bad eyes, frozen ears). Health program includes vaccination against bovine respiratory complex, clostridial diseases and leptospirosis as well as calfhood vaccination for brucellosis. Heifers must be treated with an endecticide and certified free of anaplasmosis before sale as VAPAH. Reproductive requirements for open heifers are reproductive tract score of 3 and yearling pelvic area $\geq 150 \text{ cm}^2$, whereas bred heifers must conceive within 50 d of the beginning of the breeding season and have a pelvic area $\geq 180 \text{ cm}^2$ at 18 m of age. Maximum birth weight EPD for service sire (SS) must not exceed the equivalent of the top 40% of Angus breed birth weight EPD. In addition, SS must be breed average for YW EPD. Heifers sired by bulls that meet minimum YW and milk EPD standards are designated as VAPAH Plus. Requirements are updated annually. Approximately, 1700 heifers from 45 farms have been enrolled in the VAPAH program. One thousand eighty-eight heifers have been sold since the start of the program with 57.0 % of the heifers qualifying as VAPAH Plus.

Key Words: Beef, Extension, Replacement heifer

828 A heifer development system emphasizing genetics - The Virginia Premium Assured Heifer Program: marketing. J. B. Hall*, B. R. McKinnon, S. P. Greiner, and W. D. Whittier, *Virginia Tech, Blacksburg, VA.*

The Virginia Premium Assured Heifer (VAPAH) Program is a novel replacement beef heifer development program emphasizing genetics of the heifer and service sire. Heifers meeting VAPAH requirements are identified with a VAPAH eartag to facilitate trace-back, if necessary. Heifers sired by bulls that meet additional genetic standards for growth and milk based on EPDs are designated as VAPAH Plus. Marketing of heifers is facilitated by extension agents and specialists with livestock markets and the Virginia Cattlemen's Association serving as marketing agents. Additionally, VAPAH can be marketed by private treaty. Since 2000, 1088 VAPAH have been marketed. To make comparisons among VAPAH and non-VAPAH, data on 686 heifers marketed from January 2000 to August 2001 were examined. Average price received per heifer was \$980.14, \$947.66 and \$880.93 for bred VAPAH Plus, VAPAH and non-VAPAH, respectively, and \$745.11, \$729.57 and \$665.37 for open VAPAH Plus, VAPAH and non-VAPAH, respectively. These sale results indicate that buyers are willing to pay over \$60/hd more for VAPAH compared to non-VAPAH and an additional \$15 to \$30/hd for VAPAH Plus compared to VAPAH. Thirty-nine farms that purchased a total of 371 heifers responded to a buyer's survey. Satisfaction ratings (1 = very satisfied to 5 = very unsatisfied) were 2.3 and 1.5 for bred and open VAPAH, respectively. Likelihood of buyers purchasing VAPAH again (1 = definitely to 5 = never) was 2.15 (bred) and 2.00 (open). However, when VAPAH and non-VAPAH were offered in the same sale, some buyers indicated considerable confusion in understanding the difference between the designations. To increase marketability of VAPAH outside the region, a web site has been developed that features heifer requirements, upcoming sales, sale summaries and digital images of VAPAH sold or for sale. Based on sale results and buyer surveys, VAPAH and non-VAPAH will not be offered in the same sale. Buyer and producer surveys as well as sale results will be used to refine marketing methods for VAPAH.

Key Words: Beef, Extension, Marketing

Growth and Development

829 Porcine leptin alters fatty acid metabolism by swine adipocytes. T.G. Ramsay*¹, ¹USDA-ARS.

The present study examined whether or not recombinant porcine leptin can alter lipid synthesis in porcine adipocytes. The stromal vascular (SV) cell fraction of neonatal subcutaneous adipose tissue was isolated by collagenase digestion, filtration, and subsequent centrifugation. These SV cells were seeded on 25-cm² tissue culture flasks and proliferated to confluency in 10% fetal bovine serum in DMEM/F12 (50:50).

Cultures were differentiated using 2.5% pig serum + 10 nM insulin + 100 nM hydrocortisone. After 7 d of lipid filling, cultures were washed free of this medium, incubated overnight in DMEM/F12 containing 2% pig serum and then used for experiments. Acute experiments assessed 1-¹⁴C-palmitate metabolism in cultures exposed to porcine leptin (0 to 1000 ng/mL medium) for 4 h. Chronic experiments used cultures incubated with 0 to 1000 ng porcine leptin/mL medium for 44 h prior to measurements of 1-¹⁴C-palmitate oxidation and incorporation into

lipid during a 4 hour incubation. Acute treatment with leptin did not affect palmitate oxidation ($P>0.05$, $n=8$) but reduced palmitate incorporation into lipids by up to 45% ($P<0.05$, $n=8$). Chronic exposure to leptin increased palmitate oxidation by 36%, although only at the highest concentration of leptin tested: 1000 ng leptin/mL medium ($P<0.05$, $n=8$). Chronic leptin exposure reduced palmitate incorporation into total lipids by 40% at 100 ng/mL medium ($P<0.05$, $n=8$). Lipoprotein lipase activity was unaffected by leptin ($P>0.05$, $n=4$). These data demonstrate leptin functions to promote partitioning of energy away from lipid accretion within porcine adipose tissue by stimulating fatty acid oxidation indirectly and inhibiting lipid synthesis directly.

Key Words: Leptin, Adipocyte, Cell Culture

830 Maternal n-3 Fatty Acid Supplementation to Enhance Brown Fat Thermogenesis in Newborn Lambs. C. Chen*, G. E. Carstens, C. M. Theis, S. L. Archibeque, M. W. Kurz, C. D. Gilbert, L. J. Slay, and S. B. Smith, *Texas A&M University*.

The aim of this study was to determine whether dietary supplementation of n-3 polyunsaturated fatty acid (PUFA) during late gestation would stimulate recruitment of brown adipose tissue (BAT) in utero to improve cold tolerance of newborn lambs. Thirty twin-bearing ewes were allotted to one of six groups ($n = 5$) beginning 40–15 d prior to lambing. Groups were randomly assigned to treatments in a 2x3 factorial arrangement with factors being: level of rumen-protected fat (2, 4 or 8%), and source of rumen-protected fat (high in saturated/monosaturated fatty acid [SMFA; Energy Booster®] or high in n-3 PUFA; formaldehyde-protected soy/linseed lipid). Ewes were individually fed in an open-sided barn. All lambs were separated from ewes and placed in a warm chamber (25°C) within 2 h of age. At 4 h of age, all lambs were placed in a cold chamber (0°C) for 2 h and rectal temperatures (RT) measured at 15-min intervals. One lamb per twin pair was killed at 6 h of age and the other lamb was returned to the warm chamber till 22 h of age. Cold-induced RT responses were again measured for 2 h and the second lamb killed at 24 h of age. Prenatal ADG were greater ($P < .01$) in ewes fed PUFA vs SMFA diets, but level and source of fat did not affect lamb birth weights. PUFA-fed ewes had higher plasma concentrations of 18:2, 18:3 and EPA, and lower concentrations of 16:0, 16:1, and 18:1 than ewes fed SMFA diets. Plasma SFA:PUFA ratios were lower in PUFA-fed ewes (1.63 vs 2.14 .17). BAT of lambs born to PUFA-fed ewes had higher concentrations of 18:2, EPA and DHA than lambs born to SMFA-fed ewes. The SFA:PUFA ratios in BAT were lower in lambs from PUFA-fed ewes (15.4 vs 20.4 2.4), however, BAT mass, cytochrome c oxidase activity and GDP binding were not affected by level or source of dietary fat. Cold-induced RT responses of lambs were not affected by source of prenatal fat, but increased quadratically as level of prenatal fat increased (39.4, 39.7 and 39.1 .06°C for 2, 4 and 8% fat, respectively). Prenatal n-3 fatty acid supplementation altered the fatty acid profile of BAT, but did not affect BAT thermogenic activity or cold tolerance of newborn lambs.

Key Words: Lamb, Brown Fat, Polyunsaturated Fatty Acid

831 Effects of daidzein supplementation to the diet of pregnant sows on maternal performance and neonatal piglet growth. G. Kuhn¹, M. Ren², F. Schneider¹, E. Kanitz¹, M. Tuchscherer¹, K. Nürnberg¹, B. Stabenow¹, K. Ender¹, and C. Rehfeldt^{*1}. ¹Research Institute for the Biology of Farm Animals, Dummerstorf, Germany, ²Nanjing Agricultural University, Nanjing, China.

The objective of this study was to investigate the effects of a daidzein supplement to the diet of pregnant sows on litter and piglet performance, endocrine characteristics, and insulin-like growth factor-1 receptor (IGF-1R) mRNA expression in neonates. Eight sows received a daidzein supplement of 8 mg/kg feed from d 85 of gestation up to parturition and six sows were used as control. Three days before parturition blood samples were taken from sows while colostrum samples were collected at farrowing. Immediately after parturition, two male piglets of average birth weight were selected from each litter for analysis of IGF-1R gene expression in different tissues. Blood samples were collected from the remaining piglets at d 1 of age. The percentage of piglets born alive was higher in the daidzein group than in control ($P=0.01$) whereas the percentage of runts tended to be lower ($P=0.15$). Litter weight of live born piglets was higher ($P<0.01$) in the daidzein treated group. Birth weight of piglets was increased ($P=0.02$) by daidzein treatment with differences being higher in males ($P=0.02$) than in females

($P=0.12$). Concentrations of insulin and IGF-1 in blood of sows were not influenced by daidzein before parturition. Blood IGF-1 concentration of one day old piglets was higher in the daidzein group than in controls ($P=0.07$). Likewise, IGF-1 concentration in sow colostrum was higher ($P=0.07$). There was no effect of daidzein on the fatty acid composition of piglet plasma or on the composition of colostrum (protein, lipids, lactose). Compared with the control, muscle IGF-1R mRNA level was significantly higher ($P<0.05$) in the daidzein group whereas IGF-1R mRNA levels in thymus and liver tended to be higher ($P=0.08$, $P=0.09$, respectively). The results suggest that daidzein supplementation during late gestation is capable of affecting maternal performance and fetal growth.

Key Words: Daidzein, Sows, Piglets

832 Effects of exogenous somatotropin during early gestation on postnatal development of muscle fibers in pigs. C. Rehfeldt*, G. Kuhn, and K. Ender, *Research Institute for the Biology of Farm Animals, Dummerstorf, Germany*.

The effects of maternal treatment with porcine somatotropin (pST) during early gestation on postnatal development of muscle fibers were determined. Crossbred gilts received daily injections of either 3 mL of a placebo ($n=7$) or 6 mg of pST ($n=7$) from d 10 to 37 of gestation with gradual withdrawal from d 28. Muscle samples were collected at birth ($n=41$) from low-weight (LW), middle-weight (MW), and heavy-weight (HW) littermates, at weaning (d 49, $n=35$), and at 182 d of age ($n=54$). Average birth weight and weights of semitendinosus (ST) and psoas major (PM) muscles were unchanged by maternal pST treatment. However, weight group x treatment interactions ($P < 0.02$) revealed decreases in body weight (BW) and ST weight in HW and increases in LW piglets. Administration of pST increased the number of primary ($P < 0.05$) and secondary fibers ($P < 0.10$) in neonatal ST muscle of LW littermates, whereas no changes were observed in the PM muscle. Muscular protein concentration was higher ($P < 0.07$) after pST treatment. From birth to weaning, total muscle fibre number per muscle cross section (MFN) increased threefold in both ST and PM muscle ($P < 0.0001$). From weaning to d 182, MFN remained almost unchanged in ST, but increased in PM by a factor of 2.4 ($P < 0.001$). No significant effects of pST treatment on MFN were found at d 49 and 182 of age, but MFN appeared to be more balanced among originally LW, MW, and HW littermates. At d 49 or 182 of age, there were no differences in BW, carcass weight or weights of ST and PM muscles. Only minimal changes in fiber characteristics were observed in longissimus, ST, and PM muscles due to pST treatment. At d 49, fiber cross sectional area (FCSA) of slow-twitch oxidative (STO) fibers decreased ($P = 0.05$) in ST. At d 182, STO fiber percentage tended to be higher ($P = 0.13$) in ST, while the average FCSA tended to be lower ($P = 0.14$) in PM. The results suggest that maternal pST treatment during early gestation is able to affect neonatal muscle, but scarcely influences postnatal muscle growth.

Key Words: Somatotropin, Muscle, Growth

833 Effect of reconstitution with commensal bacteria on intestinal physiology and performance in the germ-free pig. T.W. Shirkey*, B.G. Goldade, J.K. Marshall, R.H. Siggers, M.D. Drew, B. Laarveld, A. Estrada, and A.G. Van Kessel, *University of Saskatchewan, Saskatoon, SK, Canada*.

To determine the effect of different commensal intestinal bacteria on intestinal physiology and production performance, 16 piglets were aseptically obtained by caesarian section and allocated into 4 gnotobiotic isolators balanced for litter of origin, sex and weight. One isolator was maintained germ-free (GF), and piglets in the remaining isolators were orally inoculated with either *Escherichia coli* K88- (EC), *Lactobacillus fermentum* (LF), or fresh adult porcine feces (PF). Piglets were fed irradiated bovine colostrum (1 d), sow milk replacer (400 mL/kg/d for 15 d) and a commercial weaning diet (*ad libitum* for 10 d). Body weight was recorded every other day and piglets were killed at 26 d of age. Culture of cecal contents indicated colonization of EC and LF groups by *Escherichia spp.* and *Lactobacillus spp.*, respectively. Cecal cultures also indicated 2 spore-forming contaminants (*Clostridium spp.* and *Bacillus spp.*) present in all four isolators. Relative liver and spleen weight (g/kg BW) and small intestinal (SI) length (m/kg BW) was greater in PF versus GF, EC and LF treatment groups. Weight of SI per unit length determined at 25% and 95% of intestinal length was highest in

GF pigs and lowest in either the EC (25%) or PF (95%) group. GF piglets had the highest average daily gain, followed by LF, EC and PF treatments. Commensal intestinal bacteria influence intestinal morphology and may negatively affect performance in pigs.

Item	GF	LF	EC	PF
Liver, g/kg BW	32.54 ^a	31.70 ^a	33.20 ^a	38.73 ^b
Spleen, g/kg BW	1.74 ^a	1.76 ^a	1.87 ^a	2.89 ^b
Heart, g/kg BW	6.98	6.65	6.88	6.58
SI length, m/kg BW	1.19 ^a	1.27 ^a	1.35 ^a	2.15 ^b
SI weight 25%, g/10 cm	3.68 ^a	3.17 ^{ab}	2.79 ^b	3.27 ^{ab}
SI weight 95%, g/10 cm	5.37 ^a	4.70 ^{ab}	4.49 ^{ab}	3.54 ^b
Pre-wean ADG, g	178.3 ^a	168.8 ^a	121.3 ^b	51.0 ^c
Post-wean ADG, g	270.3 ^a	231.3 ^a	246.7 ^a	127.8 ^b
Total ADG, g	212.3 ^a	192.0 ^{ab}	167.7 ^b	79.5 ^c

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

Key Words: Intestinal bacteria, Gnotobiotic, Performance

834 Ghrelin induces GH secretion in pigs. D. H. St-Pierre* and P. Dubreuil, *University of Montreal.*

Ghrelin (G), a linear 28-amino acid peptide octanoylated at Ser³ was isolated in 1999 from rat stomach and identified as the endogenous ligand of the GHS-R. The potent stimulating effect of G on GH secretion was demonstrated in humans and rats. In our laboratory, the pig has been used during the past several years as an animal model to evaluate the effect of various GH secretagogues. Six crossbred male pigs (51.8±7.2 kg) were used in two 6x6 (6 days) non-balanced latin square design experiments to evaluate GH-releasing potency of G. In both experiments, saline control (SC; 3 mL) and peptides were injected iv and blood samples were collected at 20 minute intervals for 3 hours with additional sampling at 10 and 30 minutes. In exp. 1, native octanoylated (O) free-carboxyl (C) ghrelin (OCG); non-octanoylated ghrelin (nOCG); octanoylated amide ghrelin (ONG); nONG; and a potent analog of GRF, [des-Tyr¹, D-Ala², Ala¹⁵]-GRF_{1-29NH₂} (GRF) were compared at 1.5 nmol/kg. In exp. 2, the effect of ONG was compared at: 0; 0.1; 0.3; 1.0; 3.0; and 9.0 nmol/kg. GH-AUCs for exp. 1 were 639^a: SC; 593^a: nOCG; 667^a: nONG; 1125^b: GRF; 1849^c: OCG; and 2385^d: ONG, SEM: 143 ng.min/mL, ^{a,b,c,d} are significantly different (p < 0.05). GH-AUCs for exp. 2 were: 446^a: SC; 666^a: 0.1 nmol/kg; 1223^b: 0.3 nmol/kg; 1372^b: 1.0 nmol/kg; 1768^c: 3.0 nmol/kg; 2027^c: and 9.0 nmol/kg, SEM: 107 ng.min/mL, ^{a,b,c} are significantly different (p < 0.05). Results indicate that while OCG and ONG potentially stimulate GH release, non-octanoylated ghrelin analogs are inactive. GH secretion depends on dose of ghrelin injected and does not seem to plateau. The experiments suggest that, as in humans and rats, the octanoylated form of ghrelin is required for biological activity in pigs and its potency varies in a dose-dependant manner.

Key Words: Ghrelin, GH secretion

835 The effects of zeranol implantation on pituitary growth hormone-releasing hormone receptor expression in growing beef steers. E. E. Connor*, S. Kahl, T. H. Elsasser, and T. S. Rumsey, *USDA-ARS, Animal and Natural Resources Institute, Beltsville, MD.*

Estrogenic growth promotants increase rate of gain and feed efficiency in beef cattle in part through stimulated synthesis and release of pituitary growth hormone (GH); however, the mechanism of GH stimulation is not well understood. The purpose of the present study was to examine the effects of an estrogenic anabolic compound, zeranol, on ADG, GH response to thyrotropin-releasing hormone + growth hormone-releasing hormone (TRH+GHRH) challenge, and pituitary GHRH receptor mRNA expression in growing beef steers. Sixteen steers averaging 301 ± 6 kg BW were assigned randomly to a control group or to one of two zeranol treatment groups that were implanted (36 mg Ralgro) for a total of 42 d (1 implantation) or 162 d (3 implantations) until slaughter. Five days prior to slaughter, all animals were challenged with TRH+GHRH (1.0 + 0.1 µg/kg, respectively, i.v.) and blood samples were collected at 0, 5, 10, 15, 20, 30, 45, 60, and 120 min relative to challenge for plasma GH determination. The GH response to TRH+GHRH challenge was calculated as the area under the GH response curve (AUC) using trapezoid summation. At slaughter, pituitary

glands were collected, weighed, and immediately frozen in liquid nitrogen for subsequent extraction of total RNA. Pituitary GHRH receptor mRNA expression was compared using relative quantitative real-time RT-PCR. Zeranol implantation resulted in increased ADG (P < 0.01) and increased AUC in response to TRH+GHRH challenge (P < 0.05). The GH responses to TRH+GHRH challenge were significantly lower on d 157 than on d 37 (P < 0.05). There was no effect (P > 0.05) of time or zeranol implantation on pituitary weight or expression of GHRH receptor mRNA. Our results suggest that increased ADG and GH secretion due to zeranol implantation are not mediated by changes in transcription of the GHRH receptor gene in cattle.

Key Words: Estrogens, Cattle, Growth hormone-releasing hormone

836 Steady-state levels of IGF-I, IGFBP-3, IGFBP-5, myostatin and hepatocyte growth factor mRNA in semimembranosus muscles and /or livers of steroid implanted and non-implanted steers. M.E. White*, B.J. Johnson, M.R. Hathaway, and W.R. Dayton, *University of Minnesota, St. Paul, MN/USA.*

Ribonuclease protection assays (RPA) and real-time RT-PCR were used to measure steady-state semimembranosus muscle and/or hepatic levels of insulin-like growth factor (IGF)-I, insulin-like growth factor binding protein (IGFBP)-3, IGFBP-5, hepatocyte growth factor (HGF) and myostatin mRNAs in steers implanted from 32 to 38 d with Revalor-S[®], a combined trenbolone acetate and estradiol implant. IGF-I mRNA levels were 69% higher (P<.01, n=7) in the livers of implanted steers than in the livers of non-implanted steers. Similarly, IGF-I mRNA levels were 37% higher (P<.04, n=7) and 27% higher (P<.01, n=7) in the semimembranosus muscles of implanted steers than in the same muscles from non-implanted steers using real-time RT-PCR and RPA respectively. Hepatic IGFBP-3 mRNA levels were numerically 24% higher (P<.07, n=7) in implanted steers than in non-implanted steers using RPA. Hepatic HGF and IGFBP-5 mRNA levels were not different in implanted and non-implanted steers. Similarly, muscle IGFBP-3, IGFBP-5, and myostatin mRNA levels were not affected by implantation. Muscle HGF mRNA was difficult to detect using RPA and results from this assay indicated that HGF mRNA was not significantly different between implanted and non-implanted animals. However using real-time RT-PCR, muscle HGF was 50% lower (p<.03, n=7) in implanted steers than in non-implanted steers. Previous data from these same steers have shown that circulating IGF-I and IGFBP-3 concentrations were 30 to 40% higher (P<.01, n=7) in implanted steers than in non-implanted, control steers. Additionally, the number of actively proliferating satellite cells that could be isolated from the semimembranosus muscle was 45% higher (P<.01, n=7) for implanted steers than for non-implanted steers. Viewed together these data suggest that elevated muscle IGF-I levels stimulate increased satellite cell proliferation resulting in the increased muscle growth observed in Revalor-S[®] implanted steers.

Key Words: IGF-I, Muscle, Steroid Implant

837 Effect of Revalor-S[®] on hepatic and muscle expression of components of the somatotrophic axis in Simmental calves and yearling steers. B. A. Crooker*, L. S. Ma, W. J. Weber, M. E. White, M. R. Hathaway, and W. R. Dayton, *Department of Animal Science, University of Minnesota.*

Steers received Revalor-S[®] or a sham on day 0 to examine systemic and local effects of steroid implants and age on components of the somatotrophic axis. Blood samples and hepatic and longissimus dorsi biopsies were obtained from calves (study A; implant, N=5; control, N=5; 307 ± 9 kg BW) and yearlings (study B; implant, N=5; control, N=5; 411 ± 21 kg BW) on day 0, 3, 7, 14, 21, 28 and 42 (yearlings only). Serum IGF-I was determined by RIA. Hepatic GH receptor (GHR), IGF-I, IGF-BP3 and IGF-BP5 mRNA were determined by ribonuclease protection assay. Muscle IGF-I mRNA in calves was determined by RPA and in yearlings by real-time PCR. The PCR reverse primer for IGF-I spanned the junction of exons 3 and 4 which prevented amplification of genomic DNA. All mRNA results are reported relative to cyclophilin. Data were analyzed as repeated measures using d 0 as a covariate. Results differed when P < 0.05. Revalor[®] did not affect BW of calves (359 ± 3 kg at d 28) but increased BW of yearlings (445, 481 ± 6 kg at d 28). Serum IGF-I was greater in implant yearlings by d 21 (316, 176 ± 23 ng/ml) and the trend (P = 0.07) was similar in calves (407, 339 ± 26 ng/ml). Although stable in controls and similar in controls and implants at d 0,

hepatic IGF-I mRNA was greater in implants than controls during d 14 to 28 (A, 80%; B, 87% increase). A similar pattern occurred for muscle IGF-I mRNA in calves (93% increase). In yearlings, muscle IGF-I mRNA in implants was 116% greater than controls at d 28. Hepatic GHR-1A mRNA was not affected by implant in either study. IGFBP-3 mRNA was greater in implants than controls after d 7 (60% increase) in yearlings but unaltered in calves. IGF-BP5 mRNA was not affected by implant in either study. Results suggest Revalor[®] increased systemic IGF-I (presumably via liver) and local IGF-I in muscle. Either or both may be involved in muscle hypertrophy. These effects were manifested in increased BW gain in yearlings.

Key Words: Liver, Muscle, IGF-I

838 Production, purification and characterization of porcine recombinant insulin-like growth factor binding protein (rpIGFBP)-3 and an anti-rpIGFBP-3 antibody that inhibits IGFBP-3 activity. M. S. Pampusch, E. I. Kamanga-Sollo, M. E. White, M. R. Hathaway, and W. R. Dayton*, *University of Minnesota, St. Paul, MN.*

Insulin-like growth factor binding protein (IGFBP)-3 mediates the biological actions of insulin-like growth factors and may have IGF-I-independent effects on proliferation and apoptosis. IGFBP-3 expression is down-regulated during differentiation of porcine embryonic myogenic (PEM) cells. In order to better assess the role of IGFBP-3 in PEM cell proliferation and differentiation, we have produced and purified recombinant porcine IGFBP-3 (rpIGFBP-3) and an antibody specific for rpIGFBP-3. The N terminal sequence of IGFBP-3 was obtained by 5' RACE PCR using porcine liver RNA as a template. The full open reading frame of IGFBP-3 was amplified from porcine liver RNA and sequenced in both directions by fluorescent automated DNA sequencing. The expressed IGFBP-3 construct contained a 6-histidine tag on the C terminus and a secretion signal. rpIGFBP-3 was produced in a baculovirus expression system under serum-free conditions and purified from conditioned media by nickel affinity chromatography followed by IGF-I-affinity chromatography. Purity of the protein was assessed by silver stained SDS PAGE. rpIGFBP-3 binds IGF-I, as shown by ligand blotting, and cross-reacts with anti human IGFBP-3 antibody. rpIGFBP-3 suppresses IGF-I-stimulated proliferation of cultured PEM cells. A rabbit polyclonal IgG raised against rpIGFBP-3 recognizes rpIGFBP-3 and native IGFBP-3 in serum but does not crossreact with other proteins present in PEM cell lysate or PEM cell conditioned media. The anti-rpIGFBP-3 antibody abolishes the anti-proliferative activity of rpIGFBP-3 in PEM cell cultures. These reagents will provide the tools needed to study the IGF-dependent and IGF-independent effects of IGFBP-3 on proliferation and differentiation of PEM cells.

Key Words: IGFBP-3, Myogenic Cell Culture, Porcine

839 Serum insulin-like growth factor binding protein-3 (IGFBP-3) concentrations parallel antimicrobial-induced increases in serum insulin-like growth factor I (IGF-I) concentrations in pigs. M. R. Hathaway*, M. S. Pampusch, M. E. White, and W. R. Dayton, *University of Minnesota, St. Paul, MN.*

Previously, we have shown that sera obtained from pigs receiving subtherapeutic levels of dietary antimicrobials have increased levels of insulin-like growth factor-I (IGF-I). Since the insulin-like growth factor binding proteins (IGFBP) regulate the bioactivity of the IGFs the present study was designed to determine whether feeding the antimicrobial Aureozol to young pigs also altered IGFBP concentrations. The effect of subtherapeutic antimicrobial supplementation on the sera concentrations of IGFBP-2, -3, and -4 was determined in crossbred weanling pigs. Pigs were allotted to a diet with or without Aureozol for 4 wk. IGFBP-3 and IGF-I analyses were performed on blood samples that were drawn weekly. Four weeks after Aureozol was included in the diet of weanling pigs, circulating levels of IGFBP-3 were increased 45.7% compared to pigs fed the control diet. After an initial drop at weaning, serum IGFBP-3 values increased gradually over time, reaching pre-weaning levels in the Aureozol group on d 21 and in the control group on d 27. The treatment induced difference in serum IGFBP-3 was detected on d 21 ($P < .001$) and d 27 ($P < .001$). In direct contrast, sera IGFBP-2 levels increased with weaning and then decreased gradually over time to pre-weaning levels by d 21. Sera IGFBP-2 levels did not differ between treatment groups at any time ($P < .57$). Sera IGFBP-4

levels did not differ between treatment groups or between time points throughout the study. Aureozol supplementation resulted in a 45.2% increase in serum IGF-I concentrations overall ($P < .03$). The Aureozol fed pigs had a 14.2% increase in body weight gain ($P < .014$) and a 59.6% increase in average daily gain ($P < .012$) compared with pigs fed the control diet. Antimicrobial-induced increases in serum IGFBP-3 and serum IGF-I may be involved in the enhanced growth performance observed with Aureozol supplementation.

Key Words: IGFBP, Pig, Antimicrobial

840 Insulin-like growth factor binding protein (IGFBP)-3 is partially responsible for the proliferation-suppressing activity of transforming growth factor beta (TGF beta) on porcine embryonic myogenic cell cultures. E. I. Kamanga-Sollo, M. S. Pampusch, M. E. White, M. R. Hathaway, and W. R. Dayton*, *University of Minnesota, St. Paul, MN.*

Transforming Growth Factor beta (TGF beta) has been shown to enhance insulin-like growth factor binding protein (IGFBP)-3 production and release in a number of cell types. Similarly, we have shown that treatment of cultured porcine embryonic myogenic (PEM) cells with TGF beta causes a 2 to 3 fold increase ($P < .01$) in IGFBP-3 protein in conditioned media (assessed using IGF-I Western ligand blotting) and a similar increase ($P < .01$) in steady-state mRNA levels (measured using real-time RT-PCR). Additionally, treatment of PEM cells with either TGF beta or recombinant porcine IGFBP-3 (rpIGFBP-3) causes a concentration-dependent suppression of IGF-I-stimulated proliferation (measured by tritiated-thymidine incorporation). We have produced and characterized a polyclonal antibody specific for rpIGFBP-3 and we have shown that this antibody is able to completely inhibit the ability of exogenous IGFBP-3 to suppress proliferation of cultured PEM cells. Utilizing this anti-rpIGFBP-3 antibody, we have shown that inactivation of IGFBP-3 in the medium of TGF beta-treated PEM cells results in loss of 50 to 70 percent of the TGF-beta-induced suppression of PEM cell proliferation. These data show that the TGF beta-induced increase in IGFBP-3 is responsible for part of the suppression of proliferation observed in TGF beta-treated PEM cells. This observation is particularly significant in view of the role of the TGF beta superfamily member myostatin in regulating skeletal muscle mass.

Key Words: IGFBP-3, TGF beta, Porcine Muscle Cells

841 Polyclonal antibodies recognize only the latent peptide of myostatin but not the active form of myostatin in the chicken. Y.S. Kim*, Y.K. Lee, and M.A. Dunn, *University of Hawaii at Manoa, Honolulu, HI.*

Myostatin regulates skeletal muscle growth, but very little is known about the molecular mechanism by which myostatin increases muscle growth. Because anti-myostatin antibodies will be useful in investigating the mechanism of action of myostatin, we designed a project to produce polyclonal anti-myostatin antibodies. A PCR-amplified full sequence and a 369 bp C-terminal fragment containing the active form of chicken myostatin were cloned into an expression vector, and myostatin proteins were expressed in *E. coli*. Inclusion bodies containing the full sequence and C-terminal fragment were solubilized, then proteins were fractionated by SDS-PAGE. Myostatin bands were cut out and electro-eluted to prepare purified myostatins. Rabbits were immunized against the full sequence and C-terminal chicken myostatin to produce polyclonal anti-myostatin antibodies. IgG was separated from the sera using Protein A affinity chromatography. Antibody binding specificity was examined using Western transfer and immunoblotting. Both IgGs generated against the full sequence and C-terminal myostatin showed strong binding to the recombinant myostatins in a Western blot. When binding specificity was examined in various chicken tissues including liver, heart, skeletal muscle, crop, spleen, kidney and brain, the IgG generated against the full sequence myostatin had a prominent binding to a 37 kD band only in skeletal muscle, but not in any other tissues. Since the molecular wt of the latent peptide of myostatin is close to 37 kD, this result indicates that the polyclonal antibody probably recognizes only the latent peptide of chicken myostatin. In contrast, the IgG generated against the C-terminal recombinant myostatin did not show any skeletal muscle selective binding. Therefore, we conclude that antibodies recognizing the active form of chicken myostatin were not generated by immunization

with the recombinant myostatins probably due to the close homology of the active forms of myostatin across species.

Key Words: Anti-myostatin antibody, Myostatin, Chicken

842 The effect of conjugated linoleic acid on the differentiation of L8 myoblasts. C.S. Chung¹, T.D. Brandebourg^{*2}, and C.Y. Hu², ¹Department of Animal Science, Chungbuk National University, Republic of Korea, ²Oregon State University, Corvallis.

Feeding conjugated linoleic acids (CLA) decreases subcutaneous fat and increases lean deposition in growing pigs. However, the underlying mechanisms responsible for these CLA-induced changes in carcass composition are poorly understood. The objective of this study was to examine the effect of CLA on muscle growth by determining how administration of either CLA or specific CLA isomers [cis-9,cis-11 (9c11c), cis-9,trans-11 (9c11t), trans-9,trans-11 (9t11t), trans-10,cis-12 (10t12c)] effects the differentiation of cultured muscle cells. In order to study the effect of CLA on muscle cell differentiation, L8 myoblasts were seeded in low-glucose DME supplemented with 10% fetal bovine serum on d -2 and induced to differentiate in DME supplemented with 2% horse serum on d 0. In separate experiments, CLA, 9c11c, 9c11t, 9t11t, or 10t12c was administered at concentrations of 10, 25, or 50 μ M for each of the following intervals: d -1 to d 0, d 0 to d 1 and d 1 to d 4. Differentiation was evaluated by measuring creatine kinase activity on d 5 following treatment at the designated intervals. When administered from d -1 to d 0, the CLA mixture inhibited creatine kinase activity 27% at 25 μ M and 42% at 50 μ M while creatine kinase activity was decreased by 24%, 71% and 72% versus control as 10t12c concentration increased to 50 μ M respectively. All other isomers failed to effect creatine kinase activity when administered for this duration regardless of treatment level. When administered from d 0 to d 1, 10t12c inhibited creatine kinase activity by 44% at 25 μ M and 63% at 50 μ M while neither the CLA mixture nor the remaining specific isomers had an effect. When administered from d 1 to d 5, the CLA mixture inhibited creatine kinase activity 51%, 66% and 73% as treatment levels increased to 50 μ M respectively while the 10t12c isomer maximally inhibited creatine kinase activity 76% at 10 μ M. Like the shorter intervals, no other isomer affected creatine kinase activity. These data suggest that the administration of CLA may inhibit muscle cell differentiation and thus fails to explain how feeding CLA to growing pigs results in increased lean gain.

Key Words: CLA, Differentiation, L8 myoblasts

843 Effects of synthetic conjugated linoleic acid (CLA) or bio-formed CLA as high CLA beef on rat growth and adipose tissue development. P.S. Mir^{*1}, E.K. Okine², L. Goonewardene³, M.L. He¹, and Z. Mir, ¹Agriculture and Agri-Food Canada, Lethbridge AB, ²University of Alberta, Edmonton AB, ³Alberta Agriculture Food and Rural Development, AB.

Two experiments were conducted concurrently for 60 days with rats to determine the effects of feeding synthetic CLA containing 53% CLA cis 9, trans 11 and 44% CLA\ trans 10, cis 12\ or bio-formed CLA as high CLA beef from steers fed sunflower oil to increase CLA content by 144% from 3.36 to 8.20 mg/g lipid, on adipose tissue development. In experiment 1, 30 (10/diet) weaned male Wistar rats (51 \pm 0.65 g) were fed, ad libitum, a control diet containing casein and soybean oil, control with supplemental synthetic CLA at 1.1% of diet DM or the control with sunflower oil replacing the soybean oil. In experiment 2, 20 (10/diet) weaned male Wistar rats (52.5 \pm 2.5g) were fed, ad libitum, diets where freeze dried beef replaced the casein. The meat in the two diets was derived from either steers raised without dietary oil or from high CLA beef. At the end of the experiment the rats were humanely sacrificed and the organs, muscles and the retro-peritoneal and inguinal fat pads were extracted. In both experiments diets fed to the rats did not affect rate of growth or carcass, muscle and organ (liver, heart and kidney) weights. However, in experiment 1, dietary synthetic CLA reduced ($P < 0.01$) weight of the retro-peritoneal fat pad relative to that in rats fed the control diet, but not adipocyte number in either fat depot. Although fat pad weight in rats fed sunflower oil was similar to that of rats fed the control diet, the adipocyte number was increased ($P < 0.05$) by 37%. In experiment 2, fat pad weights were similar for the two meat treatments, but adipocyte number in both pads was decreased

($P < 0.05$) in rats fed the high CLA beef by 40%. Data suggests that dietary CLA whether synthetic or from high CLA beef can decrease lipid storage potential by decreasing adipocyte numbers and size in fat pads.

Key Words: Rat, adipose development, CLA, high CLA beef

844 Study of carcass, organ, muscle, fat tissue weight, and concentration in rats fed CLA or its precursors by Principal Component Analysis (PCA). L.A. Goonewardene^{*1}, Z. Wang¹, P.S. Mir², E. Okine³, Z. Mir², and M. He², ¹Alberta Agriculture, Food and Rural Development, Edmonton, AB, ²Agriculture and Agri-Food Canada, Lethbridge, AB, ³University of Alberta, Edmonton, AB.

Carcass, organ and muscle weight, and fat tissue data were obtained from 30 weaned male Wistar rats fed one of three diets, (ten rats/diet) ad libitum for 60 d. The diets were basal containing casein and soybean oil supplemented with conjugated linoleic acid (CLA; 53% cis 9, trans 11 and 44% trans 10, cis 12) at 1.1% diet dry matter, basal where sunflower oil replaced soybean oil, and basal where freeze dried beef derived from steers fed oil to increase CLA replaced casein. The Principal Component Analysis was used to identify linear relationships among variables using a multivariate approach, describe the variables by a few components, and obtain an overview of the pattern of variables relative to the diets. The first principal component extracted carcass weight, organ and muscle weight variables and accounted for 41.3% of the total variation. The second principal component included all of the fat tissue variables and accounted for 20.5% of the total variation. The rats fed the synthetic CLA diet were associated with high carcass, liver, kidney, and heart, gastrocnemius and soleus muscle weights, and low retroperitoneal and inguinal fat weights, and low adipocyte numbers in the fat tissues. In rat models, short periods of synthetic CLA feeding may have a greater impact on decreasing fat accretion in selected fat tissues and feeding either CLA enriched meat or sunflower oil is expected to have little effect, as fat reduction is both CLA intake and isomer dependent.

Key Words: Conjugated Linoleic Acid, feeding, Principal Component Analysis, muscle, fat, organs

845 Measurement of bone mineral content and bone mineral density of pig carcasses by dual energy x-ray absorptiometry. A. D. Mitchell^{*1}, A. M. Scholz², and V. G. Pursel¹, ¹USDA, Agricultural Research Service, Beltsville, MD, ²Ludwig Maximilians University-Munich, Oberschleissheim, Germany.

Traditional methods of assessing the bone mineral status of pig carcasses involve dissection, ashing, and/or chemical analysis. By the use of dual energy X-ray absorptiometry (DXA) it is now possible to perform many of these measurements on the intact carcass. The purpose of this study was to quantify the total and regional bone mineral content (BMC, g) and bone mineral density (BMD, g/cm²) in pig carcasses. A total of 393 half-carcasses (10 - 52 kg, CWT) were scanned by DXA. Regional analysis was available only for CWT >30 kg. Results were analyzed by linear and polynomial regression. Relative to CWT, the BMC for half-carcass, shoulder, ham, loin and side (ribs) were described by 2nd order polynomial regression with (R^2) values of 0.98, 0.74, 0.95, and 0.82, respectively. Relative to half-carcass BMC, the BMC of the shoulder, ham, loin and side were described by linear regression with "growth" coefficients (b = slope) of 0.467, 0.327, 239, and 0.011 and (R^2) values of 0.91, 0.77, 0.82, and 0.04, respectively. Likewise, the increase in BMD relative to CWT was described by 2nd order polynomial regression with (R^2) values of 0.79, 0.56, 0.01, 0.25, and 0.01, for half-carcass, shoulder, ham, loin, and side, respectively. Relative to half-carcass BMD, the BMD of the various regions was described by linear regression with "growth" coefficients (b = slope) of 1.349, 0.777, 0.911, and 0.157 for the shoulder, ham, loin, and side. Thus, during growth from 30 to 52 kg CWT, the largest increase in BMC and BMD was observed in the shoulder while the least amount of increase occurred in the side or ribs.

Key Words: Bone Mineral, Pigs, DXA

846 Predicting growth efficiency in live animals using infrared thermography (IRT). S.L. Scott^{*1}, A.L. Schaefer², A.D. Kennedy³, R.J. Christopherson⁴, A.K.W. Tong², and H. Harrison⁵, ¹Agriculture and Agri-Food Canada, Brandon, Manitoba, Canada, ²Agriculture and Agri-Food Canada, Lacombe, Alberta, Canada, ³University of Manitoba, Winnipeg, Manitoba, Canada, ⁴University of Alberta, Edmonton, Alberta, Canada, ⁵VitaHealth Inc., Winnipeg, Manitoba, Canada.

Within populations of beef cattle raised for slaughter, there is a great deal of variability in growth efficiency. This leads to variability in profit per head, because some animals are marketed underfinished while penmates may be marketed overfinished. The objective of this study was to develop a non-invasive, inexpensive method to predict growth efficiency in live cattle in order to sort them into uniform groups. Since more efficient animals lose less heat to the environment, we used infrared thermography (IRT) to measure heat lost from the animal's body by radiation; this avenue of heat loss accounts for around 60% of total heat loss. The heat loss was then related to growth efficiency to develop a predictive index. Eighteen yearling crossbred heifers averaging 370 kg body weight were randomly allocated to one of two treatments: 1) Cold ad libitum (CAL) in which animals were adapted to -18°C for three weeks in environmental chambers and given a pelleted feed (alfalfa-based; 88.7% dry matter, 0.68 Mcal NE kg⁻¹, 12% crude protein, 0.02% Rumensin[®] and 0.025% MGA) ad libitum, and 2) Warm ad libitum (WAL) in which the animals were adapted to +18°C for three weeks in environmental chambers and given the same pelleted feed ad libitum. Heat loss was measured by two methods on day 22 of the study in a thermoneutral environment: 1) Measurement of oxygen consumption by indirect calorimetry, and 2) Determination of total radiant heat loss from the body surface using infrared thermography. Body weights and feed intake of the animals were also measured throughout the study. Heat production calculated from oxygen consumption was 0.133 Mcal kg^{-0.75} day⁻¹ in the WAL group and 0.155 Mcal kg^{-0.75} day⁻¹ in the CAL group (P<0.05). A Spearman ranking test showed that feed efficiency significantly ranked with heat loss measured by IRT (P<0.05). This means that animals with the highest growth efficiencies displayed the lowest heat loss values based on IRT. Therefore, heat loss as measured by IRT can be used as an index of feed efficiency in cattle.

Key Words: Infrared thermography, Growth efficiency, Beef cattle

Meat Science and Muscle Biology Meat Quality

848 Effect of days fed on live weight gains and carcass traits in feedlot heifers. G. L. Bishop^{*}, T. E. Lawrence, J. R. Brethour, T. T. Marston, and B. J. Johnson, *Kansas State University, Manhattan.*

A serial harvest trial was conducted to quantify the effects of days on feed (DOF) on feedlot performance and carcass characteristics of feedlot heifers. Moderate framed, crossbred heifers (n=160, BW=362 ± 5.3 kg) were processed, implanted with Synovex[®] PlusTM, and allotted to different feeding groups (92, 113, 134, and 155 d). Heifers were harvested at a commercial packing facility and carcass measurements were collected approximately 24 h postmortem. Feedlot ADG was similar (P>0.58) between feeding groups from d0 to d92. Overall ADG was similar (P>0.07) for heifers fed 92 (1.21 kg/d), 113 (1.30 kg/d), and 134 d (1.21 kg/d) but decreased (P<0.01) for heifers fed 155 d (1.09 kg/d). Final weight increased from d92 to d134 (P<0.01). Heifers harvested on d155 had similar (P>0.39) final weight as their d134 contemporaries. Incremental increases (P<0.05) in hot carcass weight were observed with increasing DOF (92=284.5 kg; 113=300.0 kg; 134=323.2 kg; 154=333.6 kg). Dressing percentage (DP) was lowest (P<0.07) at d92 and d113 (59.6% vs. 58.8%, respectively), intermediate (P<0.01) at d134 (60.1%) and greatest (P<0.01) at d155 (62.1%). Marbling scores were similar (P>0.54) between d92 and d113, and increased from d113 to d134 (P<0.01). No differences (P>0.50) were measured in ribeye area (REA) between d92, d113, and d134 heifers, but REA was greatest (P<0.01) in heifers fed 155 d. Backfat increased (P<0.05) from d92 to d113, but d113, d134, and d155 were not different. Yield grade increased (P<0.05) from d92 to d113, but was similar (P>0.05) for groups fed longer than 113 d. Overall carcass maturity did not differ, but tended to increase at d155

847 Application of the Richard's function to characterize growth potential for different biological types of cattle. C. B. Williams^{*}, *U.S. Meat Animal Research Center, Clay Center, NE.*

Different patterns of growth in cattle result mostly from different patterns of nutrient intake and most of the observed variation in nutrient intake is due to diet quality, and physical capacity and nutrient requirements of the animal. Nutrient intake of animals given ad libitum access to a nutrient dense diet is largely controlled by nutrient requirements. To predict growth response for different nutrient intakes, the nutrient requirements for growth should be based on the full growth potential of the animal. On high quality diets, nutrient intake would support potential growth, and on low quality diets, physical capacity would limit nutrient intake, resulting in a lower than potential growth response. The Richard's function was used to characterize the growth potential of 21 biological types of cattle that were evaluated at MARC. Parameters for this function are 1) asymptotic value for empty body weight (EBW) at maturity (A), 2) scaling parameter (b), 3) maturing index (k), and 4) inflection parameter (M). Standard reference EBW (SREBW) was defined as EBW of mature cattle that contained 25% fat, and stage of maturity was defined as EBW/SREBW. The value of M was set to 5.8 for all breeds, so that the mean stage of maturity for steers and females was .5 at the point of inflection. Breed values for A were set at 1.6 and 1.4 times published values of SREBW for steers and cows, respectively. These values were based on data that showed steers and cows on high quality diets attained mature EBW that were 1.6 and 1.4 times SREBW, respectively. Time at birth was set to zero, and breed values for b were calculated from birth weight, A, and M. Breed values for k were estimated by using the first derivative of the Richard's function to predict observed growth with values of k that varied from .002 to .004 in increments of .0001. The k value that minimized the sum of squared deviations between observed and predicted values was selected. Evaluation using independent data sets showed a close agreement between predicted and observed growth curves.

Key Words: Cattle, Growth Curves, Model

(P<0.06). Increasing DOF caused heifer carcasses to become fatter and heavier with greater marbling scores, while live weight gain decreased.

Key Words: Heifers, Serial harvest, Carcass

849 The effect of pregnancy status on feedlot performance and carcass quality. G. L. Bishop^{*}, T. E. Lawrence, J. R. Brethour, and T. T. Marston, *Kansas State University, Manhattan.*

Sixty-eight, spring-born yearling heifers were used to determine the effects of pregnancy status on carcass traits and feedlot performance. All heifers were estrus synchronized and artificially inseminated 60 d prior to the finishing phase. Ultrasound and rectal palpation was used to determine if the heifers would be considered open (OPEN) or pregnant (PREG). Heifers were placed in the feeding facility (BW=418 ± 5.3 kg), and after a two wk step-up period, were fed a sorghum grain-based diet (CP=12.9%, NEg=1.50 Mcal/kg) until harvest. Heifers did not receive a growth implant during their lifetime. Ultrasound was used to predict a backfat endpoint of 13 mm at either 105 or 147 days on feed. Cattle were individually weighed within 24 h of slaughter. Fetal age averaged 174 d at harvest. Pregnancy status was visually confirmed at the abattoir and agreed with treatment assignments. After a 24 h chilling period, carcass measurements were collected. Because backfat was similar between harvest dates (P>0.99), carcass data were pooled for analysis. Final weight, ADG, and backfat were not different (P>0.50) for OPEN vs. PREG heifers (579 ± 6.3 kg, 1.30 kg/d, 13.5 mm; 584 ± 8.2 kg, 1.33 kg/d, 14.2 mm, respectively). The OPEN and PREG heifers had similar (P<0.35) hot carcass weights (362 ± 4.5 kg vs. 355 ± 6.0 kg, respectively). Even with these similarities, dressing percentage was greater (P<0.01) for OPEN (62.6%) than for PREG (60.4%) heifers. There was a trend (P=0.16) for OPEN heifers to have about 3.2

sq cm larger ribeye areas than PREG contemporaries. Numerical USDA yield grades tended ($P < 0.20$) to be greater for PREG (2.36) than OPEN (2.16) heifers, as was USDA marbling score (Modest18 vs. Small94). Although little difference was noted ($P = 0.14$) in overall maturity estimates between PREG and OPEN heifers, PREG heifers tended to have lower maturity scores (A69 vs. A75). Our data indicate that short-term pregnancy has minimal effects on most feedlot performance and carcass traits with the exception of hot carcass yield.

Key Words: Heifers, Pregnancy, Carcass

850 Metabolism of 3-methylindole (skatole) by porcine hepatocytes. F. Lanthier, Y. Lou, and E.J. Squires, University of Guelph, Guelph, ON, Canada.

The objective of this study was to determine the metabolite profile of 3-methylindole (skatole) in porcine hepatocytes. Hepatocytes were prepared from six gilts and incubated with skatole. Media was extracted after 0, 15, 30, and 60 minutes of incubation, and metabolites were quantified using HPLC-UV and HPLC-Fluorescence. The rate of production of each metabolite was determined and metabolites were expressed as a percent of the total metabolites produced. There were four major metabolites produced in porcine hepatocytes: 3-Hydroxy-3-methyloxindole (HMOI), 3-Methyloxindole (3MOI), Indole 3-carbinol (I3C), and 6-Hydroxyskatole (6-OH-skts), which include: 6-hydroxy-3-methylindole, 6-sulfatoxyskatole, and 6-hydroxyskatole glucuronide. Two metabolite profiles were observed. HMOI and 6-OH-skts were significantly different in the two profiles while 3MOI and I3C were not ($p = 0.05$). Profile 1: $18.3\% \pm 4.5$ HMOI, $17.9\% \pm 2.0$ 3MOI, $2.0\% \pm 0.4$ I3C, and $61.9\% \pm 6.0$ 6-OH-skts. Profile 2: $52.7\% \pm 3.1$ HMOI, $18.8\% \pm 3.1$ 3MOI, $2.1\% \pm 0.5$ I3C, and $26.5\% \pm 4.5$ 6-OH-skts. Regression analysis revealed that HMOI and 6-OH-skts are negatively correlated ($R^2 = 0.9379$). Increased production of 6-hydroxyskatole has been associated with efficient skatole clearance. The skatole metabolite profiles reported here using hepatocyte incubations agree more closely to in vivo profiles of skatole metabolism than to in vitro profiles. This suggests that hepatocyte incubations are a useful model for the study of skatole metabolism. Future research will focus on determining the key enzymes involved in skatole metabolism in pigs.

Key Words: Skatole, Boar taint

851 Influence of sex class and slaughter weight on meat quality of pig. M.A. Latorre^{*1}, M. Nieto², M.D. Garcia-Cachan³, M.I. Gracia¹, and G.G. Mateos, ¹Universidad Politécnica de Madrid, Spain, ²Copese S.A., Segovia, Spain, ³Estación Tecnológica de la Carne, Salamanca, Spain.

A trial was conducted to study the influence of sex and slaughter weight on meat quality of Pietrain*Large White x Landrace*Large White pigs. There were six treatments arranged factorially with two sexes (castrates and females) and three slaughter weights (115, 124, and 133 kg). Each treatment was replicated four times and the experimental unit was formed by four loin samples (175 ± 10 g) obtained from the last rib of four pigs of each replicate chosen at random. All the animals received *ad libitum* access to a common diet based on barley, wheat, and soybean meal that contained 2,415 kcal NE/kg, 17% CP, and 0.70% total lysine. Meat color as measured by the CIELAB method was affected by slaughter weight; L* and b* values decreased, and a* and chroma values increased with increasing slaughter weight ($P < 0.01$). Meat color, however, was not affected by sex. Cooking losses were greater for females than for castrates (19.6 vs 17.9%; $P < 0.05$). Also, the loin from females tended to have greater Warner-Bratzler shear force values than meat from castrates (8.5 vs 7.7%; $P = 0.07$). Defrosting losses decreased with increasing slaughter weight (8.2, 6.6, and 5.7%, for 115, 124, and 133 kg, respectively; $P < 0.01$). Loin from castrates had less protein (23.7 vs 24.0%; $P < 0.05$) and more intramuscular fat (2.81 vs 2.33%; $P < 0.05$) than loin from females, but moisture content was not modified by sex (73.6 vs 73.8% for castrates and females, respectively; $P > 0.05$). Neither fat nor protein content of the loin was affected by slaughter weight. It was concluded that increasing slaughter weight tended to improve the color and the quality of the meat of pigs destined to the industry for cured products.

Key Words: Meat quality, Slaughter weight, Pigs

852 Effect of exercise on the activity of proteolytic enzymes in skeletal muscle and carcass quality of Iberian pigs. R. Lazaro^{*1}, F. Toldra², J.M. Ferrer², L. Silio³, M.C. Rodríguez³, and C.J. Lopez-Bote⁴, ¹Universidad Politécnica de Madrid, ²Instituto de Agroquímica y Tecnología de los Alimentos (CSIC), ³Instituto Nacional de Investigaciones Agroalimentarias, ⁴Universidad Complutense de Madrid.

A total of sixteen castrated males (two full sibs per litter) was used to study the influence of physical exercise on the activity of the proteolytic enzymes present in the skeletal muscles of Iberian pigs. There were two experimental treatments and eight animals of 111 kg of initial body weight per treatment. Pigs from one group were maintained under individual confinement conditions (3 m² per pig) and pigs from the other group were kept outdoor in individual facilities provided with a corridor of 5 m wide and 1,000 m long. Both groups received a barley-soybean meal diet provided at 9:00 a.m. and 5:00 p.m., daily. For pigs kept outdoor, the morning feed was supplied at one extreme of the corridor while the afternoon feed was supplied at the other end, forcing pigs to walk at least 2 km daily. Visual observation indicated that outdoor pigs walked and moved frequently, while indoor pigs remained resting most of the time. At the end of the trial (106 d of age and a final body weight of around 166 kg) no differences between treatments were observed for daily gain, carcass fatness measured at P₂ level, or pH of the *longissimus* ($P > 0.05$). Immediately after slaughter, a sample of the *psaos major* muscle was obtained and the activity of the proteolytic enzymes was analyzed. No significant differences between experimental groups were detected for cathepsin B, arginyl aminopeptidase and methionyl aminopeptidase ($P > 0.05$). However, the activities of cathepsin B + L (29,100 vs. 23,900 U/g muscle), alanyl aminopeptidase (12.9 vs. 11.2 U/g muscle), and dipeptidyl peptidase III (2.8 vs. 1.9 U/g muscle) were higher for confined than for outdoor kept pigs ($P < 0.05$), suggesting that the breakdown of the muscle protein was lower in exercised pigs. Therefore, exercise might improve protein accumulation by reducing protein breakdown rather than by increasing protein synthesis.

Key Words: Iberian pigs, Exercise, Proteolytic enzymes

853 Study of residual feed intake and frame type on carcass composition using Principal Component Analysis (PCA). Z. Wang^{*1}, J.A. Basarab¹, L.A. Goonewardene¹, M.A. Price², J.L. Aalhus³, E. K. Okine², and W.M. Snelling⁴, ¹Alberta Agriculture, Food and Rural Development, ²University of Alberta, ³Agriculture and Agri-Food Canada, ⁴Beefbooster, Canada, AB, Ltd..

Individual feed intakes were obtained and residual feed intakes (RFI) calculated on seventy-five spring born steer calves of three frame types, 30 from large (foundation breeds, Limousin, Gelbvieh and Charolais), 30 from medium (foundation breeds, Angus and Hereford) and 15 from small (foundation breeds, various small breeds) frame types. The animals were grouped into three (high, medium and low) RFI groups based on standard deviations from the mean. Carcass composition that included muscle, fat and bone distribution and the composition of nine wholesale cuts were analyzed by principal component analysis (PCA). For carcass composition, the first (lean) and second (fat) principal components accounted for 71.1% and 27.3% of the total variation in carcass composition respectively. There was no association between RFI groups and carcass composition. A clear association between carcass compositions and frame type was found. The results show that the large frame type cattle had more lean muscle deposition than the medium frame animals and the medium frame animals deposited more lean muscle than small frame. The association between total fat deposition and frame type showed an opposite trend. RFI is an efficiency measure related to feed intake and the differences in RFI do not translate into either difference in body tissue composition or wholesale cuts.

Key Words: Residual feed intake, Carcass composition, frame type, Principal Component Analysis

854 Oxidation and color of stored pork from pigs given supplemental magnesium through drinking water. B. R. Frederick^{*}, E. van Heugten, and M. T. See, North Carolina State University, Raleigh, NC.

Sixteen barrows and sixteen gilts (119 \pm 4 kg BW) were individually penned, provided 2.7 kg of feed (0.12% Mg) daily, and allowed free access to water via a nipple waterer for the duration of the study. Pigs were

randomly allotted by weight and sex to receive 900 ppm Mg in drinking water for 0, 2, 4, or 6 d prior to slaughter. Pigs were then transported 110 km to a commercial abattoir and slaughtered approximately 45 min after arrival. At 24 h postmortem, *longissimus* and *semimembranosus* chops were placed on styrofoam trays with absorbent pads and wrapped in oxygen permeable film for 0, 4, or 8 d of display storage at 4°C. The remaining posterior portion of the loin was split into two equal sections, vacuum packed, and stored at 4°C for 25 or 50 d. After storage, Minolta color measurements were obtained after 45 min of bloom from an interior chop of the vacuum packed loins. Magnesium addition for 2 d reduced the extent of lipid oxidation (TBARS) in the loin following 4 d of display storage compared to 0 d of Mg (145 vs. 192 ± 11 μg of malonaldehyde (MDA)/kg of tissue, $P < 0.05$). Although not different than 0 d of Mg supplementation (219 μg of MDA/kg), lipid oxidation of the ham during 8 d of display storage decreased linearly ($P < 0.02$) as duration of supplementation decreased (250, 235, and 194 ± 17 μg of MDA/kg). Magnesium addition for 2 and 4 d decreased loin lightness (L^*) and yellowness (b^*) following 25 d of storage compared to 0 d of supplementation, 51.6 and 51.9 vs. 56.4 1.1 ($P < 0.05$) and 7.9 and 8.0 vs. 9.0 ± 0.4 ($P < 0.10$), respectively. However, Mg supplementation did not affect loin color after 50 d of storage. Although not different than 0 d of Mg supplementation (183 μg of MDA/kg), lipid oxidation of the loin during 50 d of storage decreased linearly ($P < 0.03$) as duration of supplementation decreased (210, 178, and 166 ± 12 μg of MDA/kg). Magnesium supplementation through drinking water for as brief as 2 d prior to slaughter improved color of vacuum packed loins and reduced the extent of lipid oxidation of loins during retail display.

Key Words: Pork quality, magnesium sulfate, lipid oxidation

855 Effect of dietary levels of vitamin E on fiber characteristics of lamb longissimus. F. Nicastro*, L. Zezza, F. Pinto, and R. Gallo, *Department of Animal Production, University of Bari, Bari, Italy.*

Twenty-eight, 8 d old Val di Belice male lambs were injected with one of four doses of acetate DL- α -tocopheryl acetate (group I : 0 IU; group II : 800 IU; group III : 1200 IU; group IV : 1700 IU) until they reached 40 d of age. The animals were slaughtered on d 47, and samples of longissimus (LD) were collected from all animals 48 h after slaughter. The muscle samples were rolled in talcum powder prior to freezing in liquid nitrogen and left inside the cryostat for about an hour to equilibrate to -20°C. Cross sections 10 μm in thickness were cut and mounted on glass microscopic slides and were reacted with myofibrillar ATPase at alkaline pH in order to differentiate muscle fiber types according to their glycolytic capability. Reciprocal slides also were reacted with NADH-Tr to differentiate muscle fibers based on their oxidative capability. Fibers were classified into Beta-Red (Red), alpha-Red (Intermediate) and alpha-White (White) types. Sections also were stained with Oil-Red-O and hematoxylin to stain fat cells in the intercellular space. Fiber size and fat cell size were determined using a Zeiss particle size analyzer. Data were analyzed by the statistical analysis system, through the general linear model and least squares means procedures. The LD from group III had larger fiber diameter (37.5 vs 28.3 and 27.5 μm ; $P < 0.05$) than that of groups I and II. The LD from group II lambs had larger red fibers (23.5 μm ; $P < 0.05$), while no significant difference ($P > 0.05$) was noted for intermediate and white fibers. Percentages for all three fiber types were influenced by dietary level of vitamin E with a higher proportion of intermediate fibers (43.7%; $P < 0.05$) in group III lambs. No significant differences in fat cell parameters were observed among treatments. The effects of dietary vitamin E levels on muscle fiber characteristics may have implications for meat quality traits.

Key Words: lamb, diet, fiber

856 Control of dietary energy level and vitamin E intramuscular supplementation to optimize lamb meat production and quality II. Intramuscular collagen properties. A. Manchisi, F. Filetti, C. Cavone, M. Gambacorta, and G. Maiorano*, *University of Molise, Campobasso, Italy.*

A low energy level in the diet improves meat nutritional quality but can decrease meat tenderness. Our recent studies on lambs have indicated that vitamin E supplementation affects intramuscular collagen (IMC) amount and crosslinking, which are factors contributing to meat tenderness. Therefore, the aim of this study was to test a combined pattern of dietary energy level and vitamin E supplementation in lamb

in order to improve IMC properties. Twenty-four 15-d-old Ile de France male lambs were allotted within weight in a 2x2 factorial arrangement of DL- α -tocopheryl acetate supplementation (C, control = 0 and V = 150 IU/wk, i.m. injected for 8 wk) and dietary energy level (N, normal = 7.6 and L, low = 6.5 MJ/kg DM). Lambs, weaned at 22 d of age, were allowed *ad libitum* access to a weaning diet for a week and, and then to experimental diets until slaughter (71 d of age). *Longissimus* samples were taken from held (24 h at 2 to 4°C) carcasses, lyophilized and then hydrolyzed in 6N HCl for analysis of hydroxyproline (Hyp) and hydroxylsypyrindoline (HLP) crosslink. IMC amount was calculated assuming that collagen weighed 7.25 times the measured Hyp weight. HLP was quantified by RP-HPLC. Collagen amount (22.9, 23.5, 24.0 and 23.2 μg /mg of muscle for CN, VN, CL and VL, respectively) was not affected ($P > 0.05$) by studied factors. The i.m. vitamin E, associated to the N energy diet, lead to a decrease ($P < 0.05$) in HLP concentration (2.1 vs 2.7 μg /mg of muscle for VN and CN, respectively) and produced a slowing down in IMC maturation, as indicated by the HLP/IMC ratio lower ($P < 0.01$) in VN (0.06 mol/mol) than in CN (0.08 mol/mol). No differences ($P > 0.05$) due to vitamin E were found between CL and VL in HLP (2.4 and 2.3 μg /mg, respectively) and in HLP/IMC (0.07 and 0.07 mol/mol, respectively). Results show that an i.m. supplementation with 1,200 IU of DL- α -tocopheryl acetate in lambs, associated with a normal energy level in the diet, decreased collagen crosslinking in lamb *longissimus* which might improve meat tenderness.

Key Words: Intramuscular Collagen, Vitamin E, Dietary Energy

857 Control of dietary energy level and vitamin E intramuscular supplementation to optimize lamb meat production and quality I. Feedlot performance and carcass quantitative and qualitative characteristics. F. Filetti, G. Maiorano*, C. Cavone, A. Prisciantelli, M. Gambacorta, and A. Manchisi, *University of Molise, Campobasso, Italy.*

Dietary energy level and vitamin E supplementation are important factors affecting meat quality. Therefore, this study was conducted to test a combined pattern of these two factors in lamb in order to optimize lamb meat production and quality. Twenty-four 15-d-old Ile de France male lambs were allotted within weight in a 2 x 2 factorial arrangement of DL- α -tocopheryl acetate supplementation (C, control = 0 and V = 150 IU/wk, i.m. injected for 8 wk) and dietary energy level (N, normal = 7.6 and L, low = 6.5 MJ/kg DM). Lambs, weaned at 22 d of age, were allowed *ad libitum* access to a weaning diet for a week and then to the experimental diets. Live weight and feed intake were weekly evaluated. At 71 d of age lambs were slaughtered and carcass weight was recorded after dressing and after chilling at 2 to 4°C for 24 h. In addition, pelvic limb weight, metacarpal growth plate width, *longissimus* (LD) area and pH (45 min and 24 h postmortem = pH_1 and pH_u , respectively) were measured. Feedlot performance, carcass weights, dressing percentages, metacarpal growth plate ossification, and LD area were not affected ($P > 0.05$) by studied factors. Regardless of dietary energy level, vitamin E supplementation reduced carcass shrink losses (over 10 %; $P < 0.05$) and pelvic limb percentage (10.3 and 10.3 vs 12.4 and 12.0 % for VN, VL, CN and CL, respectively; $P < 0.01$). Both pH values were higher ($P < 0.05$) in vitamin E treated lambs ($\text{pH}_1 = 6.49$ and 6.64, $\text{pH}_u = 5.70$ and 5.73 for VN and VL, respectively) than in controls ($\text{pH}_1 = 5.86$ and 6.13, $\text{pH}_u = 5.60$ and 5.64 for CN and CL, respectively). Results suggest that care must be taken in supplementing young lambs with i.m. 1,200 IU of DL- α -tocopheryl acetate, especially for the occurrence of negative effects on pelvic limb growth.

Key Words: Lamb, Vitamin E, Dietary Energy

858 Application of a sensitive and robust ELISA for haptoglobin measurement in meat juice and its relation to blood haptoglobin concentrations. S. Hiss^{1,2}, S. Knura-Deszczka¹, G. Regula³, B. Petersen¹, and H. Sauerwein*¹, ¹Bonn University, ²Biofocus GmbH, Recklinghausen, Germany, ³Swiss Federal Veterinary Office, Bern, Switzerland.

Quantification of haptoglobin (Hp), an acute phase protein, in blood is presently discussed as being useful to monitor animal health and welfare. We developed an ELISA which is specific for porcine Hp, is not impaired by hemolytic samples and is sufficiently sensitive to be applied in meat juice. Hp was purified from porcine serum after Na_2SO_4 precipitation by affinity chromatography on hemoglobin-sepharose followed by gel filtration. Purity and identity were confirmed by SDS-PAGE.

Specific rabbit antisera were obtained. Biotinylated porcine Hp was used as tracer and incubated with Hp standard or sample in microtiter plates coated with anti rabbit sheep IgG Fc fragments. After adding the specific rabbit antiserum, plates were incubated for 1 h, washed and evaluated using the streptavidin peroxidase system. The limit of detection was 0.02 mg/L, parallelism of serum and meat juice dilutions was proven, and the recovery of Hp added to serum samples was 99.6%. The coefficients of intra- and inter-assay variation were 3.3 (n=5) and 10.2 (n=16), respectively. At slaughter, after CO₂ stunning, blood and muscle samples (diaphragmatic pillar [DP] and m. brachiocephalicus [MB]) were collected from 106 hybrid slaughter pigs (100-110 kg). Meat juice was obtained after freezing and thawing the muscle samples. Concentrations [mean (SD)] were 0.39 (0.5) mg/mL in blood, 0.04 (0.06) mg/mL in DP juice, and 0.06 (0.06) mg/mL in MB juice. Hp concentrations in blood were correlated with those in DP juice ($P < 0.001$; $r = 0.750$) and MB juice ($P < 0.001$; $r = 0.776$). In view of the many reports on Hp measurements being predictive for animal health even in the subclinical range, we conclude that Hp quantification in meat juice might be a useful parameter to assess the potential impact of animal health on meat quality at slaughter and further along the processing chain.

Key Words: Haptoglobin, Acute phase protein, Pig production

859 Estimation of Canadian and European lean yields and composition of pig carcasses by dual-energy X-ray absorptiometry. M. Marcoux^{*1,2}, J.F. Bernier², and C. Pomar¹, ¹Agriculture and Agri-Food Canada, Lennoxville, Québec, Canada, ²Université Laval, Sainte-Foy, Québec, Canada.

Dissection is the preferred reference method for the determination of carcass lean yield. However, this method is time-consuming, expensive and subject to biases. Dual-energy X-ray absorptiometry (DEXA) capabilities to estimate dissected tissue masses in primal cuts and overall carcasses was studied on 136 pig carcasses selected in a commercial slaughterhouse in a 2x3x3 factorial arrangement. Sex (barrows and gilts), fat depth at the last rib, 7 cm off the mid-line (< 15.8 , 15.8 to 19.8 and > 19.8 mm) and carcass weight (75.5 to 81.8, 81.9 to 86.2 and 86.3 to 92.7 kg) were the main factors. Using the same number of observations for each subclass, including the less frequent ones, increased prediction model robustness. Alternately, right and left half carcasses were separated into primal cuts (shoulder, ham, belly and loin), scanned by DEXA, dissected and lean yield calculated according to the Canadian method. The other side was dissected and lean yield calculated according to the European method. DEXA readings were used to predict weight of lean, fat (including skin), bone and total weight of primal cuts and carcasses, and to predict the Canadian and the European lean yields. The best relationships were obtained when predicting ham ($R^2 = 0.99$, $RSD = 0.06$), loin ($R^2 = 0.99$, $RSD = 0.07$), shoulder ($R^2 = 0.96$, $RSD = 0.14$), belly ($R^2 = 0.93$, $RSD = 0.14$), half carcass ($R^2 = 0.98$, $RSD = 0.27$), ham lean ($R^2 = 0.89$, $RSD = 0.19$), loin lean ($R^2 = 0.89$, $RSD = 0.18$) and shoulder lean ($R^2 = 0.87$, $RSD = 0.20$) weights, and the meat weight used in the estimation of the Canadian ($R^2 = 0.92$, $RSD = 0.44$) and the European lean ($R^2 = 0.82$, $RSD = 0.60$) yields. While fat weight in carcass and primal cuts was accurately estimated by DEXA ($R^2 \geq 0.72$, $RSD \leq 0.58$), DEXA was less accurate when predicting dissected bone weights ($R^2 \leq 0.54$, $RSD \geq 0.10$). DEXA measurements can be used to predict lean yields, dissected lean from pig carcasses and primal cuts, but not dissected bone weights.

Key Words: Pigs, Carcass grading, X-radiation

860 Comparing the Canadian lean yield predicted from Destron and Hennessy probe measurements in pork. C. Pomar^{*}, J. Rivest, and M. Marcoux, Agriculture and Agri-Food Canada, Lennoxville, Québec, Canada.

In Canada, grading methods based on Destron (PG-100) (DPG) and Hennessy (HGP2) (HGP) probe measurements were last time approved in 1994. However, today hog carcasses are heavier and leaner. The objective of this study was to verify if both grading methods predict similar lean yields and grading indexes in modern pork carcasses. For each carcass, selected databases included information on hot carcass weight and backfat and muscle depths measured with both probes. Probes had to be inserted alternatively at the Canadian grading site by a certified operator under experimental conditions. Databases included (1) 1458 carcasses probed in the 1992 Canadian National Cutout, (2) 500 carcasses probed in 1997, (3) 82 carcasses probed in 1998 by the Fdration des

Producteurs de Porc du Québec and (4) 270 carcasses probed during the revision of the grading system in 1999. Lean yield prediction equations were those used in Canada since 1994. Grading indexes were attributed according to the 1999 official grid. The null hypothesis for the difference between the HGP and DPG predicted lean yields and HGP AND DPG attributed indexes was tested with the non-parametric Wilcoxon signed-rank test. The relationships between HGP and DPG predicted lean yields and between HGP and DPG indexes were studied by regression analysis. For the four databases used, HGP-DPG lean yields were different from zero ($P < 0.001$) with values of 0.32, 0.35, 0.38, and 0.18, in chronological order. HGP-DPG grading indexes also were different from zero with values of 0.51 ($P < 0.0001$), 0.36 ($P < 0.0001$) and 0.50 ($P < 0.0001$), 0.21 ($P < 0.09$), respectively. Regression analyses between HGP and DPG predicted lean yields and between HGP and DPG indexes indicated that the underestimation of lean yields and indexes by the DPG method increased with increasing carcass leanness.

Key Words: Swine, Carcass grading, Invasive probes

861 Estimating the Canadian lean yield and European lean content of pork carcasses based on different methodologies for measuring fat and muscle depth. C. Pomar^{*1}, A. Fortin², and M. Marcoux¹, ¹Agriculture and Agri-Food Canada, Lennoxville, Québec, Canada, ²Agriculture and Agri-Food Canada, Lacombe, Alberta, Canada.

Research was undertaken to evaluate the precision of different classification probes for measuring backfat thickness and muscle depth, to compare classification techniques used in Canada and France and to develop current equations for predicting Canadian lean yield (CLY) and European lean content (TVM). Two hundred seventy pig carcasses were selected in a commercial slaughterhouse in a 2 x 3 x 3 factorial arrangement. Sex (barrows and gilts), fat depth at the last rib, 7 cm off the mid-line (< 15.75 , 15.75 to 19.75 , and > 19.75 mm) and carcass weight (75.5 to 81.8, 81.9 to 86.2, and 86.3 to 92.7 kg) were the main factors. Forcing each sex, weight and fat depth classes to have the same observation number increased prediction model robustness. Hennessy (HGP2), Destron (PG-100) and CGM optic probes were used according to the Canadian and French CGM methods. The CVT ultrasound probe was used with two transducers (PCA-5049, 172 mm and PCB-5011, 125 mm). Both sides of each carcass were dissected alternatively according to the Canadian and European cutout methods. All probes precisely measured backfat thickness ($R^2 \geq .79$, $RSD \leq 1.87$ mm), but they were less precise in estimating muscle depth ($R^2 \leq .41$, $RSD \geq 3.55$ mm). They were not effective measuring the intercostal muscle depth ($R^2 \leq .09$, $RSD \geq 2.72$ mm). When predicting CLY or TVM, adding fat or muscle depths as quadratic terms or their interactions to a model, which already included fat and muscle depths, did not improve ($P \leq 0.05$) the R^2 or decrease ($P \leq 0.05$) the RSD. Sex identification, perforation angle or inclusion of an additional measurement site or carcass weight did not greatly reduce the model RSD. According to the Canadian method, observed RSD for predicting CLY were 1.52, 1.53, 1.62, 1.67 and 1.82, respectively, and 2.14, 2.15, 2.24, 2.24, 2.52 when predicting TVM. Overall, the CVT-PCB-5011 probe produced the smallest RSD when predicting the CLY or TVM. The Hennessy, CVT-PCA-5049, CGM and Destron probes followed in that order.

Key Words: Swine, Carcass grading, Grading probes

862 Use of 25-hydroxyvitamin D₃ to improve beef tenderness. A. E. Wertz^{*1}, A. Trenkle¹, R. L. Horst², F. C. Parrish¹, E. J. Huff-Lonergan¹, T. J. Knight¹, R. N. Sonon¹, and D. C. Beitz¹, ¹Iowa State University, Ames, IA, ²National Animal Disease Center, USDA-ARS, Ames, IA.

Previous research in our laboratory has indicated that plasma calcium concentration remained elevated after the oral administration of 25-hydroxyvitamin D₃ (25-OHD) had been terminated. We hypothesized that a one-time oral bolus of 25-OHD would be sufficient to elevate plasma and tissue calcium concentrations so that the calcium-dependent protease system could more rapidly degrade myofibrillar proteins post-mortem and result in more tender beef. The objective of this trial was to evaluate the effects of a one-time oral bolus of 25-OHD on plasma calcium concentration and tenderness of loin steaks from beef cattle. Continental crossbred steers (n=108) were allotted to 18 pens (six head per pen). Treatments were 25-OHD dosage (62.5 or 125 mg) and time before harvest (35, 21, 7, or 4 d). Each dosage by time combination

was assigned randomly to two pens, and two pens served as the control, receiving no 25-OHD. A blood sample was collected at harvest for control and all treatment groups. A 2.54-cm loin steak was removed at 48 h postmortem, vacuum packaged, and aged at 2°C to d 6 postmortem. Steaks from one-half of the cattle in each pen were used for measurement of Warner-Bratzler shear force and troponin-T degradation as indicators of muscle tenderness. Average DM intake, ADG, and feed efficiency did not differ ($P > 0.05$) as a result of 25-OHD treatment. The one-time oral bolus of 25-OHD, regardless of time of administration, did not elevate ($P > 0.05$) the calcium concentration of plasma collected at harvest. Warner-Bratzler shear force averaged 4.0 kg among treatments and did not differ ($P > 0.05$) as a result of 25-OHD treatment. The intensity of the 30 kDa protein component of troponin-T degradation was not different ($P > 0.05$) as a result of 25-OHD treatment. Additionally, hot carcass weight, fat thickness, quality grade, yield grade, and longissimus area were not different ($P > 0.05$) as a result of 25-OHD treatment. Administration of a one-time oral bolus of 25-OHD 35, 21, 7, or 4 d before harvest was not sufficient to result in elevated plasma calcium concentration at harvest or in the improved tenderness of the loin steak at 6 d postmortem.

Key Words: 25-Hydroxyvitamin D₃, Beef, Tenderness

863 The effect of antemortem harvest conditions on stress and meat quality in Muskox. A.L. Schaefer^{*1}, W.M. Robertson¹, J.L. Aalhus¹, J.A. Nagy², and B. Elkin³, ¹*Agriculture and Agri-Food Canada, Lacombe, AB*, ²*Dept. Resources, Wildlife and Economic Development, Inuvik, NWT*, ³*Dept. of Resources, Wildlife and Economic Development, Yellowknife, NWT*.

Banks Inland, Northwest Territories supports a large population of muskoxen (*Ovibos moschatus*). Muskoxen are harvested for subsistence use and for export of meat, quiviut and hides. The purpose of the present study was to examine the impact of harvest conditions (gathered or field shot) on indices of stress and meat quality. Data are reported from 36 animals from 2 to 4 years of age and represented both males and females. For gathered animals (n=20) the muskoxen were herded from approximately 22 km distance in one day prior to holding overnight in a capture pen. The animals were provided with hay treated with glucose, amino acids and electrolytes in the preslaughter capture pen. The animals were allowed to rest for 12 hours prior to slaughter. For field shot animals (n=16), the muskoxen were located on their natural range and shot within minutes of discovery. Immediately postmortem blood samples were collected into EDTA tubes from which blood smears were prepared and differential white blood cell counts measured. For gathered animals, one carcass side was frozen and one side held at approximately 4 to 5°C for 24 h postmortem. Muscle pH in the longissimus lumborum (LL) was measured at the 12th rib approximately 24 h postmortem. Muscle colour on thawed samples was measured on the longissimus thoracis (LT) at 7 days postmortem. Neutrophil/lymphocyte ratios (N/L) in gathered animals averaged 2.17 (0.95 SD) which were higher ($P < 0.01$) than the N/L ratios seen in the field shot animals 0.59 (0.29). Muscle pH also was relatively high in gathered animals averaging 6.59 (0.19). Objective colour in the LT was slightly dark, displaying L*, a* and b* values of 29.52 (2.0), 16.66 (2.56), and 6.26 (1.73), respectively. The data suggest that gathering and lairage can be stressful events for wild muskox with detrimental effects on meat quality attributes.

Key Words: Muskox, Stress, Meat Quality

864 Effect of cooking methods on camel meat quality. I.B. Hashim^{*}, *United Arab Emirates University, Al-Ain, UAE*.

In the Gulf region, during the pre-oil period the camel (*Camelus dromedaries*) was the main source of food (meat and milk). Due to

the socio-economic changes in the United Arab Emirates camel meat is consumed mainly during social ceremonies. Meat of young camels, below 3 years, is comparable in taste and texture to beef. But usually camels are slaughtered at an older age, which results in greater meat toughness. The objectives of the study were to investigate the effect of cooking methods (roasting, braising, grilling and microwaving) on: cooking loss, moisture and fat content, sensory quality (appearance, color, odor, taste, tenderness, and juiciness) and overall acceptance of cooked camel meat. Sixty-four female students were selected to evaluate the cooked meat using 9-point hedonic scale (1=extremely dislike and 9=extremely like). Fat content was not affected ($P > 0.05$) by cooking method. Cooking loss (62.1 and 60.9%) was significantly higher ($P < 0.05$) while moisture content (36.4 and 38.2%) was significantly lower ($P < 0.05$) for grilled and roasted meat, respectively, compared to braising or microwaving. Roasted camel meat was significantly more ($P < 0.05$) juicy (7.8) and tender (7.5) compared to the meat cooked using other cooking methods (5.9 to 6.9 for juiciness) and (6.2 to 6.6 for tenderness). Roasted camel meat had the highest ratings for all sensory attributes, including overall acceptance (7.8), compared to meat cooked using the other methods, and thus, roasting is the best method for cooking camel meat.

Key Words: Camel meat, Cooking methods, Sensory quality

865 Pharmacological modulation of nitric oxide in beef longissimus lumborum causes chemical, not physiological changes to meat quality. J.J. Cottrell^{*1,2}, F.R. Dunshea², and R.D. Warner^{1,2}, ¹*Victoria University, Werribee, Victoria, Australia*, ²*Natural Resources and Environment, Werribee, Victoria, Australia*.

The *longissimus lumborum* (LL) was hot-boned at 25 min postmortem from 42 Hereford or Hereford cross beef carcasses (191 to 244 kg hot carcass weight) and injected with the nitric oxide (NO) donor sodium nitroprusside (SNP) and substrate inhibitors of nitric oxide synthase (NOS) to determine the effect of nitric oxide (NO) on meat quality. Solutions consisting of saline (0 mM), SNP (1, 10 and 100 mM) or the NOS inhibitors (90% L N^g-N-nitro-L-arginine methyl ester hydrochloride and 10% N-nitro-L-arginine, NOS-) (1, 10 and 100 mM) were randomly allocated to each LL and injected 10% w/w in a 2 x 1 cm matrix. Data were analysed using ANOVA within SNP and NOS- treatment concentrations (0, 1, 10, 100 mM). SNP and NOS- did not affect Warner-Bratzler shear force (5.2, 5.1, 6.5, and 5.9, $P=0.46$ and 5.2, 5.6 and 7.1 kg/cm², $P=0.227$ for 0 and 1, 10 and 100 mM NOS- and SNP) or myofibrillar fragmentation index (76, 83, 72, and 73, $P=0.87$ and 84, 88, 70 units $P=0.65$ 0 and 1, 10 and 100 mM NOS- and SNP) after 14 d of aging. Meat oxidation, measured by thiobarbituric acid reactive substances (TBARS), was inversely proportional ($P < 0.001$) to SNP concentration (0.071, 0.686, 0.441, and 0.011 g malonaldehyde/kg meat, for 0 and 1, 10 and 100 mM SNP, respectively), while oxidation was unaffected by NOS- in LL aged for 14 days (0.062, 0.082, and 0.179, for 1, 10 and 100 mM NOS-; $P=0.11$). Since NO is an oxidant it should increase oxidation as seen by the 1mM SNP dose. However doses above 1mM may have resulted in reactions with cyanide, a breakdown product of SNP, thus, reducing the oxidation initiated by NO, and therefore, SNP caused chemical, not NO mediated, effects on meat quality. NOS activity is O₂ dependent and most likely maximally inhibited postmortem. If so, then substrate inhibitors will be unable to further reduce NOS activity. In conclusion, it appears that SNP is not suitable to use as a NO donor in meat because of its degradation to cyanide over time and its reduction of NOS activity in hot-boned beef LL. *Supported in part by Meat and Livestock Australia.*

Key Words: Nitric oxide, Meat quality, Bovine

Nonruminant Nutrition Nutrient Metabolism and Feed Evaluation or Processing

866 Predicting amino acids in triticale by NIRS and simple regression equations. S. Jaikaran^{*}, E. Prommer, D. Salmon, H. Hsu, and G. Recinos-Diaz, *Alberta Agriculture Food and Rural Development*.

The routine determination of amino acid composition of triticale is of major interest to animal nutritionists who use this data for the precise

and accurate formulation of diets for monogastric animals. Chemical analysis for amino acids is labour intensive, costly and produces chemical effluents which are environmentally destructive. In addition, this method destroys the original sample. A new technology for nutrient analysis is available in the form of Near Infrared Spectroscopy (NIRS) which is rapid, cost effective, more accurate, environmentally friendly

(uses no chemicals) and requires less labor input than traditional chemical analysis methods. This study utilized 674 whole grain triticale samples from which 60 were selected by NIRS for chemical analysis using HPLC. The data were used to develop linear regression equations for calculating amino acids from crude protein and to calibrate the NIRSystem 6500 to measure protein, moisture and 18 amino acids in triticale. Regression equations for thirteen amino acids had R² values of 0.80 and higher while two were between 0.70 and 0.80. Methionine, cystine and tryptophan had the lowest R²; 0.55, 0.59 and 0.55, respectively, with lysine at 0.74. R² values for NIRS calibrations to predict amino acid content in both whole and ground triticale were slightly better than linear regression equations, being about ten points higher overall.

Key Words: Triticale, Amino acids, Near infrared spectroscopy

867 Evaluation of maternal muscle protein mobilization during lactation in first-litter sows of differing body size. E. J. Clowes^{*1}, F. X. Aherne¹, A. L. Schaefer², and V. E. Baracos¹, ¹University of Alberta, Edmonton, AB, Canada, ²Agriculture and Agri-Food Canada, Lacombe, AB, Canada.

Our objective was to predict muscle mobilization in lactating first-litter sows using measures that can be made on live animals in real time. In a 2 x 2 factorial design, 77 Genex gilts were fed to achieve a standard or high body mass at parturition and to lose a moderate (MPL) or high (HPL) amount of muscle in lactation. Muscle mass was determined objectively by carcass cutout at slaughter (d 26) within a few hours of weaning. We measured body weight (BW), and used ultrasound to determine backfat depth (BF), loin muscle area, and loin depth (LD) at three sites throughout gestation and lactation. A chilled half-side of the carcass was divided into the primal cuts (shoulder, loin, ham and belly). The mass of muscle and fat tissue in all primal cuts, except the belly, was measured after dissection. A triceps muscle sample was collected at slaughter to determine various biochemical measures which were also used to formulate the prediction equations for muscle mass. The gestational feeding resulted in two clearly distinct groups of animals with mean body weights of respectively 193 and 165 kg at parturition. The HPL sows lost more ($P < 0.001$) muscle tissue in lactation (-17 vs -24 1.6% muscle mass at parturition) than MPL sows, but fat losses did not differ between treatments (-13% fat mass at parturition). Large losses of muscle protein mass were associated with decreased muscle RNA:DNA ratio ($P < 0.05$), protein:DNA ratio ($P < 0.01$) and muscle protein concentration ($P < 0.01$). The mass of fat ($r^2 = 0.79$) tissue could be predicted from body weight and backfat according to the equation: fat (kg) = $-7.75 (2.69) + 0.078 (0.018) BW + 0.762 (0.074) BF$. The mass of muscle tissue could be predicted from body weight and backfat alone ($r^2 = 0.83$), however this was improved by the addition of loin-eye area ($r^2 = 0.86$) and protein:DNA ratio ($r^2 = 0.84$). The best prediction of muscle mass was from body weight, backfat depth and loin depth ($r^2 = 0.87$): muscle (kg) = $-2.23 (3.66) + 0.303 (0.031) BW + 0.494 (0.123) LD \# 0.959 (0.127) BF$.

Key Words: Sow lactation, Protein loss, Skeletal muscle

868 Ileal endogenous crude protein and amino acid outputs and true ileal amino acid digestibility values associated with soybean meal are affected by growth stages of pigs. K. Bregendahl^{*}, L. Liu, T. Archbold, and M. Z. Fan, University of Guelph, Guelph, Ontario, Canada.

An experiment was conducted to determine distal ileal endogenous CP and AA outputs and true ileal CP and AA digestibility values associated with soybean meal (SBM, 48% CP) for post-weaned pigs by the regression analysis technique and to examine effects of growth stages on the endogenous CP and AA outputs and true AA digestibility values. Four barrows, with average initial and final BW of 7 and 21 kg, respectively, were fitted with a T-cannula at the distal ileum, and fed four cornstarch-based diets according to a 4 x 4 Latin square design. The four diets contained 6.5, 13.1, 19.7, and 26.3% CP (as-fed basis) from SBM, respectively. Chromic oxide (0.4%) was used as an indigestible marker. Each experimental period consisted of 4 d of adaptation and 4 d of ileal digesta collection. Data were compared with results reported in our previous study with growing-finishing (35-79 kg BW) pigs (Fan et al., 1995, J. Anim. Sci. 73:2319-2328) using a two-tailed t-test. The true ileal CP and AA digestibility values (%) of SBM were not different ($P > 0.05$) between post-weaned and growing-finishing pigs with the exception ($P < 0.05$) of Glu (89.8 \pm 2.0 vs 88.3 \pm 1.4), Leu (92.1 \pm 1.5

vs 90.5 \pm 0.8), Ser (93.1 \pm 1.7 vs 89.2 \pm 0.9), Thr (90.6 \pm 1.7 vs 86.6 \pm 1.2), and Tyr (90.3 \pm 2.1 vs 92.7 \pm 0.7). The ileal endogenous outputs (g/kg DMI) of CP (10.8 \pm 3.0 vs 16.5 \pm 2.1), Ala (0.38 \pm 0.18 vs 0.59 \pm 0.09), Asp (0.59 \pm 0.35 vs 0.90 \pm 0.18), Glu (0.38 \pm 0.95 vs 1.06 \pm 0.35), Gly (0.77 \pm 0.17 vs 1.17 \pm 0.16), Ile (0.33 \pm 0.12 vs 0.46 \pm 0.08), and Lys (0.17 \pm 0.35 vs 0.47 \pm 0.10) were lower ($P < 0.05$), whereas Met (0.17 \pm 0.05 vs 0.13 \pm 0.02) and Phe (0.52 \pm 0.23 vs 0.31 \pm 0.10) were higher ($P < 0.05$) in post-weaned than in growing-finishing pigs. No effects ($P > 0.05$) of growth stages on the ileal endogenous outputs of Leu, Ser, Thr, and Tyr were observed. In conclusion, distal ileal endogenous CP and AA outputs and true ileal AA digestibility values associated with SBM are affected by the growth stages of pigs.

Key Words: Endogenous outputs, True ileal AA digestibility, Pigs

869 Ileal amino acid digestibilities by pigs fed soybean meal samples from five different countries. L. K. Karr-Lilienthal^{*}, N. R. Merchen, C. M. Greishop, M. A. Flahaven, and G. C. Fahey, Jr., University of Illinois, Urbana-Champaign.

Conditions used in the processing of soybeans (SB) have an effect on digestibilities of amino acids (AA) found in the resultant soybean meal (SBM). This study evaluated SBM from five major SB-producing countries (US, Brazil, Argentina, China, and India). An industry representative in each country collected samples of unprocessed SB, and SBM subjectively determined to be of high, intermediate, and low quality. The SB from each country were processed under uniform conditions to SBM in the US. Five experiments (each examining SBM from one country) were conducted to determine apparent and true AA digestibilities in diets containing these SBM. Pigs were fitted with simple T-cannulas at the terminal ileum and allotted to treatments in Latin square designs. Within each experiment, diets included the respective SBM processed in the US, the high, intermediate, or low quality SBM processed within the country, and a common SBM used as a control. Data from pigs fed a low protein casein diet in each study were used to calculate true AA digestibilities. Within each country comparison, pigs fed the SBM processed in the US had lower ($P < 0.05$) true N and lys digestibilities than pigs fed any of the SBM processed within the country of origin except the US. This indicates that conditions at the US processing plant were not appropriate for SB from other countries. True N and lys digestibilities of the diets containing the high, intermediate, and low quality SBM did not follow expected patterns. There were no differences ($P > 0.05$) in N and lys digestibilities of the different quality SBM from India or Brazil. Pigs fed low quality SBM from the US and China had lower ($P < 0.05$) digestibilities of N and lys than pigs fed the intermediate and high quality SBM from these countries. Pigs fed the low and intermediate quality SBM from Argentina had higher ($P < 0.05$) digestibilities of lys than pigs fed the high quality SBM. These results indicate that differences in digestibilities of AA existed among SBM from these countries, but subjective quality estimations did not accurately reflect these differences.

Key Words: Swine, Soybean meal, Amino acid digestibilities

870 Ileal nutrient digestibilities by pigs fed selected soybean meals. E.L. Propst^{*}, D.M. Albin, M.R. Smiricky, C.M. Grieshop, V.M. Gabert, N.R. Merchen, and G.C. Fahey, Jr., University of Illinois, Urbana, IL 61801.

An experiment was conducted to evaluate apparent and true ileal nutrient digestibilities by growing pigs fed soybean meals (SBM) produced from soybeans (SB) collected from the major SB-producing countries and processed under uniform conditions at one location in the United States (US). Seven pigs were surgically fitted with a simple T-cannula at the distal ileum and fed semipurified diets in a 7 x 7 Latin square design. Treatments included five diets containing SBM produced from SB grown in Argentina, Brazil, China, India, or US, and two diets containing either a control SBM or casein. The SB were collected by an American Soybean Association representative located within each country and brought to the US where processing conditions were standardized. All SBM diets were formulated to contain 17% crude protein (CP), excluding the casein diet (4.43% CP), which was used to estimate endogenous nitrogen losses for calculation of true ileal amino acid digestibilities. Apparent and true ileal digestibilities of CP, total essential amino acids (TEAA), total non-essential amino acids (TNEAA), and total amino acids (TAA) were lower ($P < 0.05$) for pigs fed diets containing SBM from India SB

compared to all other diets. Conversely, pigs fed the US and control diets had the highest ($P < 0.05$) ileal digestibilities of CP, TEAA, TNEAA, and TAA. Pigs fed SBM from India SB also had the lowest ($P < 0.05$) apparent and true digestibilities of the sulfur amino acids (methionine and cysteine) and threonine, the first- and second-limiting amino acids (AA) in SBM, respectively. The US and control SBM diets had the highest ($P < 0.05$) true digestibilities of methionine and threonine. Oligosaccharide intakes varied ($P < 0.05$) among pigs fed SBM from different countries; however, only raffinose digestibilities were significantly different among diets, with SBM from Brazil SB exhibiting the highest ($P < 0.05$) digestibility. Soybean meals made from SB grown in different regions of the world vary widely in nutrient intakes and digestibility at the ileum of swine.

Key Words: Swine, SBM, Digestibility

871 Effect of dietary L-carnitine and oil supplementation on the metabolic response to handling in finishing pigs. T. M. Bertol^{*1,2}, M. Ellis¹, D. N. Hamilton¹, and E. W. Johnson¹, ¹University of Illinois at Urbana-Champaign, ²CNPq-Brazil.

A study was carried out to evaluate the effect of dietary L-carnitine and oil supplementation on acid-base balance and energy source utilization in slaughter weight pigs. The study was carried out as a 2 x 2 factorial with two levels of L-carnitine (0, 150 ppm) and two levels of oil (0, 5%). Pigs (BW = 91.6 ± 0.4 kg) were housed in mixed-sex groups of five and had *ad libitum* access to corn/soybean meal based diets (0.68% digestible lysine, 3340 kcal ME/kg) for three weeks. At the end of the feeding period (BW = 110.4 ± 6.78 kg), pigs were subjected to a standard handling procedure, which consisted of moving the pigs individually through a facility (12.2 x 0.91 m) for eight laps (up and down the facility), using electric prods (2 times/lap). Blood was collected from the jugular vein one h before (to establish baseline values) and immediately after handling. Pigs fed 150 ppm L-carnitine had lower baseline glucose values (83.57 vs 78.48 mg/dL; $P < 0.01$). Base line values for the 5% oil treatment were higher ($P < 0.05$) for non-esterified fatty acids (42.26 vs 59.05 μ EQ/L) and lower ($P < 0.05$) for pH (7.39 vs 7.35), and base excess (9.10 vs 5.35 mmol/L). The difference between the baseline and post-handling values suggest that L-carnitine reduced ($P < 0.05$) the extent of changes in blood pH (-0.28 vs -0.22) and SO_2 (13.16 vs 0.44%), while 5% oil supplementation was associated with a greater increase in SO_2 (-1.14 vs 14.74%). There was an interaction ($P < 0.05$) between oil and L-carnitine for blood glucose and PO_2 levels. In pigs fed diets with 0% oil, there was no effect of L-carnitine on changes in these parameters, however, for the 5% oil treatment changes in blood glucose and PO_2 levels as a result of handling were lower for pigs on the 150 ppm L-carnitine level. In conclusion, dietary supplementation with L-carnitine produced a moderate improvement in blood acid-base balance during handling, whereas oil supplementation had no effect.

Key Words: Acid-base, Finishing swine, L-carnitine

872 Effect of dietary lysine and leucine levels on carcass composition, meat quality, and growth performance in finishing pigs. J. D. Kim^{*}, Y. Hyun, D. N. Hamilton, D. H. Baker, F. K. McKeith, and M. Ellis, University of Illinois, Urbana.

The objective of this study was to determine the effect of dietary levels of lysine and leucine on carcass composition, meat quality and growth performance in finishing pigs (73.2 ± 0.77 to 126 ± 1.95 kg live weight). A total of 36 individually-fed barrows were used in a 2x3 factorial with the dietary treatments as follow: 1) Lysine level (Reduced [0.5%] vs Required [0.7%]), and 2) Leucine level (Low [1.0%] vs Moderate [2.0%] vs High [3.0%]). Pigs were given *ad libitum* access to feed and water for a 6 wk-period at the end of which they were slaughtered at a commercial facility and carcass and meat quality measurements obtained. Dietary leucine level had no effect ($P > 0.05$) on growth performance. Pigs fed diets with 0.7% compared to 0.5% lysine had lower ADFI (4.82 vs 5.12 kg; SE 0.073; $P < 0.05$), however, there was no effect ($P > 0.05$) of lysine level on ADG (1.17 vs 1.15 kg; SE 0.035) or G:F (0.24 vs 0.22; SE 0.006). Loin-eye area was increased (43.1 vs 38.8 cm²; SE 0.72; $P < 0.01$) and muscle firmness scores were lower (2.0 vs 2.5; SE 0.13; $P < 0.05$) for pigs fed the Required lysine diet. Dietary leucine level had no effect ($P > 0.05$) on carcass measurements. There were interactions ($P < 0.05$) between dietary lysine and leucine level for longissimus marbling and chemical fat content. For pigs fed the Required lysine level, there was no effect ($P > 0.05$) of leucine level on either marbling (2.5

vs 1.8 vs 1.8 for the Low, Moderate, and High leucine levels, resp.; SE 1.03) or fat content (2.0 vs 2.0 vs 2.1 %, resp.; SE 1.00). However, on the Reduced lysine diet both marbling (2.7 vs 3.7 vs 4.0, resp; SE 1.03) and fat content (2.4 vs 4.4 vs 3.7 %, resp.; SE 1.00) increased ($P < 0.05$) with increasing dietary leucine level. In conclusion, dietary leucine level increased longissimus fat content in lysine deficient diets but not in lysine-adequate diets.

Key Words: Lysine, Leucine, Meat quality

873 The effect of ractopamine dose and duration of feeding on growth performance and carcass characteristics of finishing pigs. T. A. Armstrong^{*1}, D. J. Ivers¹, J. R. Wagner¹, D. B. Anderson¹, D. J. Jones¹, W. C. Weldon¹, K. R. Maddock², and E. P. Berg², ¹Elanco Animal Health, Greenfield, IN, ²Univ. of Missouri, Columbia.

A total of 400 Dekalb EB sired barrows were used to evaluate effects of dietary ractopamine (RAC, Paylean[®], Elanco Animal Health) concentrations (0, 5, 10, or 20 ppm) and feeding durations (1 to 5 wk) on growth performance and carcass characteristics. Barrows were randomly assigned to pens (5 per pen) based on weight to achieve five weight blocks of 16 pens, representing one to five weeks of feeding. The lightest block averaged 79.8 kg and the heaviest block averaged 103.8 kg at trial initiation, to target an experiment-wide average final slaughter weight of 109 kg. Within each weight block, pens were randomly assigned to a control diet (18.5% CP, 1.13% lysine) containing one of the four dietary concentrations of RAC. Pigs and feeders were weighed weekly, and the weight blocks (80 barrows per block) were sent to a commercial packing plant after 6, 13, 20, 27, or 35d on test. Overall, RAC improved ($P < 0.05$) ADG during each time period; however, the response was not consistent over time. During each time period, RAC fed pigs had an improved ($P < 0.05$) gain:feed (G:F), and after 3, 4, and 5 wk of feeding, pigs fed 20 ppm RAC had improved ($P < 0.05$) G:F compared to lower dietary RAC concentrations. Hot carcass weight (HCW) was increased ($P < 0.05$) by RAC after 2 to 5 wk of feeding. After 4 and 5 wk, 20 ppm pigs had increased ($P < 0.05$) HCW compared to pigs fed 5 and 10 ppm, respectively. The NPPC fat-free lean estimate and the 10th rib loin muscle area were increased ($P < 0.05$) by 10 and 20 ppm RAC after 4 wk and by 20 ppm RAC after 5 wk. Japanese and NPPC color scores and Hunter color values for the fresh loin were not affected ($P > 0.05$) by RAC. Dietary RAC addition improved ADG, HCW, and G:F, and barrows fed higher RAC concentrations were more efficient at utilizing feed for gain. In addition, feeding RAC for 4 to 5 wk resulted in more consistent carcass results.

Key Words: Ractopamine, Pigs, Pork

874 Apparent ileal amino acid digestibility in sorghum, corn and wheat for growing pigs. B.A. Araiza, M. Cervantes^{*}, S. Espinoza, V.M. González, M. Cervantes, N. Torrentera, and L. Avendaño, ICA, Universidad Autónoma de Baja California, Mexicali.

One experiment was conducted to determine the apparent ileal digestibility (AID) of amino acids (AA) in corn, grain sorghum and wheat for growing pigs. Six pigs fitted with cannulas in terminal ileum were used during three experimental periods, according to a replicated 3 x 3 Latin Square design. Pigs were adapted for seven days to the experimental diets, followed by two days of ileal sample collection in each period. The experimental diets were formulated with each of the evaluated cereal grains, and supplemented with vitamins and minerals. Digestibility (%) and grain content (g/kg) of digestible amino acids in corn, grain sorghum, and wheat were: Arginine 80.9, 70.6, 83.9, and 3.6, 2.6, 4.4; Histidine, 82.0, 71.3, 84.0, and 2.3, 1.6, 2.1; isoleucine, 70.6, 68.0, 77.2, and 2.1, 2.4, 2.8; leucine, 80.4, 76.1, 80.6, and 8.4, 8.8, 5.7; lysine, 67.6, 55.3, 73.0, and 1.9, 1.2, 2.3; methionine, 81.3, 74.7, 84.6, and 1.2, 1.0, 1.4; phenylalanine, 77.6, 73.5, 83.4, and 3.3, 3.4, 4.0; threonine, 61.8, 55.7, 67.5, and 2.0, 1.7, 2.2; valine, 73.6, 69.2, 77.3, and 3.5, 3.5, 3.8, respectively. The AID of all the essential AA was higher ($P < 0.05$) in pigs fed the wheat-based diet, as compared with the grain sorghum diet. No difference ($P > .10$) was found in the AID of arginine, histidine, and leucine, between wheat and corn, but the AID of the remaining essential AA was higher ($P < .05$) in wheat. Also, the AID of all the essential AA was higher ($P < .05$) in corn, as compared with grain sorghum. Threonine had the lowest AID values in the three cereals, whereas arginine, histidine, leucine, and methionine had the highest digestibility values.

The content of digestible leucine in corn and grain sorghum, and that of histidine in grain sorghum was higher, as compared with wheat, but the content of the remaining essential AA was higher in wheat. The AID, and the total and digestible content of essential AA suggest that the nutritional value of wheat is from 41 to 92% and from 11 to 27% superior to that of grain sorghum and corn, respectively.

Key Words: Pigs, Cereal grains, Amino acid digestibility

875 Influence of nucleotides and glutamine dietary supplementation on gut health of weanling piglets. V. Dell’Orto, A. Di Giancamillo, G. Savoini*, R. Paratte, C.M. Domeneghini, and V. Bontempo, *University of Milan, Italy.*

The aim of the experiment was to evaluate the effects of nucleotides and glutamine dietary supplementation on promoting gut growth and health of weanling piglets. Twelve weanling female piglets (21 days old; 5 ± 0.5 kg LW) were grouped three per pen in an environmentally controlled room and fed one of four diets for 28 d. Diet 1 was control diet (C); diet 2 was C + 0.05% nucleotides (N); diet 3 was C + 0.5% L-glutamine (G); diet 4 was C + N + G (NG). Nucleotides were a combination of nucleosides, nucleotides, and bases (Prosol S.p.A., Bergamo, Italy). Nucleotides and crystalline L-glutamine (Merk, Darmstadt, Germany) were mixed into the daily ration of the treated groups. Piglets weight was recorded at the beginning of the experimental diets administration and weekly during the trial. Feed intake of each group was measured weekly. At the end of the trial piglets were sacrificed. The distal ileum and the liver were collected for the histological study, and distal ileum for the histometric examination. In addition, anti-PCNA (proliferating cell nuclear antigen) serum and anti-human macrophage serum were used to analyse ileum immunoreactivity. The treatments did not affect average daily gain (C= 203 g; G= 233 g; N= 214 g; NG= 257 g). Glutamine and nucleotides dietary supplementation significantly affected villus height (C= 147.78 µm; G= 200.26 µm; N= 188.58 µm; NG= 215.00 µm; P < 0.01) and crypt depth (C= 80.31 µm; G= 152.47 µm; N= 139.16 µm; NG= 179.79 µm; P < 0.01). No difference was observed on macrophage-like activity. Anti-PCNA activity revealed a higher mitotic activity in the ileum of piglets supplemented with nucleotides and glutamine. These data suggest that the inclusion of nucleotides and glutamine to weanling piglet diets has a positive effect on growth and maturation of ileal mucosa.

Key Words: Nucleotides, Glutamine, Piglets

876 Compensatory growth and nitrogen balance in grower-finisher pigs. J. Fabian*, L. I. Chiba, L. T. Frobish, W. H. McElhenney, D. L. Kuhlers, and K. Nadarajah, *Auburn University, Auburn University, AL.*

A total of 16 castrated male pigs weighing approximately 20 kg were used in two trials to investigate the effect of grower (G) diets [5.0 or 11.0 g lysine (Lys)/kg] on growth performance and nitrogen (N) balance. Common finisher 1 (F1) and 2 (F2) diets were offered when pigs reached approximately 50 and 80 kg, respectively. Pigs were placed in metabolism crates three times (43, 70, and 91 kg for the G, F1, and F2 phases, respectively) for the total collection of feces and urine. There were no diet x trial interactions of interest. Pigs fed the low-Lys grower diet grew more slowly and less efficiently (P < 0.001) during the G phase and had more ultrasound backfat (P < 0.01) at the end of the G phase than those fed the high-Lys grower diet. During the F1 phase, pigs previously fed the low-Lys diet grew more efficiently (P < 0.05) than those fed the high-Lys diet. The G diet had no effect on overall weight gain, carcass traits, lean accretion, or meat quality. At 43 kg, pigs fed the low-Lys diet had less serum urea N (P < 0.001), triglycerides (P < 0.05) and total protein (P = 0.07), and more glucose (P < 0.01) than those fed the high-Lys diet. During the G phase, pigs fed the high-Lys diet consumed more N (P < 0.001) and had higher N digestibility (P < 0.05), retention (P < 0.001), and utilization (P < 0.05), but they excreted more fecal (P < 0.05) and urinary (P < 0.001) N than those fed the low-Lys diet. Pigs fed the low-Lys grower diet had greater N utilization (P < 0.05) and retention (P = 0.08) during the F1 phase, and excreted less (P < 0.05) urinary N during the F1 and F2 phases than those fed the high-lysine grower diet. The results indicate that pigs subjected to early amino acid restrictions compensated completely in terms of growth rate and body composition. In addition, restricted pigs exhibited compensatory N retention and reduced N excretion. Compensatory

growth can, therefore, have a positive impact not only on the overall efficiency of pig production but also on the environment.

Key Words: Pigs, Amino acid restrictions, Nitrogen balance

877 Effect of a protein source derived from yeast extract on performance and health of weanling piglets. S.V. Hunziker and P. Spring, *Swiss College of Agriculture, Zollikofen, Switzerland.*

The aim of this study was to evaluate the effect of a protein source derived from yeast extract (NuPro™, Alltech Inc.) on performance and health of weanling piglets. Eighty piglets (Swiss Large White) were assigned by genetics and weight to 16 groups of 5 piglets in a block design with 2 treatments (8 replicates per treatment). The control groups received a barley/wheat/soy/potato protein-based starter diet with 14.0 MJ DE, 17% CP and 1.19% lysine. In the second treatment 4% of the soy was replaced by 4% NuPro™. Mineral and amino acid concentrations were adjusted to be equal across diets. The piglets averaged 30 days of age and 9.5 kg at the beginning of the 28 day trial. Feed intake, weight gain and FCR were recorded for two 14-day periods. Medical treatments and fecal scores were recorded daily. Data were analyzed by ANOVA. Means were compared using the Tukey-Kramer test. No health-related problems occurred during the trial; and fecal scores were similar between treatments. NuPro™ substitution did not affect weight gain, however there was a trend toward improved feed conversion (P = 0.051) (Table 1). Performance data are summarized in table 1.

Table. 1: Effect of yeast extract on performance of weanling piglets.

Parameter		Control	NuPro™	SE
Feed intake (d1-14)	g	338	345	13.8
Feed intake (d15-28)	g	794	786	22.5
Feed intake (d1-28)	g	566	566	15.1
ADG (d1-14)	g	365	375	15.8
ADG (d15-28)	g	562	570	16.3
ADG (d1-28)	g	414	422	13.5
FCR (d1-14)		1.28	1.26	0.03
FCR (d15-28)		1.42	1.38	0.02
FCR (d1-28)		1.37 ^A	1.34 ^B	0.01

A,B P < 0.10

Key Words: Yeast extract, Weanling piglets, Nupro

878 Molecular cloning of a turkey intestinal peptide transporter (tPepT1) and developmental regulation of PepT1 expression in turkey and broiler embryos. L. Van*, Y-X. Pan, E. A. Wong, and K. E. Webb, Jr., *Virginia Polytechnic Institute and State University, Blacksburg.*

A cDNA clone encoding a turkey intestinal peptide transporter, tPepT1, was isolated from a turkey small intestinal cDNA library by screening with our chicken PepT1 cDNA probe. The tPepT1 cDNA is approximately 2.9 kb long and encodes a 79.4 kDa protein of 714 amino acids with 12 predicted transmembrane domains. The isoelectric point (pI) of tPepT1 is 5.88, which is much lower than that of PepT1 in chicken (pI = 7.48), rat (pI = 7.39), sheep (pI = 6.57), rabbit (pI = 7.47), and human (pI = 8.58). The amino acid sequence of tPepT1 is 94.3% identical to cPepT1 and 64.9%, 64.6%, 63.4%, and 62.8% identical to PepT1 from rat, sheep, rabbit, and human, respectively. To study developmental regulation of PepT1 in broiler and turkey embryos, 12 Cobb x Cobb broiler embryos (six males and six females) from embryonic d 16 (E16) to the day of hatch (d0) and 12 turkey embryos (six males and six females) from embryonic d 23 (E23) to the day of hatch (d0) were sampled daily. The small intestine was removed, total RNA was extracted, and abundance of PepT1 mRNA was quantified densitometrically from northern blots after hybridization with our full-length cPepT1 and tPepT1 cDNA as probes. An 18S-rRNA cDNA probe was used as an internal control to evaluate the amount of RNA loaded and transferred. In broiler embryos, there was a quadratic increase (P ≤ 0.001) in cPepT1 mRNA abundance with age. cPepT1 mRNA abundance at d0 was approximately 20-fold that at E16. There was also a quadratic increase (P ≤ 0.001) in tPepT1 mRNA abundance with age. However, the relative increase in abundance of tPepT1 mRNA from E23 to d0 was much less than in broilers (fivefold vs 20-fold). No differences were observed in PepT1 mRNA abundance between male and female birds. The dramatic increase in PepT1 mRNA abundance in the small intestine of broilers and turkeys from the late embryo stage to day of hatch

indicates that there is developmental regulation of the PepT1 gene and that there may be a crucial role for PepT1 in the neonatal chick and poult.

Key Words: Peptide transporter, Developmental regulation, Small intestine

879 Effect of protein sources on cholesterol and amino acid levels in Pacific white shrimp (*Litopenaeus vannamei*). Zongjia Cheng* and R.W. Hardy, *University of Idaho, Hagerman Fish Culture Experiment Station.*

Shrimp contain higher cholesterol levels in their body compared to most other farm animals. Manipulating dietary protein sources may change cholesterol level in shrimp body. In this experiment, seven diets were made such that diets 1 to 3 contained 25% fishmeal (FM), 25% soybean meal (SBM), and 25% casein (C), respectively. Diets 4 to 7 contained 12.5% FM + 12.5% SBM, 12.5% FM + 12.5% C, 12.5% SBM + 12.5% C, and 8.3% FM + 8.4% SBM + 8.3% C, respectively. All diets contained 0.2% supplemental cholesterol. One hundred eighty-nine shrimp, average body weight 0.57 g, were stocked into twenty-one 60 L tanks with 9 shrimp per tank, and 3 tanks per dietary treatment. Shrimp were fed twice per day to apparent satiation for 4 weeks. After the experiment was terminated, shrimp hepatopancreas were dissected and freeze dried, and cholesterol levels were measured in hepatopancreas and whole body. Average cholesterol levels in hepatopancreas were 2.87, 2.51, 3.26, 2.87, 3.13, 2.86, 3.04 g/100 g, for shrimp fed diets 1 to 7, respectively ($P = 0.2743$, $n = 3$). Average cholesterol levels in whole body minus hepatopancreas were 0.81, 0.74, 0.64, 0.71, 0.71, 0.72, 0.72 g/100 g, for shrimp fed diets 1 to 7, respectively ($P = 0.0004$, $n = 3$). Results indicated that shrimp fed casein based diets had the lowest cholesterol levels in their body, followed by those fed SBM, and shrimp fed FM based diets had the highest cholesterol levels. There were no significant differences in whole body amino acid levels for shrimp fed diets containing the different protein sources.

Key Words: Cholesterol, Shrimp, Soybean meal

880 Evaluating apparent digestibility coefficients of nutrients in alternative animal protein sources for rainbow trout (*Oncorhynchus mykiss*). Zongjia Cheng* and R.W. Hardy, *University of Idaho, Hagerman Fish Culture Experiment Station.*

Developing alternative protein sources to fishmeal for fish feeds requires a thorough evaluation of all alternatives, including by-products from the rendering industry. In this study, five experimental diets were pelleted with 0.5% chromium oxide as an inert marker. One diet was a casein-gelatin, semi-purified reference diet, which constituted 70% of the other 4 diets to which 4 types of animal protein meals, spent hen meal (SHM), poultry by-product meal (PBM), feather meal (FTM), and spray dried porcine plasma (SDPP), were added. A total of 300 rainbow trout (initial mean body weight 140.8 ± 11.1 g) were stocked into ten 40-L digestibility tanks with 30 fish per tank. Fish were assigned randomly to these five diets. The collection of feces lasted for 2 weeks, feces were collected by the sedimentation technique. Fish were force-fed once daily at 1330 h, tanks were completely cleaned after feeding, and feces were collected the next day at 1300 h. The average apparent digestibility coefficients (ADCs, %) of nutrients in SHM, PBM, FTM, and SDPP were: dry matter, 70.6, 65.1, 80.1, 99.7, respectively ($P < 0.0001$); crude protein, 87.8, 82.5, 76.6, 99.2, respectively ($P < 0.0001$); crude fat, 97.7, 79.3, 79.4, 99.2, respectively ($P = 0.0008$); and gross energy, 74.9, 74.5, 76.9, 98.5, respectively ($P = 0.0003$). Results showed that significant differences existed in ADCs of nutrients among fish fed diets containing all types of ingredients, and SDPP had the highest ADCs of nutrients.

Key Words: Apparent digestibility coefficients, Alternative animal protein source, Rainbow trout

881 Synthetic lysine and methionine supplementation into distillers dried grain based diets improves growth and feed conversion ratio for rainbow trout *Oncorhynchus mykiss*. Zongjia J. Cheng* and R.W. Hardy, *Hagerman Fish Culture Experiment Station, University of Idaho.*

Commercial trout diets contain high levels of fishmeal and relatively low levels of grain by-products such as distillers dried grain (DDG). DDG has relatively high level of crude protein, good palatability, and is less

expensive than fishmeal. In this study, DDG diets were made such that DDG was used to replace 25% (diet 2), 50% (diet 3), and 75% (diet 4) of fishmeal (herring meal) without lysine and methionine supplementation, and to replace 25% (diet 5), 50% (diet 6), and 75% (diet 7) of fishmeal with lysine and methionine supplementation, in rainbow trout diets according to a 2 x 3 factorial design. In addition, a fishmeal diet (diet 1) was used as a control. The control diet contained 30% fishmeal; control and lysine and methionine supplemented diets contained 2.24% lysine, and 0.73% methionine. All diets contained 42% CP and 3600 Kcal DE /kg diet. A total of 630 fish (initial mean BW 49.84 ± 0.05 g) were randomly stocked into twenty-one 150-L tanks with 30 fish per tank and 3 tanks per diet. Fish were fed to apparent satiation 3 times per day and 7 days per week. Diets were pelleted using a CPM laboratory pellet mill. After a 6-week growth period, average weight gain (WG) of fish fed diets 1 to 7 was: 49.0, 43.9, 46.5, 42.9, 51.3, 54.3, and 46.4 g, respectively; average FCR of fish fed diets 1 to 7 was: 1.21, 1.35, 1.25, 1.34, 1.20, 1.11, and 1.29 g feed/g gain, respectively. Survival was > 98% for fish fed all diets. Two-way ANOVA showed that lysine and methionine supplementation improved WG ($P = 0.0002$) and FCR ($P = 0.0011$). Results also showed that fish fed DDG diets to replace up to 50% fishmeal on isonitrogenous and isocaloric basis were not significantly different compared to fish fed the fishmeal control diet in terms of WG, FCR, survival ($P > 0.05$), indicating that DDG could be used at the 15% inclusion rate in trout feed formulations when lysine and methionine were supplemented.

Key Words: Lysine and methionine, Distiller's dried grain, Rainbow trout

882 Apparent digestibility of the nutrients with growing rabbits fed diets with different starch levels and fiber sources. Alex M.V. Arruda*¹, Darci C. Lopes², Augusto C. Queiroz², Horacio S. Rostagno², Walter M. Ferreira³, Luiz F.T. Albino², and Elzania S. Pereira¹, ¹UNIOESTE Universidade Estadual do Oeste do Parana, ²Universidade Federal de Vicosa, ³Universidade Federal de Minas Gerais.

The objective of the present study was to evaluate the apparent digestibility of the nutrients of growing rabbits fed diets with different starch levels (averaging 22.00 or 32.00 percent), that was accomplished by using low or high corn grain inclusion and different sources of fiber (alfalfa hay or soybean hulls). Sixty-four New Zealand White rabbits were weaned at 35 days of age, individually housed in metabolism cages and distributed to a complete randomized design in a 2 and 2 (starch level and source of fiber) factorial arrangement with 16 rabbits per treatment. The rabbits were fed with diets in pellets form. No significant effects were observed for the interaction between the starch levels and the sources of fiber (0.05 probability percentage) for the evaluated characteristics. The best apparent digestibility of the nutrients was observed in the diets with high starch level (DM "73.56" ; OM "74.30" ; CP "71.51" ; GE "63.89" ; starch "95.08" ; NDF "45.87" ; ADF "37.78" ; hemicellulose "55.57" and cellulose "39.86" ; in percentage for all parameters), except for the ether extract apparent digestibility. By the way, the best apparent digestibility of the nutrients was observed on diet with soybean hulls as the source of fiber (DM "72.37" ; OM "73.06" ; CP "69.10" ; GE "61.74" ; EE "76.84" ; starch "95.10" ; NDF "47.00" ; ADF "38.42" ; hemicellulose "55.51" and cellulose "42.42" ; in percentage for all parameters). These results suggest that diets with high starch levels or soybean hulls could be efficiently used by New Zealand White growing rabbits.

Key Words: Alfalfa hay, Corn grain, Soybean hulls

883 Performance and carcass characteristics of growing rabbits fed diets with different starch levels and sources of fiber. Alex M.V. Arruda*¹, Darci C. Lopes², Augusto C. Queiroz², Walter M. Ferreira³, Horacio S. Rostagno², Luiz F.T. Albino², Elzania S. Pereira¹, and Aloizio S. Ferreira², ¹UNIOESTE Universidade Estadual do Oeste do Parana, ²Universidade Federal de Vicosa, ³Universidade Federal de Minas Gerais.

The objective of the present study was to evaluate the performance and the quantity and quality characteristics of the carcass of growing rabbits full fed diets with different starch levels (averaging 22.00 or 32.00 percent), that was accomplished by using low or high corn grain inclusion and different sources of fiber (alfalfa hay or soybean hulls). Forty New Zealand white rabbits were weaned at 35 days of age, individually housed and distributed to a complete randomized design in a 2 and

2 (starch level and source of fiber) factorial arrangement with 10 rabbits per treatment. The rabbits were full fed with diets in the pellets form from 45 to 85 days of age. No significant effects was observed for the interaction between the starch levels and the sources of fiber (0.05 probability percentage) for the evaluated characteristics. A larger feed intake was observed in diets with alfalfa hay ("91.27" grams for day) as a source of fiber, but the weight gain and food conversion was not influenced by the dietary treatments (overall average of "30.18" grams for day and "2.94", respectively). The carcass yield, protein content, and energy and protein efficiency of the carcass was larger for the diets with high starch levels ("50.20" ; "62.36" ; "56.38" and "30.04", respectively, and in percentage for all parameters). The diets with high starch level or with soybean hulls showed a better food conversion and carcass characteristics as a consequence response of a better efficiency in the nutrient utilization.

Key Words: Alfalfa hay, Corn grain, Soybean hulls

884 Caecal microbial activity and caecotrophy nutritional contribution of growing rabbits fed diets with different starch levels and sources of fiber. Alex M.V. Arruda^{*1}, Darci C. Lopes², Walter M. Ferreira³, Augusto C. Queiroz², Horacio S. Rostagno², Luiz F.T. Albino², Elzania S. Pereira¹, and Aloizio S. Ferreira², ¹UNIOESTE Universidade Estadual do Oeste do Parana, ²Universidade Federal de Vicosa, ³Universidade Federal de Minas Gerais.

The objective of the present study was to evaluate the caecal microbial activity and caecotrophy nutritional contribution of growing rabbits full fed diets with different starch levels (averaging 22.00 or 32.00 percent), that was accomplished by using low or high corn grain inclusion and different sources of fiber (alfalfa hay or soybean hulls). This was carried out in two experiments. In the first experiment, forty New Zealand white rabbits were weaned at 35 days of age, individually housed and distributed to a complete randomized design in a 2 and 2 (starch level and source of fiber) factorial arrangement with 10 rabbits per treatment. The rabbits were full fed with diets in the pellets form from 45 to 85 days of age. The rabbits were slaughtered and the ileal and caecal contents were collected. A significant effect was observed for the interaction between the starch levels and the fiber sources (0.05 probability percentage) for the total VFA concentration. A VFA concentration of "93.82" mmol/l and "80.03" mmol/l was observed for the diets with high starch level and soybean hulls and diets with low starch level and alfalfa hay, respectively. In the second experiment, forty New Zealand white rabbits were weaned at 35 days of age, individually housed and distributed to a complete randomized design in a 2 and 2 (starch level and source of fiber) factorial arrangement with 10 rabbits per treatment. The rabbits were full fed with diets in the pellets form from 65 to 75 days of age, and subsequently for 48 hours, each animal received a wood neck-lace. A significant effect was observed for the interaction between the starch levels and the sources of fiber (0.05 probability percentage) for the caecotrophes protein and energy contents. The caecotrophes protein and energy contents of "29.66" percent and "4204.87" kcal for kg and "27.98" percent, "4080.46" kcal for kg was observed for the diets with high starch level and soybean hulls, and diets with low starch level and alfalfa hay, respectively. The diets with high starch level and soybean hulls as a source of fiber promoted a larger enhancement of the caecal contents and the best nutritional support for the growing rabbits.

Key Words: Alfalfa hay, Corn grain, Soybean hulls

885 Hormonal and reproductive performance of young hybrid boars fed rations supplemented with soybean oil as a source of fatty acids. L. D. S. Murgas¹, L. F. Uribe-Velásquez^{*2}, and E. T. Fialho¹, ¹Federal University of Lavras-UFLA-Lavras-Minas Gerais-Brazil, ²University of Caldas-Manizales-Caldas-Colombia.

Essential fatty acids in the testes could play an important role in the testicular membranes. So, they can influence the testicular hormonal synthesis. An experiment was conducted at the Animal Science Department of Lavras University (UFLA) in order to evaluate the hormonal concentrations and its relation with reproductive performance of young hybrid boars fed with rations supplemented with soybean oil as a source of fatty acids. A total of 36 boars in growing phase (47.3 kg/BW) from AGROCERES-PIC were randomly assigned on the 3 treatments of iso-proteic and isoenergetic rations with different levels of linoleic acid (1.5,

2.5 and 3.5%). At age of five months the pigs were submitted to training for semen collection. The blood collection were realized at 47.3, 72.0, 103.0 and 128.7 kg/BW. The plasma was stored at -20°C. Then testosterone and oestradiol were dosaged by RIA. Sexual behavior was recorded in two times. In order to evaluate the reproductive performance, the following records were taken: ejaculation volume, motility and spermatic vigor, spermatic concentration, total number of spermatozoa, percentage of live and dead spermatozoa. The values for testosterone concentration between treatments were: 1.33±0.10; 1.12±0.08; 1.31±0.09 ng/mL for T1, T2 and T3, respectively. The values for oestradiol were: 578.24±78.52 (T1); 465.42±68.38 (T2) and 760.82±77.29 pg/mL. Dietary supplementation of soybean oil as source of fatty acid did not alter hormonal plasma concentrations. It was observed significant linear effect (P<0.01) of weight gain on testosterone and oestradiol plasma levels. The testicular volume showed significant correlation on testosterone (0.79) and oestradiol (0.67). There was no difference for spermatic concentration, total of spermatozoa, spermatic motility and vigor as well as percentage of live or dead spermatozoa between pigs fed with the rations. It would appear that dietary supplementation of soybean oil, as source of fatty acids does not alter reproductive performance and hormonal plasma concentrations of young hybrid boars.

Key Words: Boars, Testosterone, Fatty acids

886 Effect of lipid sources on cholesterol and ω -3 fatty acid levels in Pacific white shrimp (*Litopenaeus vannamei*). Zongjia Cheng^{*} and R.W. Hardy, University of Idaho, Hagerman Fish Culture Experiment Station.

Reducing shrimp body cholesterol is of great importance because shrimp contain higher cholesterol levels than most other farm animals. In this study, seven diets were made such that diets 1 to 3 contained 3% fish oil (FO), 3% soy oil (SO), and 3% poultry fat (PF), respectively. Diets 4 to 7 contained 1.5% FO + 1.5% SO, 1.5% FO + 1.5% PF, 1.5% SO + 1.5% PF, and 1% FO + 1% SO + 1% PF, respectively. All diets contained 0.2% supplemental cholesterol. One hundred eighty-nine shrimp, average body weight 0.57 g, were stocked into twenty-one 60 L tanks with 9 shrimp per tank, and 3 tanks per dietary treatment. Shrimp were fed twice per day to apparent satiation for 4 weeks. After the experiment was terminated, shrimp hepatopancreas were dissected and freeze dried, and cholesterol levels were measured in hepatopancreas and whole body. Average cholesterol levels in hepatopancreas were 3.04, 2.96, 2.70, 2.78, 3.04, 3.25, 2.67 g/100 g, for shrimp fed diets 1 to 7, respectively (P = 0.0869, n = 3). Average cholesterol levels in whole body minus hepatopancreas were 0.76, 0.66, 0.65, 0.69, 0.70, 0.73, 0.72 g/100 g, for shrimp fed diets 1 to 7, respectively (P < 0.0001, n = 3). Results indicated that shrimp fed SO based diet had the lowest cholesterol level in their body, those fed PF were intermediate, and shrimp fed FO based diet had the highest cholesterol level. Furthermore, significant differences were found in ω 20:5 (P = 0.0047) and ω 22:5 (P = 0.0014), but not in ω 18:3 (P = 0.2345) and ω 22:6 (P = 0.3073) fatty acid levels in whole body minus hepatopancreas for shrimp fed different lipid sources.

Key Words: Cholesterol, Shrimp, Soy oil

887 Effects of extrusion processing on apparent digestibility coefficients of nutrients in soybeans for rainbow trout *Oncorhynchus mykiss*. Zongjia J. Cheng^{*} and R.W. Hardy, Hagerman Fish Culture Experiment Station, University of Idaho.

An experiment was conducted to evaluate the effects of extrusion processing on apparent digestibility coefficients (ADCs) of nutrients in soybeans for rainbow trout. Raw soybeans were either dry extruded or expelled using an Instron-Pro extruder. Raw soybeans, extruded soybeans, and expelled soybeans were mixed with a casein-gelatin reference diet at 3 : 7 ratio to determine the ADCs of nutrients for these ingredients. A total of 240 fish (mean BW 170.8± 5.5 g) were stocked into eight 150-L fish tanks with 30 fish per tank. Duplicate tanks were assigned randomly to each of the 3 diets and the reference diet. Fecal materials were collected by hand-stripping, and the process lasted for 2 weeks. Yttrium oxide (0.01%) was used as an inert marker. The average ADCs (%) of nutrients for raw soybeans, extruded soybeans, and expelled soybeans were: dry matter, 74.5, 73.8, and 75.9 (P = 0.3829); crude protein, 88.0, 97.2, and 97.9 (P = 0.0005); potassium, 99.6, 99.4, and 99.5 (P > 0.05); magnesium, 68.5, 59.6, and 68.0 (P < 0.0001); sulfur, 93.1, 97.0, and 97.3 (P < 0.0001); total-phosphorus, 21.1, 12.5, and 31.7 (P

< 0.0001); phytate-phosphorus, 29.9, 19.6, and 60.0 (P < 0.0001); copper, 89.9, 93.3, and 92.7 (P > 0.05); manganese, 20.3, 13.5, and 16.8 (P > 0.05); and zinc, 14.6, 7.2, and 15.7 (P > 0.05), respectively. Results showed that the dry extrusion processing improved ADCs of crude protein and S but not other nutrients in soybeans. Expelling processing improved ADCs of crude protein, sulfur, total-phosphorus, and phytate-phosphorus in soybeans. The improved ADCs of crude protein in extruded and expelled soybeans will have an important beneficial effect on fish growth and feed efficiency.

Key Words: Extrusion processing of soybeans, Apparent digestibility coefficients, Rainbow trout

888 Feed intake and performance of swine consuming barley-based diets with low levels of deoxynivalenol (DON) contamination. J.D. House^{*1}, G.H. Crow¹, D. Abramson², and C.M. Nyachoti¹, ¹University of Manitoba, Winnipeg, MB, ²Agriculture & Agri-Food Canada, Winnipeg, MB.

The presence of DON in swine feeds has been shown to lead to reductions in feed intake, with subsequent negative impact on performance. The ubiquitous nature of DON in the eastern prairie region of Canada necessitates the development of strategies to cope with this mycotoxin. Of primary importance is the development of regionally-specific models for the determination of the impact of DON-contamination on the performance of improved pig genotypes. To this end, an experiment was designed to determine the impact of low levels of DON on feed intake and growth performance of swine. Cotswold pigs (n = 144, initial age & weight = 61 d, 23.4 kg) were randomly assigned to barley-soybean meal based diets, containing either 0, 1 or 2 ppm DON in the final feed (4 pens, each containing 6 barrows and 6 gilts, per treatment) and formulated to contain 13.4 MJ/kg DE, 16% CP, and 0.81% total lysine. The final DON content of the diets was derived by diluting clean barley (<0.2ppm DON) with DON-contaminated barley (DON = 4.9 ppm). Diets contained barley, soybean meal, vegetable oil and a complete vitamin-mineral premix. The same diets were used throughout the grow-finish period. Feed intake (ADFI; per pen basis; kg/day), body weight gains (ADG; kg/day) and feed intake:gain (FCR) were measured on a weekly basis. As shown in the table below, ADFI, at 2 ppm DON, is depressed by 7.5%, relative to 0 ppm DON, but with only a moderate impact on performance. Future studies are required to determine the impact of higher DON concentrations as well as their impact on carcass merit. Funding: ARDI and Manitoba Pork Council.

	P				
	0 ppm DON	1 ppm DON	2 ppm DON	SEM	value
ADFI (total)	2.21 ^a	2.14 ^{ab}	2.04 ^b	0.04	0.04
ADG (total)	0.84	0.83	0.80	0.02	0.06
FCR	0.38	0.39	0.39	0.01	0.17
Days to 110 kg	162.9	164.0	165.5	1.8	0.59

Data are presented as lsmeans with standard errors of the mean (SEM). Values with different superscripts are significantly different (P<0.05) by the protected least squares difference procedure.

Key Words: Deoxynivalenol, Swine, Barley

889 Effect of harvest weight on performance and carcass quality of finishing pigs. P. G. Lawlor^{*} and P. B. Lynch, Teagasc, Moorepark Research Centre, Fermoy, Co. Cork, Ireland.

The objective of this experiment was to assess the effect of harvest weight on the performance and carcass quality of finishing pigs. Thirty six single sex groups (boars or gilts) of 13 pigs with a mean weight of 39.5 ± 3.3 kg were blocked on sex and weight and assigned at random to the following treatments: (1) harvest at 85 kg LW, (2) harvest at 95 kg LW, and (3) harvest at 105 kg LW. Each treatment group was liquid fed (3.3 kg water/kg feed) 3 times daily using a computerised wet feed system (Big Dutchman, Vechta, Germany). Feed was offered to approximate ad libitum intake. Diet 1 (13.7 MJ of DE/kg, 1.11 % lysine) was offered for 28 days after which diet 2 (13.2 MJ of DE/kg, 0.96 % lysine) was offered to harvest. Pigs were marketed once weekly. Pigs within a group were selected for harvest when they were within 5 kg of the target weight and all pigs in the group were harvested within the following two weeks. Days to slaughter was 62.0, 68.7 and 78.3 days (SEM = 0.81 ; P < 0.001) for treatments 1, 2 and 3. Live weight at harvest was 89.9, 96.2 and 103.2 kg (SEM = 0.66; P < 0.001) and carcass weight was

68.0, 73.6 and 79.2 kg (SEM = 0.56; P < 0.001) for treatments 1, 2 and 3 respectively. Intake was 2099, 2130 and 2154 g/d (SEM = 21.6; P < 0.10) and ADG was 814, 827 and 815 g/d (SEM = 9.3; P > 0.05) for treatments 1, 2 and 3, respectively. Fat depth was 10.9, 11.6, and 12.2 mm (SEM = 0.19; P < 0.001), muscle depth was 55.0, 56.4, 58.6 mm (SEM = 0.70; P < 0.01) and lean meat percentage as estimated by the Hennessy grading probe was 59.5, 59.3 and 59.4 % (SEM = 0.15; P > 0.05) for treatments 1, 2 and 3, respectively. Days to slaughter was 71.5 and 67.8 (SEM = 0.66; P < 0.001) for female and male pigs, respectively. Intake was 2162 and 2094 g/d (SEM = 17.6; P < 0.05) and ADG was 802 and 836 g/d (SEM = 7.6; P < 0.01) for females and males, respectively. Fat depth was 11.6 and 11.6 mm (SEM = 0.15; P > 0.05), muscle depth was 57.7 and 55.6 mm (SEM = 0.57; P < 0.01) and lean meat percentage was 59.7 and 59.1 % (SEM = 0.12; P < 0.01) for females and males respectively. It is concluded that increasing harvest weight does not effect pig performance. However, fat depth and muscle depth increased with increasing slaughter weight.

Key Words: Pigs, Harvest weight, Sex

890 Effect of protein and energy dense diets on feed intake and protein deposition in pigs from 20 to 65 kg body-weight. A. Roy^{*1,2}, J.F. Bernier², and C. Pomar¹, ¹Agriculture and Agri-Food Canada, Lennoxville, Quebec, Canada, ²Université Laval, Sainte-Foy, Québec, Canada.

It is frequently assumed that young pigs (under 50 kg BW) cannot eat enough feed to meet their energy requirements, limiting the expression of their full potential for protein deposition. This experiment was undertaken to investigate if increased levels of energy and protein in diets will affect voluntary feed intake, and protein and lipid deposition. Sixty-three entire males and 63 castrated males (Large White x Landrace) x Duroc weighing 22 ± 3.0 kg were randomly assigned to 9 blocks of 14 animals, 7 of each sex. Within each block, pigs were fed ad libitum one of seven experimental diets. Diets were formulated to contain one of three net energy levels (9.9, 10.8 and 11.5 MJ NE/kg) and one of three balanced protein levels (152, 165 and 178 g/kg). The 10.8 MJ NE/kg with 178 g/kg and 11.5 MJ NE/kg with 165 g/kg energy and protein combinations were omitted. Energy levels were raised by replacing cornstarch by dietary fat. Digestible lysine to balanced protein ratio was kept constant across experimental diets and equal to 8%. Pigs were slaughtered at the end of the experiment at 64 ± 5.7 kg BW. Feed intake decreased (P < .01) while digestible energy intake (MJ DE/d) remained constant when diet net energy level increased. However, net energy intake (MJ NE/d) increased linearly (P < .01) with the net energy content of the diet. This additional net energy tended to increase lipid deposition (P < .10) while protein gain remained unchanged. In contrast, the increase in dietary protein intake decreased protein deposition (P < .05) without affecting lipid deposition. These results indicate that pigs between 20 and 65 kg BW regulate digestible energy intake and that protein deposition does not appear to be limited by energy intake.

Key Words: Pigs, Feed intake, Protein retention

891 Energy of various soybean meal, rapeseed meal and coconut meal in finishing pigs. J. W. Hong¹, I. H. Kim^{*1}, Y. K. Han², J. H. Kim³, O. S. Kwon¹, S. H. Lee¹, B. J. Min¹, and W. B. Lee¹, ¹Department of Animal Resource & Science, Dankook University, Cheonan., ²Feed Res. Inst., National agri. Coop. Fed., ³Agribands Purina Korea, Inc., Seoul, Koera.

Five barrows (average initial body weight 66.4±0.7kg) were used to determine the apparent ileal digestibilities of amino acids, DM, N and energy in various soybean meal, rapeseed meal and coconut meal in finishing pigs. Dietary treatments included 1) KSBM (Korean soybean meal), 2) CSBM (Chinese soybean meal), 3) SSBM (South-American soybean meal), 4) RSM (Rapeseed meal), 5) CNM (Coconut meal). The diets were cornstarch-based and formulated so that each protein source provided the same amount of total ME (4,390 kcal/kg), CP (15.70 %), lysine (1.00 %), Ca (0.80 %) and P (0.60 %). Protein content of the KSBM was higher than the CSBM and SSBM, with all values similar to those expected (NRC, 1998), and protein content of the CNM was lower for the SBM preparation and RSM. The apparent ileal digestibilities of histidine, lysine, threonine, alanine, aspartic acid, cystine, glutamic acid and serine were greater for the KSBM, CSBM, SSBM and RSM than for the CNM (P<0.05). Also, apparent ileal digestibilities of methionine, leucine, phenylalanine, valine and tyrosine were greater for the KSBM

than for the CSBM, SSBM, RSM and CNM ($P < 0.05$). Overall, apparent ileal digestibilities of total essential amino acids were greater for the KSBM than for the CSBM, SSBM, RSM and CNM ($P < 0.05$), and apparent ileal digestibilities of total non essential amino acids was greater for the KSBM, CSBM, SSBM and RSM than for the CNM ($P < 0.05$). No differences in apparent digestibility of DM at the small intestine was observed among the treatments. However, apparent digestibility of DM at the total tract was greater for the KSBM than for the CSBM, SSBM, RSM and CNM ($P < 0.05$). Also, apparent digestibility of N and digestible energy at the small intestine and total tract were greater for the KSBM than for the RSM and CNM ($P < 0.05$).

Key Words: Plant protein source, Ileal digestibility, Pigs

892 Effect of substitution of a corn-soybean meal blend with cull chickpeas on growth performance and carcass traits in pigs. J. F. Obregon*, H. R. Guemez, J. M. Uriarte, G. Contreras, and R. Barajas, *FMVZ-Universidad Autonoma de Sinaloa (Mexico)*.

To determine the effect of substitution of a corn-soybean meal blend with cull chickpeas on performance and carcass traits in pigs, an experiment was conducted. One hundred thirty six pigs (BW = 28.4 ± 1 kg; York x Land x Hamp x Pietrain) in groups of 10 to 12 were placed in 12 concrete floor pens (2.8×6.3 m). In a CRB design, pens were fed one of two diets: 1) Corn soybean meal with 16% CP and 3.3 Mcal of ME/kg (CONT) or 2) CONT but replacement of 14% corn and 6% soybean meal (a 70/30 blend) with 20% of cull chickpeas of the variety Blanco Sinaloa (CHP). Pigs were weighed at days 0, 28 and 77 of the experiment and feed intake was recorded daily; ADG and feed/gain ratio (F/G) were calculated from these data. After 77 days nine pigs from each treatment were killed in a slaughterhouse and carcass traits measured. Body weight at day 28 (43.83 vs 46.22 kg) and d 77 (89.98 vs 91.50 kg) were not affected by treatments ($P = 0.41$). ADG for d 1 - 28 (0.59 vs 0.60 kg/d), d 29 - 77 (0.94 vs 0.92 kg/d), and d 1 - 77 (0.81 vs 0.81 kg/d) were similar ($P = 0.59$) between dietary treatments. Feed intake was not modified ($P = 0.35$) by inclusion of CHP. F/G was not impacted ($P = 0.29$) during d 1 - 28 (2.66 vs 2.67), d 29 - 77 (2.99 vs 2.89), and d 1 - 77 (2.89 vs 2.83). Hot carcass weight was similar ($P = 0.19$) and carcass yield was not affected ($P = 0.39$) by treatments (81.1 vs 82.2%). Back fat was similar ($P = 0.50$); weight of loin (4.76 vs 4.82 kg) and shoulder (4.98 vs 5.26 kg) were not affected ($P = 0.22$) by treatments. The CHP treatment increased ($P = 0.04$) the weight of leg (7.17 vs 7.82 kg) by 9%. It is concluded, that cull chickpeas can be used up to 20% in diets for pigs substituting for usual feed ingredients as corn or soybean meal without affecting performance and carcass merit.

Key Words: Chickpeas, Growth performance and carcass, Pigs

893 Effect of triticale on nutrient excretion in grow-finish pigs. Amy Lopez*, Walter Owsley, and Lowell Frobish, *Auburn University, Auburn, AL*.

Six crossbred barrows (initial average weight 48 kg) were used in a replicated 2X2 Latin Square designed experiment ($\alpha = 0.20$) to determine the effects of grain on nutrient excretion. Pigs were housed in stainless steel metabolism crates to allow for collection of urine and feces. Each period consisted of 5 days of acclimation and 5 days of collection. Ferric oxide was added as a visible marker to identify the beginning and end of each collection period. After 2 periods, pigs were moved to conventional pens for 7 days, then returned to metabolism crates for two additional periods. Diet formulations were adjusted to account for changes in daily intake prior to the last 2 periods. The two diets, corn (C) and triticale (T), were formulated to be iso-lysine and iso-phosphorus, and to meet or exceed NRC recommendations. Feed samples were collected at time of mixing and stored for analysis. Fecal samples were collected and frozen hourly, then homogenized and frozen at the end of each period. Urine samples were acidified during collection, and frozen at 12h intervals. Feed and feces samples were analyzed for dry matter, nitrogen, and phosphorus. Data were analyzed using the General Linear Model procedure of SAS. Dry matter excretion (g/d) was greater for pigs fed C than for T (203.1 vs 189.4 , $P < 0.05$.) Nitrogen excretion (g/d) was also greater for pigs fed C (20.6 vs 19.5 , $P < 0.01$.) Nitrogen digestibility was greater for pigs fed T (82.58 vs 78.90% , $P < 0.01$.) Daily phosphorus excretion was greater for pigs fed C (16.3 vs 15.9 g, $P < 0.10$.) Fecal phosphorus excretion per kg of phosphorus intake was also greater for pigs fed C (859 vs 809 g, $P < 0.01$.) Based on the results of

this experiment, feeding diets based on triticale to grow-finish pigs may significantly reduce nitrogen, phosphorus and dry matter excretion.

Key Words: Pigs, Excretion, Triticale

894 Comparison of swine performance when fed diets containing Roundup Ready Corn® (event NK603), control, or conventional corn grown during 2000 in Nebraska. R. L. Fischer¹, A. J. Lewis¹, P. S. Miller^{*1}, E. P. Stanisiewski², and G. F. Hartnell², ¹*University of Nebraska, Lincoln*, ²*Monsanto Company, St. Louis, MO*.

This experiment was conducted to evaluate growth performance and carcass quality measurements in growing-finishing pigs fed diets containing either Roundup Ready corn with event NK603 (RR-NK603), a non-transgenic control corn (RX670), or two commercial sources of non-transgenic corn (RX740 and DK647). The experiment used 72 barrows and 72 gilts with an initial BW of 22.6 kg. Pigs were allotted to a randomized complete block design using a 2×4 factorial arrangement (two sexes \times four corn hybrids). The experiment continued until the average BW was 116 kg, at which time all pigs were slaughtered. Real-time ultrasound measurements of backfat and longissimus muscle area were taken on the final day of the experiment. Carcass quality measurements were taken 24 h postmortem. Average daily gain, ADFI, and feed efficiency (ADG/ADFI) were not affected by diet ($P > 0.60$), but there was an effect of sex for all growth traits, with barrows having greater ADG (0.96 vs 0.87 kg; $P < 0.05$) and ADFI (2.53 vs 2.21 kg; $P < 0.05$) than gilts and gilts having better feed efficiency (0.39 vs 0.38 ; $P < 0.05$) than barrows. Real-time ultrasound measurements were similar among diets, however gilts had less backfat (1.83 vs 2.38 cm; $P < 0.05$) than barrows. Total body electrical conductivity measurements were not affected by diet ($P > 0.30$), but hot carcass weight was greater (92.11 vs 85.33 kg; $P < 0.05$) in barrows than gilts. Proximate analysis of longissimus muscle composition showed no effect ($P > 0.05$) of diet or sex on protein, fat, and water percentages. In summary, there were no differences in growth performance or carcass measurements in growing-finishing pigs fed diets containing either Roundup Ready corn, control corn, or two commercial sources of non-transgenic corn.

Key Words: Carcass measurements, Transgenic corn, Pigs

895 Fermented tuna fish sludge in diets for growing pigs: Intake, gain, and feed efficiency. R. Sanchez, C. S. Santana, A. A. Rodriguez*, V. Siberio, and A. E. Sanjuan, *University of Puerto Rico, Mayaguez Campus, P. R.*

Twenty-four crossbred (Yorkshire-Landrace) growing pigs (19 kg \pm 0.57), were allocated to twelve groups (2 pigs/group) to determine the effects of the inclusion of fermented tuna fish sludge (FTFS) in isocaloric and isoproteic diets. The three treatments (4 repetitions) were either a control diet, or diets containing 10 and 20% of FTFS. Feeding was *ad libitum* both in the initial (19 ± 0.57 to 38 ± 1.05 kg BW) and second (38 ± 1.05 to 59 ± 1.86 kg BW) phases. During the initial phase, weekly feed intake was significantly lower for the pigs with the 20% FTFS diet versus both the control and 10% FTFS groups (20.04 ± 1.04 vs. 26.78 ± 1.29 and 30.88 ± 1.29 kg, $P=0.002$), as was weekly weight gain (6.28 ± 0.43 kg vs. 9.18 ± 0.58 , 10.95 ± 0.58 kg, $P < 0.001$), respectively. However, during the second phase weekly weight gains did not differ significantly (9.32 ± 0.75 kg vs. 10.60 ± 0.77 and 11.62 ± 0.75 kg, $P > 0.05$), and the highest weekly feed intake was seen in pigs with the 10% FTFS diet vs. 0 and 20% FTFS levels (50.00 ± 2.00 vs. 42.11 ± 2.06 and 36.82 ± 1.96 kg, $P < 0.01$, respectively). During the entire experimental period, no differences ($P > 0.05$) were found between the control and 10% FTFS treatments for the variables: total feed intake, total weight gain, feed:gain ratio, and days in the experiment. However, pigs eating the 20% FTFS diet reached slaughter weight 16 days later (66 ± 1.82 vs. 50 ± 1.61 , $P=0.003$) and had poorer feed:gain ratio (3.85 ± 0.20 vs. 2.86 ± 0.17 , $P < 0.05$) when compared to the control. Total feed intake was significantly higher for the pigs in the 20% FTFS diet (280.43 ± 11.13 kg) vs. the control (217.90 ± 9.85 kg) and 10% FTFS group (235.84 ± 11.13 kg). These results indicate that FTFS can be effectively incorporated at levels up to 10% in commercial diets, but the 20% inclusion level may not be advantageous.

Key Words: Fermented tuna sludge, Growing pigs, Performance

896 Fermented tuna fish sludge in diets for growing pigs: Carcass characteristics. R. Sanchez, C. S. Santana, A. A. Rodriguez*, and V. Siberio, *University of Puerto Rico, Mayaguez Campus, P. R.*

Fermented tuna fish sludge (FTFS) was used as an ingredient in diets for growing pigs to evaluate its effects on carcass characteristics. Twenty-four crossbred (Yorkshire-Landrace) pigs (2 per pen) were assigned to one of three treatments: control (0% FTFS), 10% FTFS and 20% FTFS-containing diets. All diets were fed *ad libitum* and formulated to be isocaloric and isoproteic during the initial (19 ± 0.57 to 38 ± 1.05 kg BW) and second phases (38 ± 1.05 to 59 ± 1.86 kg BW). Pigs were slaughtered when they reached a final mean body weight per pen of 59 ± 1.86 kg. At slaughter, measures of carcass hot weight and yield were taken. After 24 hrs., carcass cold weight, carcass yield and length, weight and yield of principal cuts, and loin eye muscle area (polar planimeter) data were obtained. Backfat thickness was measured in both phases with a lean meter. No significant differences were found for carcass hot weight between treatments. However, the slaughter yield was lower ($P < 0.05$) for pigs in the 20% FTFS group when compared to the control group (69.22 vs. $74.96 \pm 1.23\%$, respectively). Carcass cold weight was different ($P < 0.05$) between the 10% and 20% FTFS groups (43.47 vs. 39.52 ± 1.16 kg, respectively). No significant differences between treatments were found for the variables: carcass yield and length, weights and yield of principal cuts, loin eye muscle area, and backfat thickness in either phase between treatments. In summary, no adverse effects was seen on the carcass characteristics in the 10% FTFS group, which suggests that FTFS can be incorporated in levels up to 10% in diets for growing pigs.

Key Words: Fermented tuna sludge, Growing pigs, Carcass characteristics

897 Effects of dietary types and levels of fiber on digestive and post-absorptive utilization of dietary nutrients in pigs. Y. Gao, T. C. Rideout*, and M. Z. Fan, *University of Guelph.*

The objective of this study was to examine effects of dietary fiber levels and types on digestive and post-absorptive utilization of dietary crude protein (CP), calcium (Ca), and phosphorus (P) in pigs. Five Yorkshire barrows, initial BW of 24 kg, were fed five experimental diets for five periods according to a 5×5 Latin square design. The five diets were corn and soybean meal-based and formulated to contain similar levels of CP, Ca, and P from the same sources and three levels of cellulose, a water-insoluble fiber (12.0, 16.0, and 21.0%) and pectin, a water-soluble fiber (1.6, 6.1, and 10.6%), through supplementing exogenous solkafloc cellulose and apple pectin. Each experimental period lasted 14 d with 10-d adaptation and 4-d collection of fecal samples and total excretion of urine. Partitioned as the percentage of total nutrient intake, urinary loss (32.4-66.9%) was the major route of inefficiency of CP, followed by indigestible fecal loss and the endogenous fecal loss (14-19%). Indigestible fecal loss (39-53% and 42-46%), the endogenous fecal loss (8.5-9.4% and 9.1-10.4%), and the urinary loss (0.6-1.2% and 0.3-0.8%) were the major routes of Ca and P losses and inefficiency, respectively. Compared to the low cellulose and pectin levels (12% NDF, 1.6% pectin), high level (21%) of cellulose intake decreased ($P \leq 0.05$) CP digestibility and retention, whereas the intermediate (6.1%) and high (10.6%) levels of pectin intake improved ($P \leq 0.05$) CP retention through reducing ($P \leq 0.05$) urinary N losses. Dietary levels of both insoluble and soluble fiber had no effects on Ca (47.5-61.7%) or P (54.5-57.7%) retention. In conclusion, dietary levels and types of fiber intake have differential effects on nutrient utilization in pigs.

Key Words: Dietary fiber, Nutrient utilization, Pigs

898 A technique for endoscopic insertion of a percutaneous endoscopic gastrostomy tube in swine. J.S. Radcliffe*¹, J.P. Rice¹, and R.S. Pleasant², ¹Purdue University, West Lafayette, IN, ²Virginia-Maryland College of Veterinary Medicine, Blacksburg, VA.

A technique was developed using nine crossbred barrows (39 kg BW) for inserting percutaneous endoscopic gastrostomy (PEG) tubes to allow for continuous monitoring of gastric pH. Feed and water was withheld 12h prior to surgery. Anesthesia was induced with and i.m. injection of

medetomidine (80 μ g/kg BW), ketamine (10 mg/kg BW), and butorphanol (10 mg/kg BW). Pigs were laid in right lateral recumbency, and an endoscope was advanced through the mouth and esophagus, into the stomach. The stomach was insufflated and a 1 cm incision was made through the skin and subcutaneous tissue, ventral to the 10th intercostal space. An ultrasound was used to verify that no portion of the spleen or intestines was present between the abdominal wall and the stomach. An 18 gauge Seldinger needle was passed through the skin incision and used to puncture the body and stomach walls. The inner stylette of the needle was removed and a flexible guide wire was inserted through the lumen of the needle. One end of the guide wire was grasped using an endoscopic snare and retracted from the stomach, esophagus and mouth. The other end of the guide wire remained exteriorized through the abdominal wall. A 28 french gastrostomy tube and dilator assembly were attached to the guide wire. Tension was placed on the end of the guide wire that remained exteriorized through the abdominal wall. This advanced the PEG tube through the mouth, down the esophagus, and into the gastric lumen. The dilator assembly helped facilitate exteriorization of the PEG tube through the stomach and body walls. An exterior retention sleeve was used to hold the PEG tube in place. All nine surgeries were successful and all pigs were used in a 12-wk experiment. At the end of the experiment, all pigs were killed and necropsied to assess post-surgical complications. No complications were observed. PEG tubes were located between the body and antral regions of the stomach, approximately equi-distant from the greater and lesser curvature. This technique is far less invasive and requires less time than other surgical techniques designed to access the gastric lumen.

Key Words: Pig, Gastrostomy, Endoscopy

899 Dry post-pellet application of heat-labile dry products to livestock diets. J. L. Pierce*, C. A. Moran, and A. E. Sefton, *Alltech, Inc., Nicholasville, KY.*

Enzymes and bacteria currently available will not completely survive the conditioning associated with pelleting and extrusion of feeds for livestock and poultry. To overcome this, post-pelleting application techniques have been used in recent years. The most successful application method to-date is liquid spray. However, there are many disadvantages to liquid sprays such as the effects of low temperature on liquids, clogging of spray nozzles, and calibration of minute amounts of liquid onto relatively large volumes of feed. A study was undertaken at a commercial feed mill to evaluate Allzyme Koji Phytase (Alltech, Inc., Nicholasville, KY) and bacterial adhesion to pelleted feed. The test material contained 1000 PU/g of phytase activity and $5.7 \log_{10}$ cfu *Lactobacillus plantarum* /g. It was applied immediately after fat coating into a screw conveyor at a rate of 250 g/min. Feed flow was approximately 15 tonne/h. Ten replicate samples were taken at each of three treatment locations: 1, complete feed (CF) in a storage bin; 2, screened pellets from load out (LO); and 3, fines screened from load out. The feed contained 1.3% fines. Phytase activity (PU/kg) and CV (%) were 1770, 21; 1979, 13; and 2209, 2 for each location, respectively. Phytase adhered equally well to the screened LO feed as the complete feed ($P = .16$). Fines had more phytase activity than either the CF or LO ($P < .05$), however, that only represented 1% of total activity. *L. plantarum* counts (\log_{10} cfu g⁻¹ CF, LO and F respectively) were 5.79, 5.82 and 6.33; SE = 0.09. *L. plantarum* counts in the CF and LO did not differ. Furthermore, bacterial product recovery was considered to be 100%. A higher recovery was identified in the fines ($P = .01$) due to the greater surface area available. Based on these findings, it is anticipated that a variety of other important, heat-labile, feed additives may be applied to pelleted or extruded feeds with this technology.

Key Words: Phytase, Feed, Bacteria

900 The effect of pearling on the removal of deoxynivalenol (DON) from hulled barley. J.D. House*¹, C.M. Nyachoti¹, and D. Abramson², ¹University of Manitoba, Winnipeg, MB, Canada, ²Agriculture and Agri-Food Canada, Winnipeg, MB, Canada.

The contamination of cereal grains with the mycotoxin deoxynivalenol (DON) presents a challenge to swine producers due to its anorectic effects when present in excess of 1 ppm in the diet. Effective strategies for the removal of DON from grains are critical, especially in regions where this mycotoxin is endemic. To this end, studies were conducted to test the following alternate hypothesis: The removal of the hull fraction of

DON-contaminated barley will reduce the DON content of the grain, thereby increasing its value as a feedstuff for swine. One hundred grain samples of hulled barley, with varying DON concentrations (4.8, 9.8, & 21.1 ppm), were subjected to an abrasive-type dehulling procedure, using a Strong-Scott pearling machine, for 0, 15, 30, 45, 60, 75, 90, 105, & 120 seconds (n=4 per time point per barley sample). Following the prescribed pearling times, the remaining grain fractions were analyzed for weight remaining (%), DON (ppm), crude protein (%CP), neutral detergent fibre (%NDF), ash (%ASH), gross energy (GE; kcal/kg), and calculated digestible energy values (DE; kcal/kg). Following the initial 15 seconds of pearling, 85.0 ± 0.2 (lsmean \pm SEM) of the grain mass remained. Additional pearling resulted in a linear decline of 4.5% of grain mass per 15 seconds. The initial 15 seconds of pearling reduced the DON content of the grain to 34.0 ± 0.7 % of the original value, irrespective of the initial level of contamination (ppm). Additionally, the initial 15 seconds of pearling produced a grain sample containing (as a % of un-pearled values) 103.6 ± 0.4 % CP, 70.8 ± 1.1 % ASH, 60.3 ± 1.2 % NDF, 101.2 ± 0.5 % GE, and 113.3 ± 0.7 % DE. Further pearling resulted in continued significant ($P < 0.05$) reductions in the % of DON remaining to a level of 7.9 ± 0.7 % after 120 seconds but with significant losses in grain mass. These data provide evidence that pearling (de-hulling) can serve as an effective means of reducing the DON content of barley, with improvements in the nutrient content of the resulting samples. However, the need to reduce the DON content of contaminated barley to less than 1 ppm will necessitate the removal of a significant amount of the grain mass for highly contaminated samples. Funding: Manitoba Pork Council and A.R.D.I.

Key Words: Deoxynivalenol, Decontamination, Pearling

901 Effect of quality and enzyme supplementation of wheat based diets on feed consumption and growth performance of pigs from 19 to 89 kg live weight. T.A. Van Lunen¹, K.D. Foote^{*2}, and P.H. Simmins³, ¹*Agriculture and Agri-Food Canada, Charlottetown, PEI*, ²*Atlantic Veterinary College, Charlottetown, PEI*, ³*Finnfeeds International, Marlborough, UK*.

A study was conducted to evaluate the effects of quality of wheat based diets and graded levels of a commercial enzyme mixture on growth per-

formance and feed consumption of pigs. Eight replicates of 1 pig per pen were placed on test at 19 kg live weight to dietary treatments containing one of two wheat cultivars and 5 levels of an exogenous enzyme mixture in a 2 by 5 factorial design. The wheat cultivars represented high quality and low quality grains as measured in a previous growth trial. Enzyme levels consisted of 0, 0.25, 0.5, 0.75 and 1.0 kg/T of Porzyme 9300 which contained a minimum of 4000 U/g xylanase. The pigs were fed, ad libitum, a 75% wheat based diet formulated to meet the nutrient requirements of a fast growing genotype. Water was available ad libitum via nipple drinkers. At 57 kg, all pigs were evaluated by real-time ultrasound to measure back fat depth and longissimus dorsi (LD) muscle at the P2 site. The trial ended when the pigs reached 89 kg live weight. The animals were cared for in accordance with the guidelines of the Canadian Council on Animal Care. The results indicated that wheat quality had a significant ($P < 0.05$) effect on growth rate (ADG) and feed intake (FI) with the high quality wheat resulting in a higher ADG and FI than the low quality wheat. Wheat quality had no significant effect on feed conversion ratio (FCR). The 0.75 kg/T enzyme inclusion level tended to reduce FI ($P = 0.13$) in the grower stage and significantly ($P = 0.04$) improved FCR over the length of the trial as compared to the 0 kg/T treatment. Significant differences ($P < 0.05$) in FI and FCR, for the 0.75 vs 0 kg/T treatments, were achieved in the grower stage when the data from pigs wasting feed were removed. The interaction between wheat variety and enzyme level reduced FCR by 18% ($P < 0.05$) in the grower stage with the low and high quality wheat diets at 0.75 and 0.50 kg/T xylanase levels, respectively. P2 backfat and LD depth were unaffected by dietary treatment. The results of this study indicate that some negative performance aspects of growing pigs associated with poor quality wheat-based feeds can be overcome by the use of exogenous xylanase.

Key Words: Pigs, Wheat, Xylanase

Production, Management, and the Environment Livestock Management

902 Comparison of silvopastures and open pastures for cow-calf production. S.M. DeRouen* and T.R. Clason, *Louisiana State University Agricultural Center, Homer*.

The objective of this study was to compare cow-calf production on pine silvopastures with open pastures. Cow-calf production data were collected for 4 yr. Land areas were composed of: two 4.85-ha silvopastures on a 34-yr old pine plantation (62 trees/ha) (SP); and two 4.85-ha open pastures (OP). Bahiagrass, common and Coastal bermudagrasses and sod-seeded ryegrass forages were established in both land areas and rotationally grazed. Within land areas, low rate of nitrogen (N) fertilization (LN; 112 kg/ha split over 2 applications) and high rate of N fertilization (HN; 224 kg/ha split over 4 applications) were evaluated. At the initiation of the study, 40 mature F₁ Brahman x Hereford cows were blocked by age, BW and previous calf 205-d weight (205W) and assigned to each land type x N fertilization regime (TRT). An equal stocking rate (2.06 cow-calf units/ha) of 10 cows per TRT was maintained. Cows were assigned shortly after calving in late February and remained on their respective TRT until weaning in early October. Fertile Angus bulls were used for a 60-d spring breeding season. After weaning, all cows were combined and managed equally during the fall and winter. Each of the 4 herds was rotated annually to a different TRT. Cows culled from the study were replaced with cows of the same breed type and similar age. Statistical analyses were conducted with a generalized linear mixed model procedure. A total of 160 cow and 156 calf records were collected. Cow BW and body condition score (BCS) changes were similar ($P > .22$) among TRT. Pregnancy rates were similar ($P = .76$) and were 98, 96, 92 and 94% for SP-LN, SP-HN, OP-LN and OP-HN, respectively. Calf birth date, birth weight, preweaning ADG, actual weaning weight and 205W did not differ ($P > .12$) among TRT. The 205W by SP-LN, SP-HN, OP-LN and OP-HN were 244, 251, 233 and 245 kg, respectively. In conclusion, similar cow-calf productivity was observed among silvopastures and open pastures and no differences in animal performance were

found among the two levels of nitrogen fertilization applied to either land area.

Key Words: Cow-calf production, Silvopastures, Fertilization

903 Commercial Evaluation of Prototype Meishan Hybrid Pigs for Reproductive Performance and Carcass Composition Traits. C. Okere*, J. Cosgrove, and L. Nelson, *Genex Swine Group Inc., Regina, Saskatchewan, Canada*.

The Genex Meishan Hybrid (GMH) (50% Landrace: 25% Chinese Meishan: 25% Large White) was evaluated against the standard Genex F1 gilt - Genex Hybrid (GH) (50% LW: 50% LR) in a commercial setting. Principal areas of evaluation were female reproductive performance and carcass traits of progeny following specific terminal crosses (GH x GNX3000 vs GMH x GNX3000). Non-significant genotype differences were noted for all carcass composition traits with the exception of hot carcass weight (88.7 3.6 vs 90.2 3.6 kg, $P = 0.001$) for GMH and GH progeny respectively. Compared to GH, GMH had slightly lower grade fat depths (19.1 3.9 vs 19.5 4.2 mm, $P = 0.48$), loin depths (58.2 7.2 vs 59.1 8.5 mm, $P = 0.38$), and similar estimated lean yield (60.2 1.8 vs 60.1 1.8 %, $P = 0.72$). Carcass index varied from a low of 90.0 to a high of 116.0 and were similar for both genotypes (109.5 3.8 vs 109.2 4.1, $P = 0.50$). The sexes did not differ in carcass composition traits with the exception of grade fat depths (19.2 vs 15.6 mm, $P = 0.04$) for barrows and gilts. Age at first service (220.5 vs 222.9 , 198.9 vs 197.7 d; $P = 0.89$) and wean to first service (5.0 vs 4.9 , 6.9 vs 8.8 d; $P = 0.67$) were similar for both genotypes. Mean number born alive, number weaned and weaning weights were 10.4 vs 11.1 (Farm A), 11.1 vs 11.0 (Farm B), 9.8 vs 9.6 , 8.9 vs 9.2 , 7.1 vs 6.7 , 7.0 vs 6.7 for GH and GMH respectively. Significant genotype effects were observed for number born ($P = 0.007$) and born alive ($P = 0.02$). The average parity of sows was 1.6, 1.9,

1.6 and 1.7 for GH and GMH in Farms A & B respectively. A number of conclusions can be drawn from this study 1) concerns over potential carcass performance of slaughter generation from Meishan-derived dam lines to have been overstated and 2) the prototype line containing 25% Meishan had increased number of pigs born alive and weaned per litter that must be considered in light of other features of this genotype such as carcass composition traits.

Key Words: Prototype Meishan, Reproduction, Carcass quality

904 Location and breed effects on cashmere production by goats. C. J. Lupton^{*1}, A. R. Dooling², K. Lankford³, and F. A. Pfeiffer¹, ¹Texas Agricultural Experiment Station, San Angelo, ²Pioneer Mountain Farm, Inc., Dillon, Montana, ³Susitna Ranch, Willow, Alaska.

Three groups of contemporary, fiber-producing goats representing two genotypes (Cashmere (C), higher producing and Spanish (S), lower producing; initially, 20 yearling castrate goats/genotype/group) were maintained for three years at three diverse locations in the USA to study the effects of location (equals environment including local customary management) on cashmere production and fiber characteristics. Initially (using yearling weights and fleeces) and within genotype, body weight (BW), raw fleece weight (RFW), cashmere yield (CY), cashmere down production (CDP), cashmere average fiber diameter (CAFD), and cashmere average staple length (CASL) were not different among groups. The goats were maintained on pasture and supplemented with local hays in an attempt to achieve and maintain target body weights. The three locations were close to San Angelo (TX), Dillon (MT), and Willow (AK). Each year, fleeces were shorn before the commencement of shedding in January (TX), March (MT), and April (AK). The main effects of location (both genotypes, data from three production years) were: BW in AK < MT < TX (31.0, 39.2, and 49.4 kg, respectively, $P < 0.0001$); RFW in AK < MT = TX (445, 491, and 513 g, respectively, $P < 0.005$); CY in AK > MT > TX (27.3, 21.3, 17.4 %, respectively, $P < 0.0001$); CDP in AK > MT > TX (4.0, 2.7, and 1.8 g/kg BW, respectively, $P < 0.0001$); CAFD in AK = MT < TX (17.3, 17.4, 18.6 microns, respectively, $P < 0.0001$); and CASL in AK = MT > TX (7.5, 7.1, and 6.3 cm, respectively ($P < 0.0001$)). The main effects of breed (data from four production years, $P < 0.0001$ for all reported differences) were: BW of C < S (31.4 vs 38.5 kg); RFW of C > S (454 vs 353 g); CY of C > S (22.4 vs 16.7 %); CDP of C > S (3.21 vs 1.47 g/kg BW); CAFD of C and S were not different (17.2 microns); and CASL of C > S (6.8 vs 5.2 cm). This information may assist producers and scientists in this country and abroad to better understand the effects of environment on cashmere production and fiber characteristics.

Key Words: Cashmere, Goat, Environment

905 Polymer assisted solid separation is similar for gestation, farrowing, nursery and grow-finish swine slurry. P. Walker and J. Olson^{*}, ¹Illinois State University, Normal.

Four concentration rates of Percol 757[®], a copolymer acrylamide, were evaluated as flocculants to coagulate the solids fraction of anaerobic swine slurry collected from gestation (G), farrowing (F), nursery (N), and grow-finish (G-F) pits. Fourteen samples of slurry were collected with a 2.4m probe from a pump station that was drained from each of four G, F, N and G-F .61m deep pits on 16 separate occasions during a 30 day time period. For each collection, .75g and .375g of polymer (PM) were each mixed with 6-500mL samples of slurry, stirred at 30 RPM for 10 minutes, poured into cone-shaped settlemeters and diluted with 500mL of de-ionized water. For each collection 2-500mL slurry samples were poured into settlemeters without PM addition and diluted with 500mL of de-ionized water to serve as controls. Following a 1h settling time all samples were analyzed for separable solids (SS), total suspended solids (TSS), dissolved oxygen (DO), chemical oxygen demand (COD), phosphorus (P) and nitrogen (N). In addition, two collections of G-F slurry were mixed and evaluated with .125g and .0625g of PM using the previously described procedure. No differences ($P > 0.05$) were observed in any of the parameters evaluated between .75g and .375g of PM addition. Compared to control .75g and .375g PM increased the SS concentration(mL:L), 19.43 ± 8.80% and 24.78 ± 7.89%, respectively. TSS(mg:L) removal was similar for all slurry types between .75g and .375g PM addition comparing 93.12 ± 9.79% and 91.64 ± 10.22% respectively. No differences ($P > 0.05$) in P or N% removal were observed for .75g or .375g of PM. Mean P removal was 71.1% and mean N removal

was 72.76% across all slurry types. Compared to control .125g and .0625g PM increased the SS concentration 49.12% and 42.50%, removed 100.00% and 100.00% of the TSS(mg/L), removed 50.00% and 55.72% of the N and removed 100.00% and 95.13% of the P, respectively. PM had little effect on DO and COD. The mean solids concentration of the four slurry types were 2.84 ± .14% G-F, 3.61 ± .06% N, 2.65 ± .01% F and 2.85 ± .11% G. This study suggests PM concentrations as low as .24L PM : 3800L slurry or 3.78kg PM:dry ton of solids can effectively separate the solid and liquid fractions of swine slurry.

Key Words: Polymer Assisted Separation, Swine Slurry

906 The use of two types of reduced size boluses for the electronic identification of fattening lambs. D. Garin, G. Caja^{*}, J. Ghirardi, and M. Hernandez-Jover, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Two types of cylindrical ceramic boluses: Mini (M; 9.5×37.4 mm, and 9 g), and Small (S, 15.5×38.0 mm, and 25 g) were used to evaluate the effects of application age in a total of 276 lambs. In Exp. 1, newborn lambs (n= 161) were assigned to treatments according to the bolus application procedure: C (n= 40), control without bolus; MP (n= 40), M bolus applied < 7 d old with a plastic probe; MH (n= 40), M bolus applied < 7 d old by hand; and S (n= 41), S bolus applied > 8 wk old with a balling gun. Differences ($P < 0.05$) were observed in age (4.8 and 7.6 d) and weight (5.5 and 7.0 kg) for MP and MH application procedures, respectively. Values at application of S boluses were 54.8 d and 16.0 kg BW, but eight lambs (20%) reached the final experimental BW (23 kg) before wk 8 and they were not applied. Lambs mortality (7.5%) and ADG (251 g/d) were not affected by treatments. However, three lambs of MP treatment died as a result of infections induced at application. Bolus retention rate (100%), and abattoir recovery (100%) and forestomach location (reticulum, 85.7%; and rumen, 14.3%) were not affected by bolus types. In Exp.2, only M boluses were used in new born lambs (n= 115) to evaluate the breed effects on age and weight at application. Breeds were: Manchega (n= 53), Lacaune (n= 30), and Ripollés (n= 32). Lambs were intensively fattened after weaning until 24 kg BW. Ripollés lambs had a greater application age (17.0 d; $P < 0.05$) than both dairy breeds that had similar application age (11.5 d). For all breeds application BW was similar (6.8 ± 0.2 kg). Growth performances were in accordance with the breed. Bolus retention rate was 99.1% on average. Forestomach location was incomplete (reticulum, 82.5%; rumen, 12.4%) and 5.1% M boluses were found in the abomasum. As a conclusion, the M boluses could be safely applied by hand, when young lambs had surpassed 6.8 kg BW. Our results also indicate the loss of M boluses via the reticulo-omasal opening when small diameters are used and the need to evaluate the long-term retention of mini boluses in sheep.

Key Words: Transponders, Electronic Identification, Sheep

907 Using blood urea nitrogen to predict nitrogen excretion in cattle, horses, pigs, sheep, goats, and rats. M. M. Dinneen^{*} and R. A. Kohn, *University of Maryland, College Park.*

The ability to predict how much nitrogen (N) animals excrete may help decrease N pollution and reduce excess feeding of protein on farms. The objective of this study was to evaluate the potential for predicting urine N from blood urea N (BUN) and body weight (BW) for several domestic species. Means (n=119) were used from 23 studies where BUN and total urine N were reported. Urine N (mg/d) per kg body weight was regressed for each species against BUN (mg/L) as a fixed effect and study as a random effect. For each species, the intercept was not significant, and was subsequently set to 0. The N clearance rate (liters of blood cleared of urea N per d per kg body weight) was calculated as the slope coefficient of BUN and differed from 0 ($P < 0.05$) for each species. Herbivores had lower N clearance rates than pigs, and rats had higher clearance rates than other species ($P < 0.01$). Urine N (mg/d/kg BW) would be predicted as clearance rate (see table) times BUN (mg/L). Root mean square prediction errors as a percentage of mean urine N were 39, 49, 41, 44, 11, 55 and 8% for dairy, beef, pigs, sheep, horses, rats, and goats respectively. The percentages of mean square prediction error attributed to study differences were 56, 93, 81, 86, and 36% for dairy, beef, pigs, sheep, and rats (only 1 study was used for each of horses and goats). Urine N can be predicted from BUN if methods are consistent within a study.

Species	Studies No.	Means No.	N Clearance L/d/kg BW	SE
Dairy	6	31	1.4	0.13
Beef	2	8	1.0	0.17
Horses	1	3	0.9	0.06
Pigs	4	18	2.0	0.19
Sheep	6	36	1.2	0.09
Goats	1	7	0.7	0.08
Rats	3	16	8.3	1.69

Key Words: Nitrogen excretion, Blood urea nitrogen, Waste management

908 Effect of bovine somatotropin on pregnancy rates in beef cows following presynchronization with MGA and synchronization with GnRH and PGF_{2α}. M.L. Borger and W.A. Greene*, *The Ohio State University, Wooster USA.*

Eighty beef cows were allotted to two similar groups (bST and control) based upon breed, age, postpartum interval, and postpartum cyclicity (as determined by ultrasonography). All cows were presynchronized by receiving .5 mg/d melengesterol acetate (MGA) in their ration from d -26 to d -12. Each cow was synchronized with 50 µg GnRH i.m. on d 0 and 25 mg prostaglandin (PGF_{2α}) i.m. on d 7. Cows were observed for estrus 0730 and 1930 and were artificially inseminated (AI) 8-16 h after estrus was observed. If estrus was not observed, cows received 50 µg GnRH i.m. and were AI 90 h after PGF_{2α}. At the time of AI, cows in the bST group received 500 mg bovine somatotropin (bST) s.c. while the control group received no bST. Following the synchronization period, repeat breedings were done until d 49. Cows were pregnancy diagnosed by ultrasonography on d 80. PR to synchronization (PR-SYNC) and overall PR were similar for both groups (P>.05). PR-SYNC for bST and control groups were 57.5 and 50.0%. Overall PR for bST and control groups were 90.0 and 85.0%. PR-SYNC tended to be higher for cycling cows (56.7 vs. 45.0%, P=.36) while overall PR was not affected (P>.05) by postpartum cyclicity status at time of presynchronization.

909 Location and season effects on mohair production by Angora goats. F. A. Pfeiffer*, C. J. Lupton¹, and A. R. Dooling², ¹*Texas Agricultural Experiment Station, San Angelo*, ²*Pioneer Mountain Farm, Inc., Dillon, Montana.*

Angora goats, which produce long, white, lustrous fibers known as mohair, were introduced into the US from Turkey in 1849. They have since been raised under many diverse environments with mixed results. This experiment was designed to determine effects of two different US environments on mohair production and fiber characteristics. Sixty yearling, castrated goats obtained from a Texas source were shorn so that mohair fleece (6-mo growth) and fiber properties could be determined. Subsequently, 20 relatively uniform goats were assigned to each of two groups such that average body weight (BW), grease fleece weight (GFW), clean yield (CY), clean fleece weight (CFW), clean mohair produced/unit of bodyweight (CFW/BW), average fiber diameter (AFD), average staple length (ASL), and medullation (MED, KEMP, TOTMED) were not different between groups. One group (TX) remained close to San Angelo, Texas, and the other (MT) was re-located to Dillon, Montana. The goats were maintained on pasture and supplemented with local hays for 3 yr. Each year, animals were shorn and weighed in February or March (Spring, S) and again in August or September (Fall, F) and their fleeces were re-tested. Location X season interactions were significant for all properties measured except CY, AFD, MED, KEMP, and TOTMED. The CY in MT > TX, whereas AFD in MT < TX (79.9 vs 76.1 % and 32.9 vs 36.0 microns, respectively, P < 0.0001). The MED, KEMP, and TOTMED were not different (0.85, 0.15, and 1.00 %, respectively, P > 0.14) between locations. In MT, BW, GFW, CFW, CFW/BW, and ASL were greater (P < 0.05) in F than in S (41.6 vs 32.4 kg, 3.3 vs 2.1 kg, 2.6 vs 1.7 kg, 65.9 vs 53.4 g/kg, 13.5 vs 10.4 cm, respectively). Differences were consistent with harsh, cold winters and summers in which abundant feed was available. In contrast, GFW and ASL in TX were smaller (P < 0.05) in F than in S (3.2 vs 3.7 kg and 11.4 vs 13.3 cm, respectively). The TX goats had similar (P > 0.05) BW, CFW, CFW/BW, and AFD in F and S (46.6 vs 47.9 kg, 2.5 vs 2.7 kg, 55.2 vs 56.6 g/kg, and 35.9 vs 36.1 microns, respectively). The TX data are consistent with relatively mild winters and harsh, hot summers. The lower production of

MT goats would be offset to some degree by greater unit value of the finer mohair.

Key Words: Angora goat, Location, Season

910 Animal performance and carcass quality of stocker calves on grass pasture with ad libitum access to a high energy diet. W. A. Phillips*, M. A. Brown¹, J. W. Holloway², and H. S. Mayeux¹, ¹*USDA-ARS Grazinglands Research Laboratory, El Reno, OK*, ²*Texas Agricultural Experiment Station, Uvalde.*

With improved cattle genetics and stocker management, stocker calves are heavier at the end of the production cycle and are sometimes discounted when sold in the spring as feeders. The objective of this experiment was to compare animal performance, carcass quality and feed inputs of stocker calves finished on pasture with ad libitum access to a high grain diet to a conventional confinement feeding system. Beef calves (N=278) were born in the spring, weaned in the fall, and transported from Booneville, AR or Uvalde, TX to El Reno, OK to grazed winter wheat and/or dormant native prairie during the winter and wheat pastures in the spring. In June of each year (1996 and 1997), calves were blocked by breed, source and any previous treatments. They were then randomly assigned within block to a conventional total confinement finishing system (FEEDLOT) or to a new system (GRAIN-ON-GRASS) where calves grazed warm season grass pastures at a stocking rate of 9.9 calves/ha with ad libitum access to a high grain diet. A common high grain diet was feed to both FEEDLOT and GRAIN-ON GRASS each year. Pen and pasture were used as the experimental unit. The statistical model contained group (which was a combination of year, source and calf gender), system (FEEDLOT vs GRAIN-ON -GRASS) and the two-way interaction. Average final BW (526 kg) and overall ADG (1.16 kg) were similar across finishing system. Calves in the GRAIN-ON-GRASS group were on feed for 10 d less (P < 0.01) than the calves in the FEEDLOT (137 vs 147) and consumed less (P < 0.05) feed (1087 kg vs 1312 kg). Calves in the GRAIN-ON-GRASS group had similar hot carcass weights (320 vs 326 kg), less (P < 0.04) carcass fat thickness (10.6 vs 11.1 mm), lower quality grade (10.6 vs 11.1; choice = 13.0), and lower yield grade (2.55 vs 2.86) than calves finished under the FEEDLOT system. We conclude that heavy stocker calves can be finished on grass pastures with less feed inputs as compared to a conventional feedlot system.

Key Words: Feedlot, Beef Cattle, Gain

911 Time of suckling implant influences on weaning weight and post-weaning performance in steer calves. S. M. Holt*, R. H. Pritchard¹, and H. M. Blalock¹, ¹*South Dakota State University.*

The effect of time of suckling implant (IMPL) on weaning weight (WW) and post-weaning performance of steer calves was evaluated in a complete randomized study replicated over two consecutive years. Calves were born in March and April of both years. In year 1, (n=194) and year 2, (n=196) steer calves were either not implanted (NI) or were implanted with Synovex C either in MAY, or August (AUG). Dam age was divided into immature dams of ages <4 yr (IMM, n=143) or mature dams ≥4 yr (MAT, n=247). Calves were reared on native range prior to weaning. Age groups of dams were managed separately on the ranch. At weaning (late October) all calves were transported 600km to the SDSU Research Feedlot. After resting (10 h) calves were individually weighed and processed, and BW recorded was considered the WW. All calves received a Synovex S implant during arrival processing. Calves were sorted into feedlot pens by IMPL treatment (8 to 9 steers per pen; 8 pens per treatment; 24 pens per yr). A corn silage-rolled corn diet was fed (1.85 Mcal/kg NEm and 1.18 Mcal/kg NEg) for 64 d (Yr 1) and 66 d (Yr 2). IMPL increased WW (254.6 ± 2.98) 11.5 and 8.6 kg for MAY and AUG respectively (P<.05). An IMPL x dam age interaction occurred. In MAT dams WW was increased (P<.05) 18.1 and 7.8kg for IMPL treatment MAY and AUG respectively. In IMM dams, WW was increased (P<.05) 3.7 and 7.7kg for MAY and AUG calves respectively. Post-weaning DMI was increased by IMPL (P<.05), with intakes of 6.9, 7.2 and 7.0kg for NI, MAY and AUG respectively. This difference in DMI occurred in the first 4 wk post-weaning. Final BW (350.0 ± 2.46) was increased (P<.05) 11.1 and 8.2kg for MAY and AUG calves compared to NI calves. This BW difference was unchanged from WW differences. Post-weaning ADG (1.58 ± 0.025) and feed efficiency

(0.22 ± 0.001) were not affected by IMPL. Calves from MAT dams benefited most from MAY implant while calves from IMM dams benefited more from AUG implant. Suckling implants had minimal effects on post-weaning performance.

Key Words: Implants, Weaning, Feedlot

912 Effects of feed form and placement immediately postweaning on the growth performance of piglets. B. P. Corrigan*, M. Ellis, B. F. Wolter, J. M. DeDecker, and S. E. Curtis, *University of Illinois, Urbana, IL/USA*.

This study evaluated effects of feed form and feed placement for 4 d post-weaning on piglet performance to 8 wk postweaning. Two trials were carried out in commercial wean-to-finish facilities using a randomized block design with a 2×2 factorial arrangement with treatments being feed form (dry-pellet vs gruel [1:1 ratio of weight of water to pellet]) and feed placement (feed trough only vs floor mat and feed trough [mat feeding]). Pigs also had ad libitum access to water and feed. Pigs ($n=864$) were allotted in each trial at weaning (17 ± 2 d of age) to pens of 27 animals on the basis of sex (equal ratio of barrows to gilts) and weight (4.9 and 6.1 ± 0.02 kg BW for Trials 1 and 2). Floor, feeder-trough, and mat spaces were 0.64 m², 2.3 cm, and 0.05 m²/pig, respectively. Feed form did not affect ($P>0.05$) ADG in Trials 1 or 2; however, gruel-fed pigs had higher ADFI ($P<0.05$) from start to wk 3 (328 vs 289 ± 10.8 and 362 vs 332 ± 7.8 g, for Trials 1 and 2, resp.) and showed a trend ($P=0.10$) for reduced G:F (0.60 vs 0.66 ± 0.023 and 0.68 vs 0.74 ± 0.224 , resp.). In Trial 1, mat feeding resulted in higher ($P<0.05$) ADG (92 vs 76 ± 4.6 g) and ADFI (246 vs 150 ± 8.4 g) in wk 1 and higher ($P<0.05$) ADFI (331 vs 286 ± 10.8 g) from start to wk 3, and tended ($P=0.07$) to increase ADG (197 vs 186 ± 3.3 g) from start to wk 3. In Trial 2, mat feeding increased ($P<0.05$) ADFI in wk 1 (258 vs 155 ± 5.9 g) and start to wk 3 (369 vs 326 ± 7.8 g), however, ADG was not affected ($P>0.05$). There were no treatment effects ($P>0.05$) for mortality in either trial. Mat feeding reduced morbidity in the first 3 wk in Trial 1 (0.23 vs 1.27% ; $P<0.01$) but not Trial 2 (0.58 vs 1.16%) and gruel feeding reduced morbidity in Trial 2 (0.35 vs 1.39% ; $P<0.05$) but not Trial 1 (0.46 vs 1.04%). Growth rates to 8 wk postweaning were not affected ($P>0.05$) by feed form or feed placement. These results suggest providing newly weaned pigs access to gruel feed or feeding at the mat may reduce morbidity and that mat feeding may increase growth rate in the first week postweaning.

Key Words: Wean-to-finish, Mat feeding, Gruel feeding

913 Reducing cattle impact on water quality through the use of off-stream waterers. D Veira* and L Liggins, *AAFC Range Research Unit, Kamloops, BC*.

The response of a post-partum herd to free choice access to both natural and artificial watering points was characterized and the frequency of urination and defecation in and near the natural watering point during drinking events was quantified. All cows and first calf heifers in a 172 pair commercial beef herd were tagged with Allflex transponders prior to the 2001 calving season. After calving, animals were moved into a 21 ha partially treed pasture and fed hay until turnout. During this time (Feb. 23 - Apr. 20) animals had free choice access to river water via either a traditional watering point or a water trough. Daytime use of the river was recorded using a time-lapse video system. All use of the trough was detected and recorded by a Growsafe System, which read the transponders. Over the course of 56 days, 13,111 daytime drinking events were observed. Chi-square goodness of fit test showed that the herd's use of water sources was not random ($P<0.001$) with 91.6% of these events occurring at the off-stream source. The 56 days were divided into 3 periods based on changes in climate and management; the first 17 days were characterized by the presence of snow and puddles and the last 17 days by an increased trough size. Kruskal-Wallis analysis showed that use of the trough on a per animal basis, in terms of both liters per day and number of visits, was significantly lower ($P<0.001$) while snow was present. Of the 1,101 daytime drinking events recorded at the natural watering point, 168 (15.3%) resulted in the deposition of urine and/or feces in either the river (92) or the immediate riparian area (76). At this rate of deposition, off-stream watering is assumed to have prevented a further 1,833 incidents of the deposition of urine and/or feces. When winter feeding post-calving herds, the use of natural watering points and the associated pollution of water can be substantially

reduced by the introduction of free choice off-stream water. Changes in climate may affect the success of off-stream watering.

Key Words: Cattle, Water Quality, Off-stream water

914 The effects of additional lighting and glucose supplemented drinking water on the performance of dairy calves. V. R. Osborne*, B. W. McBride, and R. R. Hacker, *University of Guelph, Guelph, Ontario, Canada*.

An experiment was conducted to test the effects of supplemental lighting and the addition of a 5 % glucose solution into the drinking water offered to calves on performance from birth to 8 wk of age. Twenty four Holstein heifer calves at birth were randomly assigned to a factorial design were treatments included 18 or 10 h of continuous light (650 lux) in combination with an addition of 50 g/L of glucose to the drinking water of calves or normal water. All calves received 4 L of whole milk daily. Overall body weight gain from birth to 8 wk of age was greater for the calves on the 18 h vs 10 h of light (38.8 vs 30.7 kg; $P<0.01$). Daily water intake (5.0 vs 3.9 L /d) and calf starter intake (592 vs 317 g/d) were also greater ($P<0.01$) with calves exposed to the longer photoperiod. The addition of glucose to the water had no effect on body weight gain, feed or water intake. The results of this trial demonstrate that extended light given to calves during the nursery period increases feed and water intake and body weight gain.

Key Words: photoperiod, growth, dairy calves

915 Effect of shade in feedlot pen on growth performance of Brahman bull calves during heat raining season under Mexican dry tropic environment. R. Barajas*¹ and J.A. Felix¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

To determine the effect of shade in feedlot pen on growth performance of Brahman bull calves during heat raining season under Mexican dry tropic environment, two experiments involved 128 animals were conducted. Experiment one was conducted from July to end September of 2000, sixty four bull calves Brahman cross (BW=219 kg), were grouped by weight, and in a complete random block experiment design, were assigned to be placed in two types of pens in that consisted the treatments: 1) Pens with shade inside (four pens) that supply 3.14 m² of shade by head (Shade treatment); or 2) Pens (four pens) without shade (NO shade treatment). Experiment two, was carry out from July to September 2001, and sixty four bull calves Brahman cross (BW=195 kg), were used in experiment with similar methodology than experiment one. Results two years experiments were pooled and analyzed as a factorial 2×2 arrangement of treatments (two years \times shade level), using each pen as repetition. The shade diminished ($P<0.01$) 5% maximum air temperature (37.9 vs. 35.9°C), and in 19% ground temperature (46.6 vs. 37.5°C). Final weight was not impacted ($P=0.20$) by shade (304 vs. 312 kg). Shade increased ($P=0.03$) ADG in 10% (1.24 vs. 1.37 kg/day). Shade decreased ($P<0.01$) in 3.6% dry matter intake (8.35 vs. 8.05 kg/day). Feed/gain ratio was improved ($P<0.01$) in 12.9% by shade in pen (6.77 vs. 5.90). Shade improved in 9% the use of NEm from the diet (1.49 vs. 1.63 Mcal/kg), and in 13% NEg (0.90 vs. 1.02 Mcal/kg). Observed/expected ratio of NEm retained from diet was increased ($P<0.01$) in 8.8% with shade in pen (1.05 vs. 0.96), and improved ($P<0.01$) in 12.9% observed/expected NEg from diet (0.97 vs. 0.86). Not interaction ($P>0.10$) shade \times year was found for any variable. This results suggests, that the use of shade inside of feedlot pens is a recommendable built facility for feedlots located in the Mexican dry tropic environment areas.

Key Words: Shade, Feedlot, Brahman, Bull Calves, Performance

916 Utilization of forage cubes to deliver feed additives to cattle on all-forage diets. K. Ominski* and K. Wittenberg, *University of Manitoba, Winnipeg, Manitoba, Canada*.

Beef and dairy producers utilizing all-forage rations are faced with the challenge of ensuring that animals receive sufficient quantities of trace minerals, ionophores and/or other feed additives on a daily basis. As such, a study was initiated to compare mineral consumption in cattle receiving supplemental mineral in a fortified cube with those receiving supplemental mineral on a free-choice basis. Thirty-six Simmental-cross/Charolais-cross gestating cattle in the second trimester of pregnancy were placed in 18 pens and fed a barley silage:barley grain (85:15,

DM basis) ration containing 100 mg Mo and 4 g S kg-1 for a period of 42 days. Following the depletion stage, a 42-day stabilization phase was achieved by feeding low copper hay (3.3 ppm, DM basis). Successful depletion of stored copper was confirmed via examination of blood and liver copper concentrations at the end of the stabilization phase. During the repletion phase, cows were fed hay and one of the following three alfalfa:barley concentrate (87:13) cubes: A - no additives (salt and mineral provided on a free-choice basis); B - salt and mineral added; and C - salt, mineral and an ionophore added. Each pen received 4 kg of cubes on a daily basis. Daily intake of mineral was 41 g 2.3 per head per day when delivered on a free-choice basis and 28 g 0 per head per day when delivered via a cube. When mineral was provided on a free-choice basis, the coefficient of variation for daily intake was 81% while the coefficient of variation for pen intake was 36%. There were no significant differences among treatments for cow or calf serum copper or zinc concentrations or for cow plasma ceruloplasmin activity in the last trimester of gestation and in the initial 6 weeks post calving. There was, however, a significant difference between treatments for calf ceruloplasmin activity (P=0.0432). This data indicates that there is significant day-to-day and pen-to-pen variation in consumption when mineral is offered on a free-choice basis. Fortified cubes may be used as an effective means of eliminating the variability in intake associated with free-choice consumption of feed additives.

Key Words: Forage cubes, Feed additives, Free-choice consumption

917 Optimization of dairy heifer purchasing decisions under herd constraints with a genetic algorithm. A. de Vries*, *University of Florida.*

The objective of this study was to develop a method that is able to optimize dairy heifer purchasing decisions under herd constraints, such as a monthly net return constraint. Currently, advanced replacement models determine optimal replacement policies based on an unlimited availability of heifers and fixed herd sizes. Typically, dynamic programming (DP) is used. The optimal replacement policies are then calculated independently of the policies for other cows in the herd. Consideration of herd constraints make optimal policies dependent on policies for other cows. As a result, the number of potential policies becomes too large to optimize with DP. A genetic algorithm (GA) can be considered a search method motivated by genetic principles. Applied here, the GA combines sequences of non-optimal purchasing decisions (genes) such that the total purchasing policy (chromosome) becomes more profitable (fit). The optimal purchasing policy for 36 months was searched under Florida conditions for 4 scenarios: [A] fixed herd size, no constraint, [B] fixed herd size, monthly return > \$60 per average cow, [C] expansion from 80% to 100% of fixed herd size, no constraint, [D] same expansion, monthly return > \$0 per average cow. The herd was simulated using a Markov chain. An additional 24 months were simulated with the optimal DP policy. The number of heifers considered to be purchased each month ranged from 0% to 5% of the maximum herd size [A, B] or 0% to 20% [C, D], in 11 equal steps each. Thus, the number of potential policies was 11³⁶ for each scenario. The GA was run 10 times with 50 random starting policies for 50 generations for each scenario. For [A], the optimal policy returned \$5984, based on DP. The best GA policy returned \$5964 [A], \$5935 [B], \$4879 [C], \$4629 [D], up from average starting policies returning \$5762, \$5272, \$2300, \$2377, respectively. The return constraint was not violated in any of the final generations for both [B] and [D]. The conclusion is that a GA is a promising method for optimizing dairy heifer purchasing decisions under herd constraints. However, the optimal policy may not be found.

Key Words: Genetic algorithm, Heifers, Economics

918 The effect of feeding period length on performance, carcass traits and net return of finishing steer calves. J.D. Arseneau*, M.C. Claeys, and R.P. Lemenager, *Purdue University.*

A total of 128 Angus-sired steer calves (initial BW 304 1.2 kg) were used to evaluate the effects of feeding period length on live performance, carcass traits, and net return. Steers were randomly allotted by weight to one of four harvest dates (131, 152, 173 or 208 d on a high grain ration). Harvest d 152 was projected to be the optimum market endpoint for this group of cattle. For calculation of net return, cattle were priced using either a common carcass grid (\$120/cwt base) or live price (\$76.36/cwt). Days on feed increased (linear;P<.01) final BW, HCW, YG, % YG 4/5's,

and % premium choice and prime. A quadratic (P<.05) response was observed for ADG, G/F and DP as days on feed increased. When utilizing a common live price for all harvest dates, net return/hd increased linearly (P<.01), while grid pricing approached significance in a quadratic manner (P=.12). Price and cost assumptions used in this study resulted in greater profits when steers were sold on a constant live price basis, however, true value is more accurately reflected by the grid pricing mechanism. It appears from this study that net returns were maximized when calves were fed approximately 173 days (1.53 cm BF, >93% choice).

Item	Days on feed				Effect	
	131	152	173	208	Linear	Quad.
Final BW, kg	520	563	604	640	**	NS
ADG, kg	1.64	1.71	1.73	1.62	NS	*
F/G	5.55	5.64	5.78	6.33	**	*
HCW, kg	324	352	378	409	**	NS
DP	63.7	63.2	64.0	64.8	**	**
YG	2.25	2.46	3.09	3.43	**	NS
YG 1/2, %	70.9	56.6	9.3	6.2	**	NS
YG 4/5, %	0.0	3.3	18.7	31.2	**	NS
Ch ⁻ , %	58.0	63.3	56.2	34.3	*	NS
Prem. Ch., %	6.4	16.6	28.1	34.3	**	NS
Prime, %	0.0	0.0	9.3	21.8	**	NS
Net return,\$/hd						
Grid	11.95	44.50	60.97	35.10	NS	NS
Live	39.79	77.05	103.61	107.59	**	NS

*P<.05; **P<.01.

Key Words: Beef, Calves, Days on feed

919 A comparison of the performance and injury scores of broiler breeder flocks illuminated by high-pressure sodium, compact fluorescent and incandescent lighting. C.M. Vandenberg*¹ and T.M. Widowski¹, *University of Guelph, Guelph, Ontario/Canada.*

Gas discharge lamps, such as compact fluorescent (CF) and high-pressure sodium (HPS) offer advantages to poultry producers because of energy savings and longer lamp lives. However, the spectral characteristics of these light sources are considerably different from those of standard incandescent (IN) lamps, which may influence bird behaviour and performance. Four pens, each holding 39 Ross broiler breeder hens and 3 Ross broiler breeder males, were illuminated by either HPS (84 lux), CF (38 lux) or IN (38 lux) from 23 to 65 wks of age. Each pen contained a feeder, nipple drinker, 10 nest boxes and a raised roost area. Hen-day egg production, during wks 25 through 65 was the same for all light sources (P>0.89). Overall fertility (averaged from samples taken at 30, 36, 44, 50, 57 and 63 wks of age) was 91.4 ± 0.85% for CF, 92.3 ± 1.5 % for IN and 94.3 ± 0.94 % for HPS (P>0.10). The percentage of eggs laid on the floor instead of in the nest boxes was significantly higher in pens illuminated by CF (9.5 ± 0.61 %) than in IN (7.4 ± 0.61%) and HPS (5.7 ± 0.61%) (P<0.02). Frequency distributions of hens scored for severity of scratches behind the wings and on the upper back differed across light source at both 52 (P<0.02) and 65 weeks of age (P<0.01) with hens in HPS having significantly fewer scratches. Percentages of hens with None, Mild or Moderate-Severe scores were 58.7%, 36% and 5.3% for CF, 51%, 40% and 9% for IN and 68.6%, 24.4% and 7% for HPS, respectively at 52 wks of age and 61.7%, 36.9% and 1.3% for CF, 54%, 42% and 4% for IN and 78.2%, 18.5% and 3.3% for HPS, respectively at 65 wks. While egg production and fertility were not affected, light source appeared to influence behaviour as indicated by nesting site and injury scores.

Key Words: Broiler breeders, Light source, Production

Ruminant Nutrition

Byproducts, Growing Cattle, and Protein

920 Composition of DDGS from dry grind ethanol plants. R. Belyea^{*1}, K. Rausch², A. Mueller¹, and M. Tumbleson², ¹University of Missouri, ²University of Illinois at Urbana-Champaign.

Increased demand for ethanol has resulted in growth in the number and size of dry grind (DG) ethanol plants. In DG processing, corn is ground, and the entire ground kernel is fermented; components, such as germ and fiber, are not fractionated and there is one major coproduct (distillers grains with solubles, DDGS). DG plants require less equipment and capital and generate small volumes of ethanol, compared to traditional wet mill plants. Most DG plants are owned by producers and contribute significantly to local economies. Much of the operational cost of DG processing is cost of corn. Income from marketing of DDGS is critical in offsetting the input cost of corn and is a major factor in the economic feasibility of DG plants. Increased number and size of DG plants has increased the volume and market competition for DDGS. DG processing differs from wet milling; the composition of DDGS from DG plants could be considerably different from that from other sources. However, there are few published analytical data. Also, variation in composition can affect market value of DDGS. The objective was to obtain DDGS characterization data and to identify potential sources of variation. Samples were taken from processing streams from dry grind plants located in the upper Midwest. They were analyzed for dry matter, total N (protein), fiber, ash, fat, minerals and amino acids using AOAC methods. DDGS from DG processing had higher fiber, fat and protein than DDGS from traditional sources. Sample to sample variation for most nutrients was similar to that reported in the literature. Variation in the composition of corn was minimal and did not contribute markedly to the variation in DDGS. There was considerable variation in the composition of and proportion of streams from which DDGS were produced. High content of certain minerals, such as P, will present marketing challenges. Improving the quality and marketability of DDGS will require better control of parent process streams.

Key Words: coproducts, ethanol, nutritional quality

921 Nonenzymatically browned sunflower seeds as a source of ruminal undegraded lipid in combination with a wet corn milling feed for lactating dairy cows. S.B. Al-Suwaigh^{*} and R.J. Grant, *University of Nebraska, Lincoln.*

The objective was to determine the effect of supplementing nonenzymatically browned sunflower seeds (chipped, dehulled, 5% sulfite liquor; NEBS) to a diet containing 40% wet corn milling feed (WCMF) on efficiency of 4% FCM production and composition of milk fat. Three diets contained 1) WCMF with no added lipid, 2) WCMF + tallow to supply 3% added lipid, and 3) WCMF + NEBS to supply 3% added lipid. All diets contained 18.5% CP, 31% NDF and were fed as TMR. Diet 1 contained 53% forage and 3% lipid. Thirty Holstein cows (9 primiparous) were assigned to these three diets at 130 DIM for 6 wk. Dry matter intake, 4% FCM, body weight, and body weight change during the 6-wk trial were not affected by diet. Production of 4% FCM and efficiency of FCM production averaged 33.3 kg/d and 1.12 kg/kg, respectively. Diet 3 resulted in the lowest ($P < 0.05$) content of C14:0 and C16:0 fatty acids in milk. The content of C18:2, C18:1(t11), and C18:2(c9,t11) was increased ($P < 0.05$) by diet 3. These results indicate that there was no improvement in efficiency of FCM production by addition of lipid to a diet containing 40% WCMF. In addition, the NEBS improved the fatty acid profile of the milk fat with no reduction in total milk fat production.

Key Words: Nonenzymatic browning, Sunflower seeds, Dairy cattle

922 Ruminal behavior of protein and starch free organic matter of Vicia Faba in dairy cows. P. Yu^{*1}, B.J. Leury², and A.R. Egan², ¹Department of Animal and Poultry Science, University of Saskatchewan, ²School of Agriculture and Food Systems, University of Melbourne.

Faba beans (*vicia faba*) (FB) were dry roasted at different temperatures (110, 130, 150°C) for 15, 30 or 45 min to determine effect of dry roasting on rumen degradation of crude protein and starch free organic matter (PSF OM). Rumen degradation characteristics of PSF OM were determined by the nylon bag incubation technique in dairy cows fed

60% hay and 40% concentrate. Measured characteristics of PSF OM were undegradable fraction (U), degradable fraction (D), lag time (T₀), and the rate of degradation (K_d) of D. Based on measured characteristics, rumen availability (RA PSF OM) and bypass PSF OM (B PSF OM) were calculated. Dry roasting did not significantly affect rumen degradation characteristics of PSF OM ($P > 0.05$). The D varied from 70.3% in RFB to 69.4, 71.9, 85.6%; U from 29.7% in RFB to 30.6, 28.2 and 14.4%; K_d from 22.4%/h in RFB to 24.4, 21.1 and 7.9%/h; RA PSF OM from 63.2 in RFB to 63.0, 64.1 and 57.5% and B PSF OM varied from 36.8% in RFB to 37.1, 36.0 and 42.5% at 110, 130 and 150°C, respectively. Dry roasting slightly decreased RA PSF OM from 140.2 (RFB) to 136.3 (110°C), 143.8 (130°C) and 131.1 (150°C) g/kg DM, respectively. The above results plus previous published results indicated dry roasting had the differently affected patterns on different compositions in FB. It strongly increased bypass crude protein (BCP) and moderately increased starch (BST) with increasing temperatures and times but least affected PSF OM. Such desirable degradation patterns in dry roasted FB might be beneficial to the high yielding cows which could use more dry roasted PSF OM as an energy source for microbial protein synthesized in the rumen and absorb more amino acids and glucose in the small intestine.

Key Words: Bypass protein and starch free organic matter, Ruminant Behavior, Legume seeds

923 Effect of substitution of a soybean meal-sorghum grain blend for cull chickpeas on growth performance and carcass traits in sheep. J.F. Obregon^{*1} and R. Barajas¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

With the objective of determinate the effect of substitution of a soybean meal-sorghum grain blend for cull chickpeas on growth performance and carcass traits in sheep, thirty two Pelibuey sheep (males; BW = 24.8 ± 0.97 kg) were used in a complete randomized block experiment design. The animals were weighed and blocked by weight, in groups of four were placed in eight ground flour pens (2 × 3 m), and assigned to consume one of two diets in that consisted the treatments: 1) Diet with 15.7% CP and 3.4 Mcal of DE/kg, containing sudan grass hay 18%, soybean meal 15.5%, ground sorghum 55%, sugarcane molasses 8.8%, urea 0.5%, and mineral premix 2.2% (control); and 2) Diet similar to control, but containing 40% of cull chickpeas (variety Blanco Sinaloa) substituting all soybean meal and 24.5% of sorghum equivalent to a 39:61 SBM-Sorghum blend (CHP treatment). Animals were weighed in day 1 and 35 days after when finished the trial, feed was offered twice a day under free access condition. Once finished experiment, they were killed in a slaughterhouse, carcass trait were recorded, carcass were dissected and main cuts were measured. Treatments not affected ($P = 0.80$) ended weight (31.03 vs. 31.05 kg), average daily gain (0.178 vs. 0.175 kg/day), feed intake (1.036 vs. 1.032 kg/day) or feed/gain (5.84 vs 5.97). NEM and NEG of cull chickpeas were estimates to be close to 2.12 and 1.45 Mcal/kg. Cold carcass weight, carcass long and wide, carcass yield, rib eye area, back fat, and KPH fat were similar ($P = 0.22$) in both treatments. Long loin, short loin, rib, leg, shoulder and neck cuts were not affected ($P = 0.18$) by treatments. It is concluded, that cull chickpeas can be included in finishing diets for finishing sheep, substituting usual feed stuff as soybean meal and sorghum without affect growth-performance, carcass trait or carcass cutability.

Key Words: Chickpeas, Soybean meal, Sorghum, Growth-Performance, Sheep

924 Effect of substitution of a soybean meal-sorghum grain blend for cull chickpeas on apparent digestibility of finishing diets for sheep. J.F. Obregon^{*1} and R. Barajas¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

With the objective to determinate the effect of substitution of a soybean meal-sorghum grain blend for cull chickpeas on apparent digestibility of finishing diets for sheep, a total fecal collection experiment was conducted. Four Pelibuey sheep (males; BW = 31.75 kg) were used in a Crossover design experiment, the sheep were assigned to consume one of two diets in that consisted the treatments: 1) Diet with 15.7% CP and 3.4 Mcal of DE/kg, containing sudan grass hay 18%, soybean meal

15.5%, ground sorghum 55%, sugarcane molasses 8.8%, urea 0.5%, and mineral premix 2.2% (control); and 2) Diet similar to control, but containing 40% of cull chickpeas (variety Blanco Sinaloa) substituting all soybean meal and 24.5% of sorghum equivalent to a 39:61 SBM-Sorghum blend (CHP treatment). Sheep were placed individually in metabolic crates (0.6 x 1.2 m). Experimental periods consists in 10 days adaptation period and four days of samples collection. From each diet treatment and period one kg of diet was taken as sample and the total fecal production was collected. DM excreted in feces (206 vs. 216 g/day) was not affected by treatments ($P = 0.32$). Crude protein in feces was similar ($P = 0.97$) in both treatments (42.0 vs. 41.9 g/day). Apparent digestibility of DM was equal ($P = 0.51$) across treatments (78.5 vs. 77.9%). Apparent digestibility of crude protein was not altered ($P = 0.78$) by CHP inclusion (74.6 vs. 74.1%). The DE of diets was similar ($P = 0.51$) with values of 3.59 and 3.33 Mcal/kg for control and CHP, respectively. The observed DE/expected DE ratio of diets was not different ($P = 0.67$) shown values of 0.97 and 0.98 for control and CHP treatments. True digestibility of CP of chickpeas was calculated to be 84% and its DE content 3.82 Mcal/kg. It is concluded, that cull chickpeas contain 3.8 Mcal of DE/kg and 84% of its protein is truly digestible, and can be included in finishing diets for sheep substituting usual feed stuff such as soybean meal and sorghum without affect digestibility or energy content.

Key Words: Chickpeas, Soybean meal, Sorghum, Digestibility, Sheep

925 Effect of substitution of whole cotton seed by naturally heat-humidity damaged cotton seed on apparent digestibility of finishing diets for sheep. A. Estrada*¹ and R. Barajas¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

With the objective to determinate the feed substitution of whole cotton seed by naturally heat-humidity damaged cotton seed on apparent digestibility of finishing diets for sheep a total fecal collection experiment was conducted. Four Pelibuey sheep (males; BW = 23.5 kg) were used in a Crossover design experiment, the sheep were assigned to consume one of two diets in that consisted the treatments: 1) Diet with 16.8% CP and 3.54 Mcal of DE/kg, containing Sudan grass hay 12%, whole cotton seed (WCS) 20%, ground sorghum grain 47%, canola meal 10%, sugarcane molasses 8%, urea 0.9%, and mineral premix 2.1% (control); and 2) Diet similar to control, but containing 20% of naturally heat-humidity damaged cotton seed substituting WCS (HDC treatment). Sheep were placed individually in metabolic crates (0.6 X 1.2 m). Experimental periods consisted in 10 days adaptation period and four days of samples collection. From each diet treatment and period one kg of diet was taken as sample and the total fecal production was collected. DM and CP was assayed. Mean daily intake of dry matter and crude protein were 602 g and 114 g, respectively. Dry matter in feces (169.4 vs. 168.5 g/day) and CP excreted in feces (32.1 vs. 31.8 g/day) were not affected by treatments ($P=0.88$). The inclusion of heat-humidity damaged cotton seed did not affect ($P=0.90$) apparent digestibility of dry matter (72.0 vs. 71.8%) and apparent digestibility of crude protein (71.3 vs. 72.6). DE of diet was not altered ($P=0.78$) by treatments (3.070 vs. 3.065 Mcal/kg). This data suggest, that cotton seed that becomes damaged by rain and further sun exposed, can be used as feedstuff in finishing diet for sheep attributing it, the same nutritional value as whole cotton seed.

Key Words: Cotton seed, Heat damage, Protein, Digestibility, Sheep

926 Evaluation of feeding value of the corn steep liquor as an energy and protein source for finishing cattle diets. C. C. Ribeiro-Filho* and A. Trenkle, Iowa State University.

Two finishing trials and one digestion trial were conducted to evaluate the feeding value of corn steep liquor, a liquid byproduct from the corn wet milling industry, as an energy and supplemental nitrogen source for finishing cattle diets. In trial 1, thirty-six yearling steers weighing 381 kg, were fed for 145 days diets containing 0 or 10% of dry matter as steep liquor. Steep liquor replaced a portion of the corn, soybean meal and urea, and all the molasses. Average daily gain, feed intake and feed efficiency were not significantly ($P>.10$) different between treatments. There were no significant differences ($P>.10$) in carcass characteristics except that steers fed steep liquor had lower ($P<.05$) marbling scores and KPH fat %. In trial 2, seventy-two crossbred steers weighing 442 kg were fed for 84 days diets containing steep liquor at 0, 6 or 12% of dry matter replacing a portion of the corn and urea, and all the molasses in the diet. There were no significant ($P>.10$) differences in performance

and carcass characteristics among treatments. For the digestion trial, nine steers with average weight of 430 kg were placed in metabolism crates for total collection. The steers were fed diets containing 0, 6, or 12% of dry matter as corn steep liquor. The experimental design was Latin Rectangle with 3x3 design repeated three times. Each experimental period was 21 days, with the first 17 days for diet adaptation and the last 4 days for collection. The average DM digestibility was 80.89, 82.35, and 82.93% for 0%, 6%, and 12% corn steep liquor, respectively. There was no significant difference in DM digestibility ($P>.10$) between 0 and 6%, but there was significant difference ($P<.10$) between 0 and 12% steep liquor. Feeding steep liquor tended to linearly increase digestibility. The results of this study indicated that corn steep liquor did not affect performance and carcass characteristics when fed up to 12% of dietary dry matter. It can be effectively used as energy and supplemental protein source in finishing cattle diets.

Key Words: Corn Steep Liquor, Byproducts, Cattle

927 Evaluation of white corn in finishing diets fed to beef cattle. C. L. Warrick* and A. Trenkle, Iowa State University.

Two trials were conducted to determine the effects of feeding white and yellow corns to finishing beef cattle. The first trial compared feedlot performance, carcass characteristics and carcass fat color of 120 Angus steers with beginning average weight of 273 kg when fed diets containing white corn (WC) or yellow corn (YC). Steers were sorted based on frame score and were randomly allotted into pens of six with 8 pens (4 large and 4 small frame) fed WC diets and 12 pens (6 large and 6 small frame) fed YC. The two diets were identical with corn type as the only variable (dry rolled corn 78.7%; corn silage 10%; ground hay 5%; molasses .75%; and supplement 5.55%). DM feed intake, ADG, feed/gain and final weights after 180 days were 8.32, 8.05 kg/d ($P < .05$); 1.52, 1.52 kg/d ($P > .1$); 5.49, 5.28 ($P < .05$); and 549.6, 548.8 kg ($P > .1$) for WC and YC, respectively. Corn type had no effects ($P > .1$) on carcass weight, dressing percent, thickness of backfat, REA, KPH, marbling or quality and yield grades which were 336.9, 336.7 kg; 61.3, 61.4%; 1.13, 1.10 cm; 83.2, 80.6 cm²; 1.70, 1.74%; 554, 544 (500 = small⁰, 400 = slight⁰); 75.8, 83.3% choice; and 2.66, 2.71 for WC and YC respectively. Color of subcutaneous fat over the ribs was whiter for cattle fed WC ($P < .01$). In the second trial dry matter digestibility was determined by collecting feces of 10 345 kg steers individually confined in metabolism crates with periods consisting of 9 days adaptation and 5 days collection. Diets containing WC or YC were fed twice daily as whole or dry rolled corn. DM digestibility was not different for corn type ($P = .71$). Dry rolling increased the digestibility of both corn types from 76.42% to 80.30% for YC and 77.60% to 79.98% for WC ($P < .01$). The results indicate that WC can be fed to finishing beef steers without a loss in performance or carcass quality and yield grades. Advantages of whiter fat in carcasses of cattle fed WC may have implications for export beef markets.

Key Words: White Corn, Finishing Cattle, Digestibility

928 Effects of steam-flaking on the nutritive value of yellow, high available phosphorus, high-oil, and white corn varieties. K. F. Wilson¹, T. C. Bramble*², G. V. Pollard³, and C. R. Richardson², ¹Loveland Ind., Greeley, CO, ²Texas Tech Univ., Lubbock, ³Southwest Texas State Univ., San Marcos.

The objective of this study was to determine the effects of steam-flaking on yellow (YC), high available phosphorus (HAP), high-oil (HO), and white corn (WC). Each variety was steam-flaked to .37 kg/L for analyses. Variables measured for nutritive value of the varieties before and after steam-flaking were DM, ash, CP, ether extract (EE), starch availability (SA), free moles of sulphydryls (FMS), and dry matter disappearance (DMD). Each variety was steam-flaked utilizing a laboratory steam-flaker. Samples were collected immediately after steam-flaking and frozen for subsequent analyses. Variety x treatment interactions ($P < 0.05$) were observed for DM, SA, and 6, 12, 18, and 24 h DMD. Increases ($P < 0.05$) in SA and FMS are more than likely attributed to the disruption of the starch-protein matrix via the thermal and mechanical insult of steam-flaking. Also, DMD was increased ($P < 0.05$) by steam-flaking the four measured times. These effects may be attributed to the exposure of the starch by steam-flaking. Of the four varieties tested, HO was greater ($P < 0.05$) in CP and EE before and after steam-flaking. The HAP variety contained ($P < 0.05$) less CP and EE regardless of processing. Following steam-flaking, YC, HO, and

WC yielded a greater percentage of starch when compared to HAP. Free moles of sulfhydryls, were lowest ($P < 0.05$) for HAP as compared to all other varieties. Results for SA and FMS were an indication of the treatment effect on DMD. Initially, HAP appeared to digest very well, but subsequent time measurements showed HAP did not digest as well as the other varieties. These results indicate that more severe processing might be needed for HAP as compared to the other varieties.

Key Words: steam-flaking, nutritive value, corn varieties

929 Impact of the chemical and physical properties of yellow, high available phosphorus, high-oil, and white corn varieties on steam-flaking. K.F. Wilson¹, G.V. Pollard^{*2}, C.R. Richardson³, and T.C. Bramble³, ¹Loveland Ind., Greeley, CO, ²Southwest Texas State Univ., San Marcos, ³Texas Tech Univ., Lubbock.

The objective of this study was to determine if the chemical and physical properties of yellow (YC), high-oil (HO), high available phosphorus (HAP), and white corn (WC) varieties affected steam-flaking (SF) properties. Measurements included DM (%), ash (%), CP (%), total starch (TS, %), ether extract (EE, %), surface area (SA, cm²), kernel mass (M, g), kernel volume (V, cm³), kernel density (K, g/cm³), true density (T, g/cm³), kernel tensile strength (KT, kg), moisture uptake (MU, sec), energy (EC, kWh), processing time (PT, min), flake durability (FD, %), and fines (F, %). Differences ($P < 0.05$) between YC and WC versus HO and HAP were observed for the components of DM, ash, CP, and EE. High-oil corn had higher ($P < 0.05$) levels of CP and EE as compared to YC, HAP, and WC. However, HAP was lower ($P < 0.05$) in CP and EE compared YC, HO, and WC. Differences ($P < 0.05$) between YC and WC versus HO and HAP exist for SA, M, V, K, T, KT, and MU. High-oil and HAP had more ($P < 0.05$) M and SA than YC and WC. Yellow corn and WC were greater ($P < 0.05$) in K and T as compared to HAP and HO, while WC required more force ($P < 0.05$) to crush with respect to TS (hard seed coat) as compared to YC, HAP, and HO. High-oil corn was more nutrient dense (CP and EE) while WC had greater ($P < 0.05$) T than the other varieties. Results of the chemical and physical analyses suggest YC requires less ($P < 0.05$) PT and EC as compared to the other varieties. However, YC had a greater ($P < 0.05$) FD with the least amount of F. In conclusion, HAP would not be optimal for steam-flaking because of FD and F issues. Therefore, HO would be advised because of the relative ease of steam-flaking and the density of nutrients. As for YC and WC, they are considered above average for nutrient density, but do to the KT, more wear to machinery might be observed.

Key Words: corn varieties, chemical-physical properties, steam-flaking

930 Methane production of lactating dairy cows fed grass silage and beet pulp based concentrates. F.P. O'Mara^{*}, J.F. Connolly, and D.K. Lovett, *University College Dublin*.

The objective of this experiment was to measure the effect of replacing digestible fibre with sugars on the dry matter intake (DMI), milk production and methane production of dairy cows. This was achieved by replacing 4 kg per day of unmolassed beet pulp with 4 kg of molassed beet pulp. In addition, each cow was fed 2 kg of concentrates (including 1 kg of soyabean meal), 100 g of mineral/vitamin mixture, and grass silage ad libitum. The experiment involved 8 cows, who were fed both diets in a cross-over design with 4 week periods. Three weeks were allowed for adaptation, with measurements taken in the final week. Methane output was measured using the sulfur hexafluoride (SF₆) technique. Boluses containing SF₆ with a pre-determined release rate were inserted into the cows' rumen 3 weeks before the first sampling period. Their breath was sampled for five 24 hour periods and methane and SF₆ were determined by gas chromatography. Daily methane output was calculated from the release rate of SF₆ from the bolus and the concentrations of methane and SF₆ in the sample. Dry matter digestibility (DMD) was estimated by twice daily dosing of chromic oxide over five days and faecal grab sampling over the final two days at 07:00, 10:00, 13:00, 16:00, 17:00 and 20:00. There were no significant differences between the treatments in daily silage or total DMI or milk yield (silage DMI, 11.1 and 11.3 kg, SED 0.15; total DMI, 16.5 and 16.7 kg, SED 0.15; milk yield, 17.7 and 18.1 kg, SED 0.65, for the unmolassed and molassed beet pulp treatments, respectively). Methane production averaged 585 l per day and was not significantly affected by treatment (580 and 590 l, SED 26.4, for the unmolassed and molassed beet pulp treatments,

respectively). The energy content of this methane was 0.075 of gross energy intake. The DMD was 0.73 (SED 0.0079) on both treatments. In conclusion, any change in methane production as a result of replacing 4 kg unmolassed beet pulp with 4 kg molassed beet pulp (equivalent to replacing 1 kg of fibre with 1 kg of sugars) was not large enough to be detected.

Key Words: Methane, Dairy Cows, Beet Pulp

931 Effect of iron sulfate supplementation of the diet on plasma gossypol concentration and productivity of lactating Holstein cows fed cracked Pima cottonseed. K. McCaughey^{*}, E. DePeters, P.H. Robinson, J. Santos, J. Pareias, and S. Taylor, *University of California, Davis, CA*.

Lactating Holstein cows were fed one of four diets containing whole Upland cottonseed (WCS) or cracked Pima cottonseed (CrP) with increasing levels of iron sulfate to evaluate the effect of supplemental iron on milk yield and composition as well as DMI in cows fed diets with relatively high levels of gossypol. All diets contained 49% concentrate, 10% cottonseed and 41% chopped alfalfa hay (DM basis). The cottonseed portion of the Control diet contained only WCS. The remaining three diets contained 6.7% CrP and 3.3% WCS. Diets containing CrP were supplemented with 0, 250, or 500 ppm iron as iron sulfate. Eight cows (4 primiparous and 4 multiparous) were used in a replicated 4x4 Latin square design. Periods were 28 d in length with the last 14 d for data collection. Milk yield (kg/d) and DMI (kg/d) decreased linearly with increasing iron sulfate in the diet ($P=0.099$ and $P=0.007$, respectively). Milk fat (%) was not affected by iron sulfate supplementation. For primiparous cows, milk yield, milk fat, and DMI were 39.2, 3.3, 26.4; 40.3, 3.6, 27.6; 38.0, 3.5, 27.0; and 36.8, 3.8, 25.4 for the Control, 0 ppm Fe, 250 ppm Fe, and 500 ppm Fe diets, respectively. Similar data for multiparous cows were 49.7, 3.1, 31.8; 51.2, 3.2, 32.8; 49.9, 3.3, 32.5; and 47.7, 2.8, 29.7, respectively. WCS, whole Pima, and CrP contained (% of meats DM) 0.65%, 0.99%, and 0.96% free gossypol and 0.27%, 0.52%, and 0.52% minus (-) isomer of gossypol, respectively. Total plasma gossypol ($\mu\text{g/ml}$) increased ($P<0.001$) with substitution of CrP for WCS and decreased at an increasing rate ($P<0.001$) with the inclusion of supplemental Fe to the diet. Total plasma gossypol of the primiparous and multiparous cows were 5.3, 4.9; 9.1, 9.8; 7.4, 7.0; and 7.1, 6.8 for the Control, 0 ppm Fe, 250 ppm Fe, and 500 ppm Fe diets, respectively. Substitution of CrP for WCS increased milk yield and DMI. Although dietary iron sulfate addition reduced plasma gossypol concentration, production of milk and DMI decreased.

Key Words: Cottonseed, Gossypol, Dairy cows

932 Relationship between bulk tank milk urea nitrogen and individual cow milk urea nitrogen values. P. Arunvipas^{*}, J. VanLeeuwen, I. Dohoo, E. Leger, and G. Keefe, *Atlantic Veterinary College, UPEI, Charlottetown PE Canada*.

The objective of this study was to determine if bulk tank milk urea nitrogen (BTMUN) are similar to the whole herd average of individual cow MUN levels in pastured dairy herds in Prince Edward Island (PEI), and whether this relationship is affected by other factors such as herd size, type of DHI recording that is used on the farm, and season of the year. In 199 herds in PEI, bulk milk samples were tested for MUN every two weeks between July, 1999 and June, 2000. During this year, all herds had all cows tested for MUN once a month. The weighted (for milk production) herd average MUN levels (WHMUN) were calculated for each month and compared to the BTMUN closest to it in time. There were 1,772 complete observations in the final dataset. These data were stratified by pasture season (yes/no), five herd size groups based on the number of milking cows in the herd (<40, 41-60, 61-80, 81-100, >100 cows/herd), and one of four different individual cow milk sampling protocols employed on the farm (owner versus technician sampling, morning and/or evening sampling). WHMUN and BTMUN had a moderate concordance correlation ($P_c = 0.81$) and a low mean difference of 0.06 mg/dl, indicating that BTMUN values provided a moderately reliable indicator to the urea status of the whole herd. This moderate reliability extended to both the pasture ($P_c = 0.79$) and non-pasture seasons ($P_c = 0.82$), and various milk sampling protocols ($P_c = 0.79-0.83$). Correlations were numerically but not statistically higher in small and medium sized herds ($P_c = 0.83$ and 0.81, respectively) than in large herds (P_c

= 0.71-0.77) seen in Atlantic Canada. The reasons why BTMUN and WHMUN are not more highly correlated remain unknown.

Key Words: Bulk tank milk urea nitrogen, Milk urea nitrogen

933 Effects of an emulsifier on the steam-flaking properties and nutrient characteristics of yellow, high available phosphorus, high-oil, and white corn varieties with regards to retrogradation. K.F. Wilson^{*1}, L.D. Thompson², G.V. Pollard³, C.R. Richardson², D. Hughes⁴, and T.C. Bramble², ¹Loveland Ind., Greeley, CO, ²Texas Tech Univ., Lubbock, ³Southwest Texas State Univ., San Marcos, ⁴Ultimate Resource, Dallas, TX.

Yellow (YC), high-oil (HO), high available phosphorus (HAP), and white corn (WC) were subjected to steam-flaking to determine if the inclusion of an emulsifier during conditioning affects processing time, energy consumption, flaked grain quality and nutritive value among the varieties. Each corn variety was steam-flaked (.37 kg/L) with and without an emulsifier. Data collected included the effects of steam-flaking (energy consumption [kWh], processing time [min], flake durability [%], and fines [%]) and nutritive value (starch availability [%] and free moles of sulfhydryls [%]) of the retrograded and non-retrograded steam-flaked corn samples. After steam-flaking, a sample was collected immediately and evaluated for flake durability and fines and a second sample was taken and frozen for analyses. Additionally, samples were placed in ambient air to dry for 8, 16, 24, and 48 h to evaluate the effects of the emulsifier on retrogradation. Interactions ($P < 0.05$) were observed for processing time, energy consumed, flake durability, and percent fines. Addition of the emulsifier increased ($P < 0.05$) processing times and energy consumption. Additionally, the emulsifier inclusion improved ($P < 0.05$) flake durability and decreased ($P < 0.05$) the percent fines for HAP. Other differences ($P < 0.05$) observed were for starch availability and free moles of sulfhydryls, which consisted of drying-time x emulsifier and corn variety x emulsifier interactions. Results implied that the emulsifier retarded ($P < 0.05$) the retrogradation process with respect to starch availability and free moles of sulfhydryls. In conclusion, this study showed that by utilizing an emulsifier, the effects of retrogradation might be slowed, and processing improved.

Key Words: emulsifier, retrogradation, steam-flaking

934 Optimal level of supplemental distillers dried grains plus solubles (DDGS) for heifers grazing tall fescue pastures. J. B. Corners^{*}, K. J. Barnhart, M. Ellersieck, and J. E. Williams, University of Missouri-Columbia, Columbia, MO.

Forty-eight heifers (258.1 ± 18.1 kg) were randomly assigned to a 4 X 2 factorial arrangement, with endophyte level (HE and LE) in tall fescue and DDGS supplementation as main effects. Twelve heifers were assigned to one of four 0.8 ha paddocks (two HE vs two LE; three animals per treatment within paddock). The four treatments were: 0.11 kg soyhull control, 0.45 kg DDGS, 0.91 kg DDGS and 1.36 kg DDGS. During the 70-day trial, supplemental intake was based on mean animal weight within each treatment. At 0700 hr, heifers were placed in individual feeding stanchions for 30 minutes and fed supplements, then returned to pasture. The twelve paddocks used during the study were clipped for removal of seed heads 10 days prior to turnout. Cattle were rotated every 21 days. Total forage availability was measured in each paddock by clipping forage 2.0 cm above the ground inside ten randomly placed 0.1 m² quadrants prior to rotation onto and after rotation off paddocks. The mean NDF and CP contents of the forage were $60.6 \pm 0.04\%$ and $9.1 \pm 1.14\%$, respectively. Mean forage availability was $5,340 \pm 1,568$ kg/ha during the grazing season. Forage intake was determined by feeding 0.45 kg pelleted alfalfa meal, containing 10g Cr₂O₃/hd daily, for 17 days. Fecal samples were collected at 0600 and 1800 hr on d 11-17. Since pasture effect ($P > 0.05$) and pasture x treatment interaction ($P > 0.05$) were not significant, only treatment effects were discussed. The addition of DDGS in increasing quantity resulted in increasing DM ($P < 0.0001$) and CP ($P < 0.0001$) intakes from the supplement. Increasing levels of DDGS supplementation resulted in a linear increase in ADG ($P < 0.02$). No difference ($P > 0.13$) was observed in the protein:gain ratio of the treatment groups. Based on findings, DDGS supplementation increased ADG regardless of endophyte level in tall fescue pasture. Forage intake data will be presented at the meeting.

Key Words: Tall Fescue, Distillers Dried Grains plus Solubles, Intake

935 Effect of substitution of whole cotton seed by naturally heat-humidity damaged cotton seed on growth performance and carcass traits in sheep. A. Estrada^{*1} and R. Barajas¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

With the objective to determinate the effect of substitution of whole cotton seed by naturally heat-humidity damaged cotton seed on growth performance and carcass traits in sheep. Thirty-two Pelibuey sheep (males; BW = 21.6 ± 1.57 kg) were used in a complete randomized block experiment design. The animals were weighed and blocked by weight, in groups of four were placed in eight ground flour pens (2 x 3 m), and assigned to consume one of two diets in that consisted the treatments: 1) Diet with 16.8% CP and 3.54 Mcal of DE/kg, containing Sudan grass hay 12%, whole cotton seed (WCS) 20%, ground sorghum grain 47%, canola meal 10%, sugarcane molasses 8%, urea 0.9%, and mineral premix 2.1% (control); and 2) Diet similar to control, but containing 20% of naturally heat-humidity damaged cotton seed substituting WCS (HDC treatment). Animals were weighed in days 1, 28 and 56, feed was offered twice a day under free access condition. At the end of the experiment (d 56), they were killed in a slaughterhouse, carcass traits were recorded, carcass were dissected and main cuts were measured. Treatments did not affect ($P = 0.58$) end weights (33.69 vs. 32.5 kg), average daily gain (0.214 vs. 0.190 kg/day), daily feed intake (1.239 vs. 1.171 kg/day), and feed/gain (5.87 vs. 6.22). NEm and NEg of heat-humidity damaged cotton seed were estimates to be close to 2.37 and 1.52 Mcal/kg. Cold carcass weight, carcass long and wide, carcass yield, rib eye area, back fat, and KPH fat were similar ($P = 0.18$) in both treatments. Long loin, short loin, rib, leg, shoulder and neck cuts were not affected ($P = 0.24$) by treatments. It is concluded, that cottonseed that becomes damaged by rain and further sun exposed, can be included in finishing diets for finishing sheep, substituting usual whole cotton seed without affect growth-performance, carcass trait or carcass cutability.

Key Words: Cotton seed, Heat damage, Growth-Performance, Sheep

936 Ensiling wet corn distillers grains alone or in combination with soyhulls. K. F. Kalscheur^{*}, A. D. Garcia, A. R. Hippen, and D. J. Schingoethe, South Dakota State University, Brookings, SD.

With the development of ethanol plants wet distillers grains have become increasingly available as a feedstuff for cattle. Improvements in the storage of wet distillers grains (WDG) can result in a reduction of spoilage and greater utilization. The objective of this study was to evaluate the fermentation and preservation characteristics of ensiling wet corn distillers grains alone or mixed with soyhulls (SH). Treatments were ensiled in laboratory silos as follows: 1) 100% WDG; 2) 85% WDG + 15% SH; and 3) 70% WDG + 30% SH. Samples of each treatment were collected for analyses prior to ensiling. The silos were opened at d 3, 7, and 21 and samples were collected to evaluate the fermentation characteristics. Packing density was kept constant across all treatments at 190 kg/m³ (DM basis). Dry matter and CP of the ensiled feeds were 35, 43, and 49% and 30.8, 24.8, and 21.1% for 100% WDG, 85% WDG, and 70% WDG, respectively. The pH of the 100% WDG was the lowest at 3.2 and increased ($P < 0.05$) with decreasing levels of WDG (4.0 and 4.3 for 85% and 70% WDG, respectively). Lactic acid (% of DM) was highest for 100% WDG (4.4%) and tended to decline as SH were included in the treatments. Acetic acid, propionic acid, and ammonia-N did not differ across treatments. There was no change in DM, CP, pH, lactic acid, propionic acid, or ammonia-N in the ensiled treatments over time ($P > 0.05$). Acetic acid increased ($P < 0.05$) from less than 0.01% of DM for d 0 and 3 to 0.89 and 0.97% for the 85% and 70% WDG treatments on d 21, respectively. There was no ethanol detected prior to ensiling, however it increased ($P < 0.05$) with ensiling time for all treatments. Ethanol concentration was the highest (2.24% of DM) for 85% WDG on d 21. The low initial pH of the WDG probably explains why there were no significant pH differences within treatments over time. Differences in pH between treatments can be explained by the dilution effect of the addition of SH. These results suggest that WDG can be effectively preserved by ensiling, either alone or with the addition of SH.

Key Words: Wet corn distillers grains, Soyhulls, Ensiling

937 Effects of Flaxseed Supplementation on Nutrient Utilization, Milk Production and Composition by Lactating Dairy Cows. H.W. Soita^{*1}, J.A. Meier¹, M. Fehr¹, D.A. Christensen¹, J.J. McKinnon¹, and A.F. Mustafa², ¹University of Saskatchewan, Saskatoon SK. CANADA, ²University of McGill, QC. CANADA.

Twelve multiparous Holstein cows at 72+16 DIM were used in a 3x3 Latin square with 21-d periods to determine the effect of replacing barley grain with raw (RFS) or micronized (MFS) flaxseed in a total mixed ration (TMR) on nutrient digestibility, milk yield and milk composition. The 3 dietary treatments (DM basis) included: 1. control ration (50% barley silage, 50% barley grain and canola meal based-concentrate); 2. control ration with 1 kg barley replaced by 1 kg raw RFS; 3. control ration with 1 kg barley replaced by 1 kg MFS. Nutrient digestibility was determined using acid insoluble ash as an indigestible marker. Neutral detergent fiber, ADF and CP digestibility were not affected by supplementation, however, calcium digestibility was reduced ($P < 0.05$) by 62 and 46% when RFS and MFS were fed, respectively. Milk yield (38.3, 39.6, and 38.4 kg/d for the control, RFS and MFS diets, respectively) was similar across treatments. Milk fat (3.50, 3.48, and 3.52 %) and protein (3.31, 3.34, and 3.31%) for the control, RFS and MFS diets, respectively, were not affected by treatment. The concentration of c9, t11-conjugated linoleic acid in milk increased ($P < 0.05$) by 49% for the MFS diets relative to the control diet (CLA; 0.51, 0.57 and 0.76 g/100g fatty acids for the control, RFS and MFS diets, respectively). The MFS diets also increased ($P < 0.05$) the C18:1, C18:2 and C18:3 concentrations in milk while reducing that of C18:0, C16:0, C14:0 and C12:0. There was no effect of raw flaxseed on milk or milk fatty acid composition. Replacing 1 kg of barley grain with 1kg of MFS in the diet of lactating cows increased the unsaturated fatty acid and the CLA content of milk without depressing nutrient digestibility or daily milk production. (Key words: Raw and Micronized flaxseed, conjugated linoleic acid, milk composition)

Key Words: Micronized or raw flaxseed, Milk composition, Conjugated linoleic acid

938 In situ rate and extent of ruminal DM and N degradation of byproduct feeds in steers fed a high-concentrate diet. S.S. Swanek^{*1}, C.R. Krehbiel¹, D.R. Gill¹, and B.A. Gardner², ¹Oklahoma State University, Stillwater, OK, ²Steve Armbruster Consulting, Inc., Stillwater, OK.

In situ rate and extent of ruminal DM and N degradation of 15 byproduct feeds was determined in steers consuming a high-concentrate diet. Byproducts were classified as high protein (HP; $>40\%$ CP; soybean meal [SBM; 48% CP], cotton seed meal [CSM], guar meal [GM], peanut meal [PM], extruded soybean meal [EXSBM], and feather meal [FM]); medium protein (MP; 20-40% CP; dried distillers grain [DDG], corn germ [CG], crambe meal [CRM], sunflower meal [SFM], and wet distillers grain without solubles [WDG]); or low protein (LP; $<20\%$ CP; wheat middlings [WM], dehydrated alfalfa meal [DEHY; 17% CP], soybean hulls [SH], and corn gluten feed [CGF]). Feeds were randomly assigned to two of four steers (8 byproducts/steer) and duplicate bags were incubated in the rumen for 0, 2, 4, 8, 12, 18, 24, and 48 h. Ruminal degradation was calculated as $A + B[K_d / (K_d + K_p)]$, where A is the assumed instantly soluble fraction and B and is the potentially degradable protein. A constant rate of passage (K_p) was used (0.05 h^{-1}). Of the HP byproducts, PM had the greatest (95.8%; $P < .01$) rumen-degradable protein (RDP), A fraction (80.1%) and ruminal DM degradability (90.6%). Feather meal had the lowest RDP (21.0%; $P < .01$) and the greatest C (rumen-undegradable) fraction (68.4%; $P < .01$). For MP, SFM had greater ($P < .05$) RDP (83.3%) than all MP byproducts except WDG (79.3%; $P = .28$). Corn Germ had the lowest ($P < .01$) A fraction (31.5%) and the greatest ($P < .02$) rate of DM disappearance (1.81%/h). Wet distillers grain without solubles had the greatest (87.3%; $P < .05$) DM disappearance and CRM had the lowest (43.3%). Wheat middlings and CGF had the highest ($P < .01$) RDP (89.5 and 91.7%), A fraction ($P = .01$; 73.7 and 78.9%) and DM degradability ($P < .01$; 68.5 and 68.7%), and the lowest ($P < .05$) rates of B fraction (0.39 and 0.28%/h) and DM disappearance (0.27 and 0.25%/h) of the LP feeds. Soybean hulls had the lowest ($P < .01$) RDP (59.2%) and DM degradability (27.4%), and the highest ($P < .01$) C fraction (20.9%). Rate and extent of N degradation varied considerably among byproduct feeds. Our data suggests a potential for feeding combinations of byproducts to optimize RDP and

microbial efficiency, and maintain a balanced amino acid profile to the small intestine.

Key Words: In Situ Ruminal Degradation, Protein, Byproduct

939 Cheese whey silage for growing holstein heifers and beef finishing steers. D.R. ZoBell^{*1}, K.C. Olson¹, and R.D. Wiedmeier¹, Utah State University.

Cheese whey silage (WS) was produced at two separate locations to determine the effect of feeding WS on production characteristics of growing holstein heifers (HH) and finishing beef steers (BS). For the HH study, WS was produced by combining liquid cheese whey (45% DM) (W), wheatgrass straw (WGS) and wheat middlings (WM) at proportions of 51.5, 38.3 and 10.2% (DMB) respectively and ensiling. The WS had a DM nutrient analysis of 46.4% DM, 13.8% CP, 17.3% ADF, 27.4% NDF, .59% Ca, .56% P, and pH of 3.9. Forty-eight HH (258 kg) were assigned to treatments of Control (C) or Treated (T) with 8 head per pen and 3 pens per treatment for this 56d study. The C heifers received a growing ration with DM proportions of 16.6% alfalfa hay (AH), 40.4% corn silage (CS), 41.0% WM and 2.0% supplement (S). Treated HH received the WS and supplement. Control and T rations were isocaloric and isonitrogenous. In the BS study, WS was produced by combining W (45% DM), wheat straw and WM at DM proportions of 63.1, 28.9 and 8.0% respectively. The WS had a DM nutrient analysis of 43.5% DM, 13.3% CP, 19.9% ADF, 28.4% NDF, .64% Ca, .67% P, and pH of 4.3. Forty steers (438 kg) were assigned to treatments of C or T with 5 head per pen and 4 pens per treatment in this 84d study. Control steers received a diet consisting of 85.6% dry-rolled barley (B), 8.1% CS, 1.5% SBM and 4.8% S (DMB). Treated steers received 84.1% B, 12.2% WS and 3.8% S (DMB). The C and T rations were isocaloric and isonitrogenous. Carcass data was obtained at time of slaughter. Statistical analysis of data for both studies were performed using the MIXED procedure of SAS. Results from the HH study indicated ADG (kg/hd/day), DMI (kg/hd/day) and FE values for C and T of 1.09 and 1.06 ($P = .79$); 8.0 and 6.55 ($P = .11$); and 7.38 and 6.52 ($P = .32$) respectively. Finishing steer results for C and T respectively were 1.11 and 1.20 ($P = .15$) for ADG (kg/hd/day); 9.05 and 9.73 ($P = .006$) for DMI (kg/hd/day); and 8.26 and 8.22 ($P = .93$) for FE and carcass traits did not differ ($P > .05$). Although production variables were not different, cost of gain was decreased by 35.3% and 5.7% respectively for the HH and BS studies, due to the lower cost of the T rations. These studies suggest there may be an economic basis for including whey silage in growing and finishing diets.

Key Words: whey silage, growing, finishing

940 Accelerated growth of dairy calves fed various levels of whole milk or milk replacer. G. D. Marx^{*1} and M. C. Jacobson, ¹University of Minnesota, Crookston.

Performance of 64 newborn Holstein dairy calves equally divided by sex and size were evaluated during a 35 d period utilizing two levels each of whole milk (WM) or milk replacer (MR). In both WM and MR fed calves, the high level was 50% higher than the control level. WM was fed at 3.64 kg or 5.46 kg/d and MR fed at 0.64 kg in 3.0 kg water or 0.96 kg in 4.7 kg water divided between two feedings/d/calves. Prewaned calves were also fed an 18% CP grain starter to appetite. Maternal colostrum was fed the first 3 d of life at 3.64 kg/d/calves. All 64 calves were weaned at 35 d and continued on a grain starter and haylage ration fed free choice for another 35 d to determine any residual effects when fed 50% additional WM or MR as baby calves. Calves were housed inside an insulated and ventilated warm calf facility. All preweaned calves were fed in individual steel pens 1.2 m x 1.5 m and weaned calves were fed in group pens 3.7 m x 3.7 m. Water was available free choice with automatic fountains in each pen. Feed intakes, refusals, feed samples, body weights and health data were collected. Data were analyzed by GLM procedure of SAS. The calves fed the high level WM and MR gained 0.46 and 0.52 kg/d and were significantly higher ($P < 0.05$) than the control calves that gained 0.38 and 0.40 kg/d. Grain starter intake by the control calves fed WM or MR was higher at 0.25 and 0.26 kg/d, but not statistically different ($P > 0.05$) than calves fed the high level that consumed 0.22 and 0.23 kg/d. Weaned calves that were fed the high levels of WM and MR as baby calves gained 0.76 and 0.78 kg/d and controls gained 0.67 and 0.73 kg/d. Grain starter intakes of the weaned calves that had been fed the high levels of WM and MR were 1.51 and 1.53 kg/d and the controls consumed 1.43 and 1.38 kg/d. No differences ($P > 0.05$) were noted in weight gains and starter intake of weaned calves.

Forage intakes and feed/gain ratios of weaned calves were similar for all groups. Scour days/calf were low and similar for all treatments and no other unusual health problems were observed. Use of higher levels of both WM or MR improves growth rate of dairy calves.

Key Words: Dairy calves, Accelerated growth, Calf nutrition

941 Skeletal muscle growth and hepatic urea kinetics in lambs offered different dietary supplies of sodium propionate or metabolisable protein. A.P. Moloney*¹ and G. E. Lobley², ¹Teagasc, Grange Research Centre, Dunsany, Co. Meath, Ireland, ²Rowett Research Institute, Bucksburn, Aberdeen AB21 9SB, UK.

Increased supply of glucogenic precursors from the rumen could spare amino acids from hepatic gluconeogenesis thereby enhancing protein accretion in the growing ruminant. The objective was to determine the effects on body composition and hepatic urea production in lambs offered different dietary supplies of propionate and metabolizable protein (MP). Sixty wether lambs (Bodyweight (BW) = 44.0 kg sd 3.38) were offered one of 6 rations (22g/kg BW + 100g hay) in a 3 (0, 40 or 100 g sodium propionate (SP) /kg) by 2 (0.9 MP requirement or 1.35 MP requirement) randomized block experiment. Carcass composition was determined after an 83-day growth period by dissection and tissue accretion calculated by reference to a representative lambs slaughtered at the beginning of the experiment. In parallel, 6 wether lambs were used in a 6 (rations) by 6 (periods) Latin Square experiment to measure urea kinetics by intravenous injection with [¹⁵N, ¹⁵N]urea followed by total urine and feces collection for 72h and measurement of enrichment of [¹⁵N, ¹⁵N]urea and [¹⁴N, ¹⁵N]urea in urine and ¹⁵N concentration in feces. There were no interactions between SP and MP supply. Increased MP supply increased (p=0.05) carcass weight (29.5 v. 30.3 kg), did not affect carcass composition or the weight of internal fat depots, increased (p< 0.05) urea-N production (26.3 v. 32.9 g/day) and decreased (p<0.05) the fractional transfer of urea-N to the gastrointestinal tract (0.638 v. 0.544). Increased SP supply did not affect hepatic urea kinetics, increased (linear p<0.05) carcass weight (29.1, 30.3 and 30.2 kg), skeletal muscle mass (16.4, 17.4 and 17.7 kg) and growth (30.1, 42.3 and 46.1 g/d for 0, 40 and 100 g SP/kg, respectively). It is concluded that an increase in SP supply increased muscle growth independent of MP supply.

Key Words: Propionate, Urea, Muscle

942 Kid preference for supplement. T.W. White*¹, H.G. Bateman¹, C.C. Williams¹, and S. Alford¹, ¹Louisiana State University Agricultural Center, Baton Rouge, LA 70803.

Eight Boer x Spanish wether kids (mean BW = 17.7 ± 0.82 kg) were used in two preference experiments. Kids were fed Coastal bermudagrass hay and offered 100 g supplement DM from corn (C); corn and soybean meal (CS); corn, soybean meal, and fish meal (CSF) as meal (M); or pellet (P) or urea-fish meal molasses liquid (L). In Exp.1, each kid was offered two supplements simultaneously in every combination at 0800 on 2 consecutive days. Supplements were removed when one was completely consumed, and the percentage of DMI calculated for each. Pellets were preferred (P < 0.01) over M and both over (P < 0.01) L. Intake was equal for CP and CSP and higher (P < 0.03) than for CSFP that was higher (P < 0.01) than for CSFM that was higher (P < 0.02) than for L. In Exp.2, supplements were offered individually and consumption timed and statistically analyzed. Pelleted CS and CP were consumed more quickly (P < 0.05) than CSFP, CSM and CM that were consumed more quickly (P < 0.01) than CSFM and L. Kids prefer supplements that contain corn or soybean meal over those that contain fish meal, and they prefer pellets over meal or liquid although they will consume each fed individually.

Key Words: Goats, Supplement preference

943 Effect of Aminophylline on Metabolic and Thermoregulatory Responses During Hypothermia Associated with Cold Exposure in Lambs. B. Zimmermann*¹, G. Diebold¹, J. Galbraith², W. Whitmore², G. Murdoch², R. Mosenthin¹, and R.J. Christopherson², ¹Hohenheim University, Institute of Animal Nutrition (450), 70593 Stuttgart, Germany, ²Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, T6G2P5 Ca.

The objective of the study was to test in two experiments the hypothesis that treatment with the phosphodiesterase inhibitor aminophylline would enhance metabolic rate and delay the development of hypothermia in lambs. In experiment 1, six lambs were allocated to aminophylline treatments on a randomized schedule such that each lamb received each of four dose levels as a single injection (0, 8, 16 or 32 mg/kg i.p.) once over a period of two weeks. Dose rates between 16 and 32 mg/kg, i.p., increased (P < 0.05) metabolic rate of lambs calculated from oxygen consumption, recorded with an open circuit respiratory system. In the second experiment, 11 male and 10 female lambs were allocated to each of two treatments. Controls received 0.9% saline injections and aminophylline-treated animals received injections of aminophylline (24 mg/kg, i.p.) before exposure to an air temperature of -15°C to determine whether treatment would delay hypothermia. Mean heat production of the lambs at -15°C ranged from 13 W/kg to 15 W/kg and was increased (P < 0.01) by aminophylline, but was not significantly affected by gender of the lambs. Aminophylline did not shorten the time for re-warming in experiment 2 even though metabolic rate was increased. Aminophylline, therefore, has some potential as a treatment for hypothermia or to improve recovery from hypothermia in lambs by increasing metabolic rate during cold stress.

Key Words: lamb, metabolic rate, aminophylline

944 Effects of ruminal and post-ruminal infusion of starch hydrolysate or glucose on the microbial ecology of the gastrointestinal tract in growing steers. J. S. Van Kessel*¹, P. C. Nedoluha, A. Williams-Campbell¹, R. L. Baldwin, VI¹, and K. R. McLeod², ¹USDA-ARS, Beltsville, MD, ²University of Kentucky, Lexington, KY.

Forty steers fitted with ruminal and abomasal infusion catheters were used to determine the effects of site of carbohydrate supply on gastrointestinal tract bacteria. Steers were assigned randomly to one of 8 groups in a complete randomized block design with a 36 d experimental period. Treatments included: 1.) a pelleted basal ration fed at 0.163 Mcal ME (kg BW^{0.75})⁻¹ d⁻¹ (LE), 2.) the basal ration fed at 0.215 Mcal ME (kg BW^{0.75})⁻¹ d⁻¹ (HE), 3.) the basal ration fed at 0.163 Mcal ME (kg BW^{0.75})⁻¹ d⁻¹ plus ruminal infusion of starch hydrolysate (SH) (RSH), 4.) the basal ration fed at 0.163 Mcal ME (kg BW^{0.75})⁻¹ d⁻¹ plus abomasal infusion of SH (ASH), and 5.) the basal ration fed at 0.163 Mcal ME (kg BW^{0.75})⁻¹ d⁻¹ plus abomasal infusion of glucose (AG). Glucose and SH were infused at 14.35 and 12.64 g/kg BW^{0.75}/d, respectively. Ruminal, intestinal, and fecal samples were obtained on d 36. Ruminal pH was low (5.79) in LE steers and unaffected (P > 0.10) by increased energy intake or carbohydrate infusions. Intestinal and fecal pHs were 6.93 and 7.00, respectively for LE steers. Energy intake (P < 0.10) and carbohydrate infusions (P < 0.01) decreased intestinal and fecal pH compared with LE. Ruminal counts of anaerobic bacteria in LE steers were 8.99 Log₁₀ cells/g. ASH and AG steers had approximately 1.5 Log₁₀ cells/g higher (P < 0.01) intestinal and fecal anaerobic populations. There were 40, 22, and 23%, respectively, fewer aerobic than anaerobic ruminal, intestinal, and fecal bacteria. Less than 1% of the anaerobic bacteria enumerated in the rumen, intestines and feces were coliforms, and 97% of the coliforms were *Escherichia coli*. Carbohydrate infusions resulted in only numerical increases in fecal coliform and *E. coli* concentrations (P > 0.10). Fecal *E. coli* were highly acid-sensitive in all steers with less than 1% surviving a 1 h exposure to low pH (2.0). This suggests that intestinal or fecal pH is not a good indicator of acid-resistance and supports the concept that there are other factors that may induce acid resistance.

Key Words: Bacteria, *Escherichia coli*, Cattle

945 Replacing corn silage with sorghum silage to supplement growing steers grazing high quality pastures: effects on productive performance. L. O. Abdelhadi*^{1,2,3}, F. J. Santini^{1,2}, and E. L. Villarreal², ¹Fac. Cs. Agrarias-UNMDP, ²INTA EEA Balcarce, ³CONICET - Argentina.

Sorghum is better adapted to lower rainfall and unfavourable soil conditions than corn, but its lower grain digestibility could affect animal responses. This study was conducted to evaluate the effect of replacing corn silage (CS) by grain sorghum silage (SS), on liveweight gain (LWG) and fat deposition rate (FDR) of grazing steers. Forty-two British steers (9 months age and 187±26 kg LW) were assigned to one of three treatments in a randomized design: TP, fresh pasture ad libitum; TCS or TSS, with pasture plus CS ('Novartis Suco' hybrid) or SS ('Dekalb DA38' hybrid), both fine chop and rolled at dough grain stage, representing 40% of the total diet (on a DM basis), respectively. Two paddocks (reps) per treatment and 7 animals per rep were used. All steers grazed in a one-day strips throughout 115 days from June to October, mixed pastures (70% grass and 30% legumes) with 2975 kg DM/ha availability (estimated weekly), 16.0% DM, 22.3% CP, 35.8% NDF and 74.6% IVDMD. Supplements contained 6.1 and 6.7% CP, 50.9 and 42.9% NDF, 13.7 and 22.9% starch, 64.7 and 51.5% IVDMD and were consumed at a rate of 2.78 and 2.89 kg DM/animal/d, 1.2% of LW for CS and SS, respectively. FDR was estimated measuring subcutaneous fat depth (FD) between 11-12th rib using an ultrasonic ecograph and steers were weighted every 21 days until the end of the experiment. Silage supplementation, led us to increase stocking rates from 2.45 in TP up to 4.66 (TCS and TSS) steers/ha, and beef production from 266 in TP up to 483 (TCS) and 488 (TSS) kg/ha. We conclude that partial replacement of high quality pastures by SS, would result in similar performance that once obtained with CS, but would affect FDR of the animals.

Item	TP	TCS	TSS
DMI, kg/d	6.81	6.96	7.21
Initial LW, kg	192.6	181.1	187.4
Final LW, kg	298.8	281.8	291.1
LWG, kg/d	0.948	0.913	0.923
Initial FD, mm	2.32	2.38	2.46
Final FD, mm	3.58	3.28	3.10
FDR, mm/30d	0.327 ^a	0.228 ^{ab}	0.148 ^b

^{abc} Means within a row with unlike superscripts differ ($P < .05$)

Key Words: Supplementation, Corn Silage, Sorghum Silage

946 Effects of ruminal infusion of electrolyte solutions on calf performance parameters. S. I. Wawrzyniak*¹, H. D. Tyler¹, and J. D. Quigley, III², ¹Iowa State University, Ames, ²American Protein Corporation, Ames, IA.

To treat dehydration, diarrheic calves are often ruminally drenched with electrolyte solutions. To determine the effects of these solutions on feed intake and average daily gain, dairy bull calves ($n=28$) were ruminally infused with either a commercial electrolyte solution or a 9% saline solution at the rate of 10% of body weight per day for three consecutive days. Control calves ($n=15$) were sham-infused by inserting the esophageal feeder without infusing any fluids. Calf starter and water were offered ad libitum and starter intake was recorded daily. Body weights were determined at day -1 (pre-infusion) and day 8 (post-infusion). Feed intake was lower for calves infused with fluids than for control calves ($P < 0.01$). Average daily gain was lower in calves infused with fluids than in control calves ($P < 0.01$). Feed intake ($P < 0.05$) and average daily gain ($P < 0.01$) were decreased for calves infused with electrolytes as compared to calves infused with saline solution or control calves. Overall, infusion of either electrolytes or saline solution into the rumen was detrimental to calf performance.

Key Words: Rumen, Electrolytes, Feed intake

947 Effect of nitrogen intake on total nitrogen excretion and its partition between urine and feces in Holstein heifers. JC Marini* and ME Van Amburgh, Cornell University.

Nitrogen (N) losses affect ground and surface water quality; in addition ammonia and nitrous oxide emissions affect air quality and the latter has been implicated as a significant contributor to global warming. Reducing N emissions, while maintaining adequate animal performance is

a challenge that animal nutritionists face today. In order to investigate the effect of dietary protein level on N excretion and its partition in urine and feces, four Holstein heifers (267±3.6 kg) were used in a Youden square design. Isocaloric diets (2.66 Mcal ME/kg DM) with a N content of 1.4, 1.9, 2.5, 3.0 and 3.4% were fed at approximately 1.8 x maintenance. Increasing the N content of the diet increased urinary N excretion (20.4, 37.8, 66.4, 93.3 and 118.8±1.05 g N/d; $P < 0.0001$) and N balance (19.7, 24.8, 29.6, 32.3 and 32.4±3.99 g N/d; $P < 0.01$), but did not affect the fecal N excretion (49.5±1.22 g N/d; $P = 0.21$). Urea accounted for 97% of the increase in urinary N excretion and urea excretion increased 25-fold between the lowest and highest level of N fed. Increasing N intake reduced the efficiency of N utilization (21.5, 21.9, 20.6, 18.1 and 16.0±2.63 %; $P = 0.07$) and increased the amount of N excreted per unit of N retained (3.82, 3.87, 4.05, 4.45, 6.37±0.92 g N excreted/g N retained; $P < 0.05$). The proportion of N excreted in the urine increased (1.1, 1.7, 2.4, 2.8 and 4.5±0.65 g urinary N/g N retained; $P < 0.001$), while the proportion of fecal N excretion decreased (2.72, 2.14, 1.66, 1.60 and 1.83±0.31 g fecal N/g N retained; $P < 0.05$) with increasing N intake. Reducing dietary N concentration not only decreased the total N excretion, but also reduced the N that is readily volatilized as ammonia (i.e. urea and urinary and fecal ammonia) and increased the carbon:N ratio of the manure, which is related to a decrease in N losses, both as ammonia and nitrous oxide. Feeding reduced amounts of protein, coupled with a high digestible diet, could be a useful tool to reduce the amount of N excreted in the environment, but at the same time maintain adequate growth rates and N retention.

Key Words: Nitrogen, Manure, Ammonia

948 The response of growing dairy calves to additional dietary chromium on growth and humoral characteristics. J.A. Jackson, S.T. Franklin, L.J. Driedger*, and C.H. Hamilton, University of Kentucky, Lexington, KY.

The objective of this study was to examine the effects of dietary addition of chromium picolinate on intake, body weight gain and liver and serum triglyceride concentrations in growing dairy calves. Twenty four Holstein bull calves were assigned to dietary treatments of 1) basal diet, 2) basal diet with 0.2 mg/kg supplemental chromium (Cr), 3) basal diet with 0.4 mg/kg supplemental Cr, and 4) basal diet with 0.8 mg/kg supplemental Cr. Calves were assigned to treatment diets at 56 to 70 days of age and fed a control diet for 1 wk. The treatment diets were fed for 9 wk. Body weights were recorded and jugular blood samples were collected on wk 0, 3, 6, and 9. Liver samples were collected via biopsy on wk 0, 6, and 9. Mean as fed intakes were 4.2, 4.5, 4.2 and 4.4 kg/d (NS) for the 0, 0.2, 0.4, and 0.8 mg/kg dietary treatments. Average body weight gains were 1.27, 1.30, 1.24, and 1.34 kg/d (NS) for calves fed the 0, 0.2, 0.4, and 0.8 mg/kg dietary treatments. Liver triglyceride concentrations averaged 0.478, 0.318, 0.255, and 0.244% wet weight ($P < .01$) and serum triglyceride concentrations averaged 36.4, 32.4, 31.6, and 31.8 mg/dl (NS) for calves fed the 0, 0.2, 0.4, and 0.8 mg/kg dietary treatments. Results would suggest that dietary Cr supplementation may alter lipid metabolism.

Key Words: Triglyceride, Chromium, Calves

949 Effects of ruminal infusion of electrolyte solutions on calf performance parameters. S. I. Wawrzyniak*¹, H. D. Tyler¹, and J. D. Quigley, III², ¹Iowa State University, Ames, ²American Protein Corporation, Ames, IA.

To treat dehydration, diarrheic calves are often ruminally drenched with electrolyte solutions. To determine the effects of these solutions on feed intake and average daily gain, dairy bull calves ($n=28$) were ruminally infused with either a commercial electrolyte solution or a 9% saline solution at the rate of 10% of body weight per day for three consecutive days. Control calves ($n=15$) were sham-infused by inserting the esophageal feeder without infusing any fluids. Calf starter and water were offered ad libitum and starter intake was recorded daily. Body weights were determined at day -1 (pre-infusion) and day 8 (post-infusion). Feed intake was lower for calves infused with fluids than for control calves ($P < 0.01$). Average daily gain was lower in calves infused with fluids than in control calves ($P < 0.01$). Feed intake ($P < 0.05$) and average daily gain ($P < 0.01$) were decreased for calves infused with electrolytes as

compared to calves infused with saline solution or control calves. Overall, infusion of either electrolytes or saline solution into the rumen was detrimental to calf performance.

Key Words: Rumen, Electrolyte, Feed intake

950 Corn processing and soybean meal treatment on performance of growing beef steers fed grass 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 (QC), Canada, ²Animal Science Dept., Laval University, Quebec (QC), Canada.

This experiment was designed to synchronize nitrogen and energy supply into the rumen and also to provide additional nitrogen at the duodenum from a treated soybean meal source. Forty medium-framed crossbred steers (260 ± 2 kg BW) were used in a 140-d study with a 2 x 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; SoypassTM) on feed intake, weight gain and feed-to-gain ratio. Grass silage (23.5, 15.1, 30.7, 42.7% of DM, CP, ADF and NDF, respectively) was offered for ad libitum consumption, while corn and soybean meal were fed at 3.5 and 0.45 kg d⁻¹, respectively. Animals were fed individually twice a day and half of the supplement was added on the top of the silage and mixed by hand. Dry matter offered andorts were recorded daily. Animals were treated against internal parasites (Ivermectin) and received an ionophore (Bovatec), and growth stimulant (RevalorTM). Steers were weighed on three consecutive days at the beginning and at the end of the experiment. A single weight was also recorded every 14 d. Dry matter intake was not affected (P > 0.10) by treatment and averaged 8.6 ± 0.3 kg d⁻¹. Average daily gain was higher (P < 0.02) for animals receiving the ground corn than those fed cracked corn (1.47 vs 1.36 ± 0.05 kg d⁻¹). Feed-to-gain ratio was not affected by treatment and averaged 6.1 ± 0.2 kg DMI kg gain⁻¹. No effect of soybean meal treatment and its interaction with corn processing was observed. In conclusion, although DMI was not affected by treatment, weight gains of growing steers fed a grass silage-based diet were improved by the reduction of corn particle size. This suggests that increasing energy availability in the rumen, by reducing corn particle size, was more beneficial than increasing the supply of amino acids at the duodenum through soybean meal processing.

Key Words: Corn processing, Soybean meal, Steer performance

951 The effect of dietary roughage and processed corn on rumen development and growth in dairy calves. D.L.J. Benschop*¹, J.P. Cant¹, and R. Spratt², ¹University of Guelph, Animal and Poultry Science, ²Agribands Purina Canada Inc.

The ingestion of highly processed cereal starters by dairy calves may reduce ruminal pH to the point that dry matter intake and growth are compromised. To test the effect of dietary roughage and less processed corn on rumen pH, development and overall growth of calves, 48 male Holstein calves were stratified by liveweight at one week of age and randomly assigned to one of four dietary treatments (n=12) for a period of eight weeks. Treatments included a steam-flaked corn (SFC)/ rolled barley (RB) multi-particle calf starter as a control (CON) and three diets in which the SFC/RB was partially replaced by 10% coarse alfalfa meal (AM), 20% AM or completely replaced by cracked corn (CC). The AM was directly incorporated into the protein pellet within the starter ration. The diets were formulated to contain 20% CP, 3.5% crude fat, 1% calcium and 0.5% phosphorous. Starter and water were available ad libitum, and two litres of calf milk replacer were fed twice daily until weaning at week five. Starter intake was measured daily, bodyweight was measured weekly, rumen fluid samples were taken on a bi-weekly basis, and half of the calves were slaughtered on week eight. The largest differences in intake and growth became most apparent post-weaning as presented in the table below. No significant differences in weights of various digestive organs between treatments were detected. A 20% inclusion of roughage in the diet of these calves increased rumen pH, total dry matter intake, average daily gain and total amount of digesta within the digestive tract. Cracked corn as a substitute for SFC/RB had no effect.

Variables	Diet				SEm
	CON	10% AM	20% AM	CC	
Initial Bodyweight (kg)	43.9	44.7	44.1	44.4	5.58
Final Bodyweight (kg)	70.3 ^{ab}	76.4 ^{ab}	77.8 ^a	69.6 ^b	9.51
Daily DMI (g)					
d29-d42	906 ^a	1134 ^{ab}	1191 ^b	974 ^{ab}	323
d43-d56	1840 ^{ab}	2015 ^{ab}	2124 ^a	1731 ^b	373
ADG (g)					
d29-d42	560 ^b	709 ^{ab}	836 ^a	593 ^b	282
d43-d56	925	937	936	745	283
Rumen pH (d56)	5.39 ^a	5.51 ^{ab}	5.67 ^b	5.54 ^{ab}	0.19

^{a,b} unlike superscripts are different (P<0.05)

Key Words: Roughage, Rumen, Growth

952 Influence of ruminal and postruminal carbohydrate infusion on visceral organ mass and adipose tissue accretion in growing beef steers. K.R. McLeod*¹, R.L. Baldwin¹, M.B. Solomon¹, A.V. Capuco¹, and D.L. Harmon², ¹USDA, ARS, Beltsville MD 20705, ²Univ. of Kentucky, Lexington, 40546.

Forty beef steers (243 ± 2 kg BW) with ruminal and abomasal infusion catheters were used to determine the effects of site of carbohydrate (CHO) digestion on visceral organ mass and adipose accretion. Treatments included a pelleted basal diet (89% orchard grass hay, 5% Soypass[®], and 5% corn gluten meal) fed at 0.162 (LE) or 0.215 Mcal ME/kg BW.75/d, LE plus ruminal (RSH) or abomasal (ASH) infusion of partially hydrolyzed maize starch, and abomasal infusion of glucose (AGLU). Starch and glucose were infused at rates of 12.6 and 14.4g/kg BW.75/d, respectively, approximating 20% of MEI. Volume (5 kg/site/d) of infusate was equalized across treatment and site with water. After 35 d of infusion, steers were slaughtered and visceral organ and adipose (mesenteric and omental) mass were determined and subcutaneous adipose thickness over the 5th and 12th rib was measured. Total intake energy (IE) was greater (P < 0.001) for HE vs LE. Dietary IE was similar (P > 0.10) between LE and CHO infusion treatments, however total IE increased (P < 0.001) with CHO infusion. Total IE was similar (P > 0.10) among CHO infusion treatments, however infused IE was greater (P < 0.001) for AGLU vs ASH (54 vs 51 kcal/kg BW.75/d). As a percentage of empty body weight (EBW), rumen, omasum, total stomach-complex, and pancreas weights were greater (P < 0.05) for HE vs LE. RSH increased (P < 0.05) rumen and pancreas weights as a percentage of EBW compared with either LE or ASH. Dietary IE did not effect (P > 0.10) adipose accretion on an EBW basis, however AGLU increased (P > 0.05) omental and total visceral adipose weights compared with either LE or ASH. There was a trend for increased adiposity, in both visceral and carcass depots, with CHO infusion compared with LE (AGLU > ASH > RSH). Increasing CHO supply ruminally appears to stimulate ruminal tissue proliferation, while increasing supply abomasally does not alter intestinal mass. Moreover, AGLU stimulated adiposity to a greater extent than ASH.

Key Words: carbohydrate, viscera, adipose

953 Effects of Alimet[®] on performance of growing cattle fed forage diets and molasses based liquid supplements. E. R. Rodriguez*¹, W. E. Kunkle¹, and M. Vazquez-Añon², ¹University of Florida, Gainesville, FL, ²Novus International, Inc., St. Charles, MO.

Previous research has shown that adding undegradable intake protein (UIP) to molasses-based supplements improved gains of forage-fed growing cattle. This research evaluated adding corn gluten meal (CGM) or a methionine hydroxy analog (MHA, Alimet[®], Novus International, Inc.) to diets for growing beef cattle fed hay supplemented with molasses based supplements. Supplement treatments were formulated to supply 0, 2, 4, and 6 g/d of total sulfur amino acids (TSAA) in UIP from either CGM (63.8% CP, 86% TDN) or Alimet[®] (40% rumen bypass methionine assumed) and were compared to a molasses-corn (control) supplement. Both UIP sources were fed in a liquid supplement slurry containing 82% fortified molasses (13% crude protein, minerals, vitamins) and 18% ground corn (8.5% CP, 88.5% TDN). Twenty-eight pens (4 head/pen) of Angus-Brahman crossbred cattle (9-12 months of age) were assigned randomly within sex and breed type. At the start of the trial, calves averaged 277 kg and were in excellent body condition (BCS,

5.8). Bermudagrass hay was offered ad libitum in hay rings outside (no shelter) and molasses slurries limit fed at 2.1 kg DM/d during the 112-day trial (December thru April). Animal data were averaged for each pen, which was the experimental unit. During the 112 day trial, cattle fed CGM at 2, 4, or 6 g/d of bypass TSAA had similar ($P>.05$) performances (.64 to .68 kg/d shrunk wt gain) and gains were 104 to 145 g/d above ($P<.05$) cattle fed the control supplement. Feeding MHA at 2, 4, or 6 g/d of bypass TSAA resulted in 59 to 118 g/d higher ($P<.05$) gain than cattle fed the control supplement. Treatment differences on height or body condition score changes were not found. Feeding 6 g/d bypass TSAA gave the highest gains that were similar ($P>.05$) for both sources and supplement cost of added gain was 65 cents/kg gain for CGM but only 43 cents/kg gain for MHA. MHA had a 22 cent/kg added gain supplement cost advantage compared to CGM and adding 17 g/d of MHA (6 g/d of bypass TSAA) to the supplement cost under 6 cents and produced over 20 cents in increased gain. Supplementing cattle with Alimet[®] or CGM resulted in similar ($P>.05$) improvements in gains of growing cattle, however Alimet[®] supplemented cattle had a lower supplement cost of added gain compared to CGM.

Key Words: Supplement, Methionine, Molasses

954 Intake, digestibility and plasma urea nitrogen in heifers fed supplements with different ruminal undegradable protein levels. R. Lopes Oliveira^{*1}, J. Carlos Pereira², D. Nascimento Junior², R. A. M. Vieira³, and M. Dias Ribeiro², ¹Faculdades UPIS, Brasília, DF, Brazil, ²Universidade Federal de Vicosa-MG, Brazil, ³Instituto Melon de Estudos e Pesquisas, Silvania-GO, Brazil.

The effects of supplements with different levels (high - 60% of crude protein, medium - 40% of crude protein, low - 20% of crude protein) of ruminal undegradable protein (RUP) by Brown-Swiss heifers grazing *Brachiaria brizantha* cv. Marandu on the intake, digestibility and plasma N-urea concentrations were studied. The experiment lasted 90 days, divided in three periods of 30 days, corresponding to May, June and July 2000. Fifteen purebred Brown Swiss heifers (five by treatment), averaging 19.7 months and 394 kg live weight (LW), were used. The pasture availability was monitored to maintain offer of 6% LW, in green dry matter (GDM). The dry matter (DM) availability, GDM and leaf:colm ratio were evaluated. The heifers were fed 2.5 kg/head/day of concentrate supplement, offered twice a day (8 a.m. and 4 p.m.). Ex-trusa was collected in animals fistulated in the esophagus. Feces were collected twice a week; the animals received 10 g chromium oxide/day. Indigestible neutral detergent fiber (NDF) in the feeds and feces were used to determine the intake and digestibility. There were no effects of supplements on the pasture, however there were differences among periods, because, as dry season progressed, the forage availability decreased and leaf:colm ratio and senescent material proportion increased. There was no effect of treatments on forage intake or forage plus supplement. DM, organic matter (OM) and CP digestibility, and total digestible nutrients (TDN) content were lower for the diets with high RUP content. It was observed interaction of period:treatment for the fiber digestibility, where in the treatments with high and medium RUP, the digestibility decreased as the dry season progressed and, in the treatment with low RUP, the digestibility increased. The animals fed supplement with high RUP content showed average plasma N-urea concentrations lower than those fed supplement with average RUP contents, followed by those fed diets with low RUP.

Key Words: *Brachiaria brizantha*, Escape protein, Supplementation

955 Use of soybean hulls as a replacement for rolled corn in receiving calf diets. C.J. Mueller*, H.M. Blalock, and R.H. Pritchard, *South Dakota State University*.

Feedlot receiving studies conducted during consecutive years were used to evaluate the use of soybean hulls (SBH) as a replacement for rolled corn (RC) in receiving calf diets. Angus steers used during year 1 (Y1; n = 155) and 2 (Y2; n = 116) were purchased from the same source. Each year populations were blocked by calves that were weaned approximately 30 d prior to shipment (EW; offspring of dams < 4 yr) and those weaned the day of shipment (NW; offspring of dams > 4 yr). Incoming BW for calves in Y1 were 264 ± 2.4 kg for NW and 265 ± 2.9 kg for EW, while Y2 calves averaged 273 ± 2.3 kg for NW and 251 ± 3.9 kg for EW. Diets fed once daily consisted of oat silage (Y1 = 45%, Y2 = 39%) and either RC (Y1 = 45%, Y2 = 50%) or SBH (Y1 = 45%, Y2 = 56%).

The balance of the diets consisted of pelleted supplements meeting key nutrient requirements (NRC). Tabular (NRC) energy values for RC and SBH diets were: Y1) 1.13 and 1.04 Mcal of NEg/kg; Y2) 1.14 and 1.05 Mcal of NEg/kg, respectively. Calf performance was determined using non-shrunk BW. Calves fed SBH diets had similar ($P > 0.10$) ADG (1.39 vs 1.44 kg; RC vs SBH) and gain efficiency (0.18 vs 0.17; RC vs SBH). A year x diet interaction occurred for DMI ($P = 0.07$). During Y1, calves fed SBH had higher DMI (7.77 vs 8.49 kg; $P < 0.001$) than calves fed RC. During Y2, DMI was similar ($P > 0.10$) between diets (7.92 vs 8.22 kg; RC vs SBH). The interaction may be a result of below average temperatures during Y1. Moderate cold stress causes increased passage rate, which may have adversely affected digestion of SBH in Y1. The EW calves had higher DMI than NW calves (7.85 vs 8.43 kg; $P < 0.001$). Higher DMI resulted in a trend toward greater ADG for EW calves compared to NW calves (1.38 vs 1.45 kg; $P = 0.062$). Gain efficiency was not affected ($P > 0.10$) by weaning management. Both studies indicate that soybean hulls are a potential substitute for rolled corn in receiving calf diets.

Key Words: Soybean hulls, Receiving diets, Feedlot cattle

956 Effect of source and level of supplemental bypass total sulfur amino acids (tsaa) on performance of growing cattle fed bermudagrass hay diets supplemented with molasses based supplements. B. R. Austin^{*1}, L. B. Davis¹, P. A. Davis¹, B. A. Reiling¹, and W. E. Kunkle¹, ¹University of Florida, Gainesville, FL, US.

Performance responses to protein supplements were evaluated to determine if responses could be explained by total sulfur amino acids (TSAA) in bypass (UIP) protein. Supplements were formulated to provide 3 or 6 g/d of bypass TSAA from either corn gluten meal (CGM) fed at 0.24 or 0.47 kg/d, or from rumen protected methionine sources. The UIP sources used were Mepron M 85 (MEP) fed at 4.15 or 8.31 g/d, Smartamine M (SMT) fed at 4.76 or 9.53 g/d, and Alimet (ALI) fed at 8.53 g/d. These were compared to a sugarcane molasses and ground corn (control) supplement. Supplements contained 84% fortified molasses (urea, minerals, vitamins) and 18% ground corn. CGM replaced corn in supplements containing CGM. Cattle were assigned to 32 pastures (1.6 ha) with two heifers and two steers in each pasture. Calves averaged 281 kg with a body condition score of 5.56 at the start of the trial (December 15, 1999). Bermuda grass hay was offered ad libitum and molasses slurries were limit fed at 2 kg DM/day. Animal data were averaged for each pen. Supplementation of bypass TSAA tended to ($P=0.06$) increase cattle gains over control (0.52 vs. 0.57 kg/d). Cattle supplemented with 3 or 6 g/d of bypass TSAA had similar ($P=0.93$) gains (0.571 vs. 0.572 kg/d). Cattle gain increased ($P<0.05$) when supplemented with 6 g/d of bypass TSAA from CGM (0.61 kg/d, $P=0.01$) or 3 g/d of bypass TSAA from ALI (0.60 kg/d, $P=0.02$). Cattle supplemented with 3 or 6 g/d of bypass TSAA from MEP had similar ($P>0.20$) gains (0.50, 0.56 vs. 0.52 kg/d) to controls. Cattle supplemented with 3 g/d of bypass TSAA from SMT tended ($P=0.056$) to have higher gains (0.59 kg/d) than the control treatment, but cattle supplemented with 6 g/d of bypass TSAA from SMT had gains (0.54 kg/d) similar ($P=0.56$) to the control treatment. Cattle supplemented with 6 g/d bypass TSAA from CGM grew more ($P<0.05$) in height than cattle supplemented with 3 g/d bypass TSAA from MEP or control cattle. Supplemental sources of bypass TSAA did not significantly affect body condition scores.

Key Words: Supplementation, Methionine, Molasses

957 Using non-pasteurized fermented whey in calf feeding. F.I. Juarez^{*1}, M. Montero¹, and H.S. Garcia², ¹CIRGOC-INIFAP, ²UNIDA-Instituto Tecnológico de Veracruz.

Whey from non-pasteurized fresh cheese making was inoculated with a probiotic lactobacilli (L. Acidophilus B-4495) and allowed to ferment for up to 48 h. Twenty-four newborn calves (Holstein x Zebu or Brown Swiss x Zebu) were housed individually and fed artificially. Three males and three females were randomly assigned to each of 4 treatments: control calves (T1) were fed 4 L fresh milk; a second group (T2) was given 4 L fresh milk and 2 L fresh whey; a third group (T3) was fed with 4 L fresh milk and 2 L fermented whey, and a fourth group consumed 3 L fresh milk and 3 L fermented whey. Milk was offered until the animals were weaned (third month of age). Whey was included in the diets after the first month in increments of 1 L/month until the sixth month and a commercial feed was offered for free consumption and at 1 kg/d

after weaned. Hay from Stargrass (*Cynodon plectostachyus*) was offered during the experiment. Response variables were daily concentrate consumption (CC), biweekly body weight (BW) and daily weight gain (DWG), for treatments, sex and interactions. A randomized model was used for ANOVA data analysis and BW at birth was employed as covariable. Means were compared using Tukey's test at a $p < 0.05$. Results indicated that whey consumption produced savings in CC; the means for treatments T1-T4 were 80.1, 47.0, 51.0 and 75.5 kg, respectively ($MSE = 4.49$). Treatment T4 had a CC greater than treatments T2 and T3 suggesting compensation by substitution of milk by whey. However this value was no greater than that for T1. BW (kg) was not affected for T4 at weaning (91.4, 85.0, 81.5, 93.9) or after 6 months (137.6, 145.3, 130.9, 144.7). Similarly, DWG values were not affected by the treatments (564, 611, 537, 604 g). It is concluded that including fermented whey saved CC by 40% and could replace milk by 25% in calf feeding.

Key Words: milk replacer, probiotic, fermented

958 Effects of 2-hydroxy-4-(methylthio) butanoic acid (HMB) and dl-methionine on microbial growth, VFA production and nutrient digestion in continuous culture. S. Noftsker*, J. Firkins, and N. St-Pierre, *The Ohio State University, Columbus OH.*

2-Hydroxy-4-(methylthio) butanoic acid (HMB) has effects on milk composition and yield, potentially through ruminal actions. Four continuous culture fermenters were used to determine the optimal level of HMB for digestibility of nutrients and synthesis of microbial crude protein, and to compare the highest level of HMB to an equal concentration of methionine supplied as dl-Met. A highly degradable hay and grain mix was fermented at three levels of HMB (0 %, 0.055 %, and 0.110 % of DM) and one level of dl-Met (0.097 %) according to a 4 X 4 Latin square design. Fermenters were fed 100 g DM daily. Digesta samples were collected during the last three days of each of the four 10 day experimental periods. Digestibilities of ADF, NDF and DM were largely insensitive to supplementation of Met, although there was an increase in ADF digestibility when Met was supplied as HMB over the same level of Met supplied as dl-Met. Microbial efficiency (g microbial N/kg OM truly digested) was not different among treatments. Total production of volatile fatty acids were influenced by HMB supplementation, with isovalerate and isobutyrate increasing linearly with increasing HMB supplementation. Propionate production peaked and butyrate dipped to a low point at 0.055 % HMB. Met provided as dl-Met produced lower amounts of butyrate and isobutyrate than Met supplied in HMB. dl-Met had numerically similar production of BCVFA (isovalerate, isobutyrate and valerate) as the control. The proportion of bacterial N produced from ammonia N showed a linear decrease with HMB, and also a trend ($p = 0.1$) for bacteria receiving dl-Met to use more ammonia N than those receiving HMB. These data suggest that supplementation of Met as HMB may have a sparing effect on BCVFA, since the BCVFA are not needed to provide carbon for synthesis of valine, isoleucine and leucine with ammonia. Methionine supplied as dl-Met does not appear to act in the same way as that provided by HMB.

Key Words: methionine, continuous culture, 2-hydroxy-4-methylthiobutanoic acid

959 Milk protein synthesis as a function of amino acid supply. L. Doeppel*¹, M.D. Hanigan², J.J. Kennelly¹, and H. Lapierre³, ¹University of Alberta, Edmonton, Canada, ²Purina Mills LLC, St. Louis, Mo, ³Dairy and Swine R & D Centre, Lennoxville, Canada.

To evaluate the relationship between milk protein yield and amino acid supply, a total of 59 trials and 213 different treatments involving post-ruminal infusions of casein or free amino acids were analyzed. Digestible duodenal flow of essential (E) amino acids (AA) was predicted from NRC (2001). Intestinal digestibility of the infusates was considered to be 100%. Total amino acid supply was the sum of dietary and infusate supply. The relationship between milk protein yield and individual EAA total supply was quadratic ($P < 0.05$, $R^2 > 0.55$) for all EAA. Therefore, for each AA, a breakpoint was iteratively determined using a least squares fitting method. Below the breakpoint, milk protein yield increased linearly with AA supply, while above, protein yield did not respond incrementally to increased AA supply. The AA supply at each breakpoint was summed to give total EAA supply, which was converted into MP supply using a factor of 0.48 (NRC, 2001). From this, the

requirement for each AA as a percentage of MP is proposed. The requirements for lysine and methionine are in line with present recommendations (NRC, 2001). In addition, the efficiency of use for lactation for each EAA was calculated as the total amount of the AA in milk/(total AA supply - AA used for maintenance). The maintenance requirement of each AA was calculated as the maintenance requirement for MP, as predicted by NRC (2001), multiplied by the AA composition of the whole empty body of cattle. Efficiency of use for each AA decreased substantially above the breakpoint with lysine, methionine, and histidine being the most efficiently used AA. These results suggest that the EAA efficiency factors for lactation used in prediction schemes should not be a constant but should be decreasing with increasing AA supply.

AA	Requirement % of MP	Efficiency below breakpoint	Efficiency above breakpoint
Arg	4.8	0.81	0.37
His	2.3	0.98	0.56
Ile	5.3	0.65	0.44
Leu	9.6	0.70	0.43
Lys	7.3	0.87	0.55
Met	2.2	0.99	0.64
Phe	5.4	0.57	0.38
Thr	5.0	0.54	0.37
Val	6.1	0.68	0.46

Key Words: Milk protein synthesis, Amino acid, Efficiency of lactation

960 Influence of 2-hydroxy-4 (methyl thio) butanoic acid isopropyl ester (HMBi) on the digestibility of organic matter and energy value of corn silage measured in vitro. J.C. Robert, N. Ballet, C. Richard, and B. Bouza, *Aventis Animal Nutrition, Antony, France.*

HMBi is a novel source of methionine for ruminants. 50% is absorbed through the rumen wall to provide metabolizable methionine. The remaining 50% is hydrolysed in the rumen to HMB and isopropanol. The objective of this experiment was to evaluate the ruminal effect of HMBi using the rumen simulation technique (HFT gas test; Menke et al., 1988) using corn silage as the substrate. Dried and ground substrate (200 mg) was incubated with 10 mL of rumen juice + 20 mL of buffer in syringes gently agitated at 39°C. HMBi was tested at the dose of 15.6 mg (12 mg methionine equivalent) vs a control (no HMBi supplementation). Gas production (Vg- mL/200 mg DM) was measured at incubation times of 1, 2, 3, 4, 6, 8, 24, 30, and 48 h. The corrected gas production at 24 h and chemical composition of corn silage were used to calculate organic matter digestibility OMD (%) and energy values (UFL/kg DM) using the prediction equations proposed by Menke et al. (1988). The results indicate a significant stimulation of rumen fermentation with HMBi supply from the 8 h incubation time onwards. HMBi supply improved, respectively, corn silage OMD and energy values ($P < 0.05$) from 68.1 to 71.2 (+4.6%) and 0.82 to 0.87 (+6.0%).

Vg (mL per 200 mg DM)				
Incubation time (h)	8	24	36	48
Control	23.1b	50.7b	55.2b	63.1b
HMBi	24.0a	54.3a	59.9a	70.1a
SED	0.13	0.23	0.36	0.69

a, b : means in the same column with different superscripts are significantly different ($P < 0.05$)

Key Words: Ruminants, Dairy cows, Rumen, Fermentation, Methionine chemical derivative

961 Ruminal metabolism of 2-hydroxy-4 (methyl thio) butanoic acid isopropyl ester (HMBi). J.C. Robert, N. Ballet, C. Richard, and B. Bouza, *Aventis Animal Nutrition, Antony, France.*

The metabolism of HMBi was studied in the rumen in vitro by the HFT gas technique (Menke et al, 1988). 200 mg of dried and ground corn silage was incubated with 10ml of rumen juice + 20ml of buffer in syringes gently agitated at 39°C. HMBi was tested at the dose of 15.6mg (12mg methionine equivalent) vs a control (no HMBi supply). In vitro, fermentation was pursued during 48 hours and the supernatant of the rumen content mixture was collected in syringes at different incubation times (h) : 1,2,3,4,6, 8,24,30,48 and treated 1/

by NaCl 1% before analysis for HMBi, HMB, methionine and ammonia and 2/ by HgCl₂ 1% before analysis for isopropanol, acetone and volatile fatty acids. HMBi concentrations (mg/ml) decreased regularly all along the fermentation, respectively at fermentation times (h) 2,8,24 and 48 : .42, .40, .08, .008 [The following modelisation could be fitted : $Y = 112.06 e^{-0.09x}$ ($R^2 = 0.99$) with Y = concentrations and x = time]. In parallel, HMB concentrations(mg/ml)increased rapidly up to a maximum at 8h incubation time and decreased thereafter : respectively at the same incubation times : .13, .29, .25, .05. Iso-propanol and acetone concentrations increased up to 8 and 24 h respectively and plateaued after. Significant differences were observed for acetate, isovalerate, total VFA and butyrate but no significant differences for propionate. Effectively, HMBi was hydrolysed to HMB and isopropanol with modification of individual VFA concentrations. Mean Isop. Acetone, VFA Concentrations (mg/ml) Treatments effects

	Iso-prop.	Aceto	Aceta	Pro-pio.	Butyr.	I soval.	Tot. VFA
Control	.01b	.05b	2.18b	.73a	.47a	.059b	3.50b
HMBi	.06a	.08a	2.26a	.75a	.45b	.065a	3.59a
SED	.0001	.0002	.0035	.011	.0002	.00003	.006

Key Words: Ruminants, Dairy cows, Rumen, Metabolism, Methionine chemical derivative

962 Effect of crude protein levels and forage source on nitrogen balance of dairy cows. K.L. Karg* and M.A. Wattiaux, *University of Wisconsin-Madison*.

Forty eight multiparous Holstein cows were used to evaluate the effects of primary forage source (alfalfa silage (AS) or corn silage (CS)) and CP level (16.5% (LP) or 17.9% (HP)) on N balance to test the hypothesis that urinary N excretion may be reduced with no loss in milk N. Cows were blocked by calving date and assigned to dietary treatments in a 2x2 factorial at wk 3 of lactation. N balance was performed on wk 13 and 14 postpartum. Diets were fed as TMRs including 55% forage (DM basis; 14% CS and 41% AS or 14% AS and 41% CS). According to NRC 2001, the ME and MP allowable milk was at least 45 kg/d for all diets. Predicted MP balance was 14, 229, 47 and 256 g/d for ASLP, ASHP, CSLP, and CSHP diets respectively. The RDP and RUP balance averaged -11,17; 127, 280; -2, 55; and 137, 299 g/d on ASLP, ASHP, CSLP, and CSHP diets respectively. Ytterbium was used as a marker and on wk 13, fecal samples were collected over a 4 d period. On wk 14, cows were fitted with catheters for a 72 h total urine collection. Data were analyzed with the MIXED procedure of SAS and differences among dietary treatments were tested with orthogonal contrasts. N intake was confounded by numerical differences in DMI, and as a result, was highest in ASHP and lowest in CSHP diets. Fecal N was lowest in CS compared to AS diets (161 vs 206 g/d) but was not affected by CP level. Urine N was lowest in LP compared to HP diets (206 vs 245 g/d) but was not affected by primary forage source. Daily milk N excretion (based on true protein) was not affected by dietary treatments. This trial demonstrated that reduction in manure N excretion may be substantial with no loss in milk N production. The impact of diet CP on urine N excretion and forage source on fecal N excretion were additive, and of similar magnitude.

Item	Treatments					p-value		
	ASLP	ASHP	CSLP	CSHP	SEM	forage	protein	FxP
N intake (g/d)	637	720	621	603	26	.01	.22	.06
N feces (g/d)	205	207	170	151	11	<.01	.41	.35
N urine (g/d)	209	251	203	238	10	.30	<.01	.72
N milk (g/d)	180	176	194	180	7	.18	.20	.43
N retained	43	86	55	35	17	.25	.51	.07

Key Words: Alfalfa silage, Corn silage, Environment

963 Effects of moist heat treatment on ruminal nutrient degradability of sunflower seed. Arif Mustafa*¹, Yvan Chouinard², and Daniel Ouellet³, ¹McGill University, ²Université Laval, ³Agriculture and Agri-Food Canada.

A study was conducted to determine the effects of moist heat treatment (autoclaving at 127 C with a steam pressure of 117 kPa for 10, 20, and 30 min) of sunflower seed on CP fractions, ruminal DM and CP degradabilities, and ruminal disappearance of amino and fatty acids. Two ruminally fistulated cows were used in a randomized complete block design. Heating of sunflower seed decreased soluble protein and increased neutral detergent insoluble protein with little effect on acid detergent insoluble protein. Results of the in situ study showed that moist heat treatment decreased (cubic effect, $P < 0.05$) ruminal degradability of DM and CP of sunflower seed. Ruminal undegraded CP of raw sunflower was low (84 g/kg of CP) and increased (cubic effect, $P < 0.05$) by 139, 143, and 164%, respectively as heating time increased from 0 to 10, 20 and 30 min, respectively. Ruminal disappearance of all amino acids (following 12 h of incubation) was lower ($P < 0.05$) for raw than heated sunflower seed. Similar results were also observed for ruminal disappearance of fatty acids. It was concluded that moist heat treatment decreased ruminal nutrient degradabilities of sunflower seed and thus increased the concentrations of amino acids and polyunsaturated fatty acids available for digestion in the small intestine.

Key Words: Sunflower seed, Ruminal nutrient degradability, Moist heat treatment

964 Antagonistic amino acids to the inhibitory amino acids on growth of mixed ruminal bacteria. H. Kajikawa*, M. Mitsumori, K. Tajima, and M. Kurihara, *National Institute of Livestock and Grassland Science, Tsukuba, Ibaraki, Japan*.

Inhibitory effects of some amino acids on the bacterial growth have been known, but little information on this subject is available for the ruminal bacteria. These inhibitions are supposed to be caused mainly by feedback inhibition of a common enzyme in a multi-branched pathway for syntheses of several amino acids. This study was conducted to confirm the presence of antagonistic amino acids to the inhibitory amino acids. Ruminal bacterial were harvested from a ruminally fistulated cow, washed with a buffer, and incubated with glucose, xylose and cellobiose. Growth of the mixed ruminal bacteria was inhibited ($P < 0.01$) when each (1 mM) of 5 amino acids, Ile, Phe, Thr, Leu or Cys was added to a control treatment, in which ammonium salt was included as a sole N source. Addition of Leu, Val, or both of them reduced the inhibitory effect of Ile, and addition of both Ile and Val also reduced the inhibition by Leu. These inhibitions by the branched amino acids would be due to an inhibition of a common enzyme, probably α -acetohydroxy acid synthase, for syntheses of the branched amino acids. The inhibition by Phe was mitigated by adding Trp or Tyr, and the growth was almost recovered by addition of both Trp and Tyr, which suggesting that the inhibition could be attributed to the suppression of a common enzyme, probably 3-deoxy- D-arabino-heptulosonate 7-phosphate synthase, for syntheses of the aromatic amino acids. The inhibitory effect of Thr, on the other hand, was not affected by adding Lys and Met, which are both synthesized from Asp along with Thr, but was mitigated ($P < 0.01$) by addition of Ala, Gln, Glu, Ser or Val. No amino acid reduced the inhibitory effect of Cys. These findings suggest that bacterial growth would be inhibited by some mechanisms other than feedback inhibition when supplemented with Thr and Cys.

Key Words: Inhibitory amino acid, Antagonistic amino acid, Rumen bacteria

965 Effects of the level of rumen undegradable protein on microbial fermentation and amino acid flow from a continuous culture system. S. Gargallo, S. Calsamiglia*, and A. Ferret, *Universitat Autònoma de Barcelona*.

Eight dual flow continuous culture fermenters were used in three replicated periods to study the effects of diets formulated to contain different amounts of heat treated soybean meal (HSBM) or corn gluten meal (CGM) on rumen microbial fermentation and amino acid (AA) flow. Fermenters were fed an isonitrogenous 60 to 40 forage to concentrate diet, composed of basal ingredients (72% of DM) and a protein supplement (28% of DM). Treatments consisted of a non-protein N supplement (50% urea and 50% tryptone) or true protein (HSBM or CGM) in the following proportions: 0% HSBM, 33% HSBM, 66% HSBM, 99% HSBM, 0%

CGM, 33% CGM, 66% CGM, and 99% CGM. True digestion of DM and OM was higher for HSBM diets than for CGM ($P < 0.05$), and decreased as the level of rumen undegradable protein (RUP) increased ($P < 0.01$). Fibre digestion was not affected by protein source or level. Ammonia N concentration decreased as the level of HSBM or CGM increased ($P < 0.01$). Non-ammonia and dietary N flow were similar between protein sources but increased as the level of true protein increased ($P < 0.01$). Bacterial N flow was not affected by treatment. Efficiency of microbial protein synthesis was similar between protein sources, but increased as the level of HSBM increased ($P < 0.01$). Protein degradation was highest for 0% HSBM and 0% CGM and decreased as the level of RUP increased ($P < 0.01$). Total volatile fatty acid (VFA) concentration and molar proportions of acetate and propionate were not affected by protein source or level, but the concentration of branched-chain VFA was higher for CGM diets ($P < 0.05$) compared to HSBM, and decreased as the level of true protein increased ($P < 0.01$). Diets containing CGM resulted in the largest ($P < 0.01$) flow of total and essential AA. The largest amount of lysine was provided by 99% HSBM ($P < 0.01$), and 99% CGM provided the largest amount of methionine ($P < 0.05$). Supplementation of diets with sources of RUP increased non-ammonia N, dietary N, total and essential AA flow, and modified the AA profile of effluent.

Key Words: Undegradable protein, Microbial fermentation, Amino acid flow

966 A dietary protein to metabolizable energy ratio: Altering soluble and potentially rumen degradable protein fractions on rumen ammonia, volatile fatty acid production, and nitrogen balance of prepubertal Holstein heifers. M.T. Gabler* and A.J. Heinrichs, *The Pennsylvania State University*.

Four prepubertal Holstein heifers, between 148 kg and 191 kg BW, fitted with rumen cannulae were used to evaluate the effects a dietary crude protein to metabolizable energy ratio (CP:ME), with altered soluble and potentially rumen degradable protein fractions, on rumen ammonia, VFA production, and nitrogen balance in a 4#4 Latin square design with a 2#2 factorial arrangement of treatments. Treatment rations were fed at 2.0% BW as DMI containing a CP:ME ratio of 62.10.8 g of dietary CP per Mcal of ME with altered soluble (AB1) (33.6 or 40.6% AB1 as a % of CP) and potentially rumen degradable (B2B3) (20.9 or 28.2% B2B3 as a % of CP) protein fractions. Treatment rations contained corn silage and grass hay as forage sources with soybean meal, SoyPlus, and urea as protein sources. Increased intakes of AB1 increased rumen ammonia ($P=0.01$) but decreased ($P=0.01$) total VFA concentrations. Molar proportions of isovalerate and isobutyrate were decreased ($P<0.02$) with increased intakes of AB1. Increased intakes of B2B3 tended to increase ($P=0.11$) total VFA concentrations while increasing ($P<0.04$) molar proportions of propionate and isobutyrate. Increased molar proportions of propionate decreased ($P=0.02$) the acetate to propionate ratio with increased intakes of B2B3. Nitrogen utilization was not affected by increased intakes of AB1 or B2B3. Although, increased intakes of AB1 tended ($P=0.14$) to increase urine urea excretion. Increasing solubility (40.6 versus 33.6% AB1 as a % of CP) of the dietary CP in a 62.10.8 CP:ME ratio did not produce benefits in total VFA concentrations, individual VFAs, and N utilization. Feeding a CP:ME ratio of 62.10.8 with increased potentially rumen degradable protein (28.2 versus 20.9% B2B3 as a % of CP) at 2.0% BW as DMI resulted in trends toward increased total VFA concentrations with increases in molar proportions of propionate and isobutyrate.

Key Words: Heifers, Soluble Protein, Potentially Rumen Degradable Protein

967 The degradability and fermentation characteristics of diets containing extruded soybean meal. A.L. Mueller*, L.M. Lake, M.S. Kerley, M.R. Ellersiek, and R.L. Belyea, *University of Missouri-Columbia, Columbia, MO*.

The objective of this study was to determine the degradability of extruded soybean meal (ESBM). Soybean meal (SBM) was left unextruded (UNEX) and extruded at exit temperatures of 116 (116E), 138 (138E), and 160°C (160E). The SBM treatments were formulated into a diet containing 43% ground corn (GC) and 43% soybean hulls (SH). In Experiment 1, the in situ rumen degradability was determined for SBM

treatments alone. In Experiment 2 and 3, the in situ and in vitro degradability and fermentation characteristics were determined for GC, SH, and diets containing UNEX (UNEX Diet), 116E (116 Diet), 138E (138 Diet), or 160E (160 Diet). In Experiment 1, the percent dry matter remaining (DMR) and nitrogen remaining (NR) after incubation increased ($P < .05$) in the ESBM treatments compared to the unextruded SBM. The 160E had more ($P < .05$) DMR and NR the later hours of digestion than the other treatments. The ESBM treatments had slower ($P < .01$) dry matter degradation (DMD) and nitrogen degradation (ND) rates than the unextruded SBM; 160E had the slowest ($P < .01$) DMD and ND rates. In Experiment 2, replacing SBM with ESBM in the diets increased ($P < .05$) the percent NR after incubation without affecting DMD ($P > .05$). The 160 Diet had more ($P < .05$) NR the later hours of digestion than the other treatments. The ESBM diet treatments had slower ($P < .01$) ND rates than UNEX Diet; treatment 160 Diet had the slowest ($P < .01$) ND rate. In Experiment 3, the percent DMR was unaffected ($P > .05$) by treatment. Diets containing ESBM had more ($P < .05$) NR than UNEX Diet; the 160 Diet had more ($P < .05$) NR than the other ESBM diets. Including ESBM in diets did not affect ($P > .05$) total volatile fatty acid (VFA), acetate, propionate, butyrate, branched chain VFA, or ammonia production. These data suggested that replacing SBM with ESBM in a dairy diet might improve the amount of rumen undegradable protein (RUP) reaching the small intestine without affecting the degradability or fermentation characteristics of the diet.

Key Words: Extruded, soybean meal, protein degradation

968 Effect of level of rumen-degraded protein on milk production, ruminal metabolism and N utilization in lactating dairy cows. S M Reynal*¹ and G A Broderick², ¹University of Wisconsin-Madison, ²U. S. Dairy Forage Research Center, Madison, WI.

Twenty-eight (8 ruminally cannulated) lactating Holstein cows were blocked by DIM, and randomly assigned to seven 4 x 4 Latin squares (2 squares of cannulated cows) to determine the effect of different levels of dietary RDP on milk production, ruminal metabolism and urinary and fecal N excretion. Diets were formulated from corn silage, alfalfa silage, high moisture corn, solvent soybean meal, SoyPass®, urea, vitamins and minerals to provide similar levels of CP coming from ingredients other than urea. Solvent soybean meal, SoyPass and urea in the diets were adjusted to achieve RDP levels of 11.6, 10, 8.3, and 6.6% of diet DM for diets A, B, C, and D, respectively. DMI, milk and fat production averaged 25.5, 42.8 and 1.3 kg/d across diets and were not different. Milk protein content was higher ($P<0.01$) for diet B than for diets C and D (3.09 vs. 3.00 and 2.97%) and intermediate for diet A (3.07%). Milk protein yield was higher ($P<0.05$) for diets A and B than for diet D (1.31 and 1.34 vs. 1.24 kg/d) and intermediate for diet C (1.29 kg/d). Milk urea N was higher ($P<0.01$) for diets A and B than for diets C and D (13.0 and 13.2 vs. 11.4 and 11.3 mg/dl). There was no effect of diet on ruminal pH. However, ruminal ammonia was higher ($P<0.01$) on diets A and B than on diet C (9.2 and 8.3 vs. 6.5 mM), and higher ($P<0.01$) on diet C than on diet D (4.0 mM). Cows fed diet A had the highest ($P<0.01$) urinary N and urine volume when compared to diets B, C and D (319 vs. 270, 255 and 224 g/d; and 28.0 vs. 19.7, 21.5 and 20.3 l/d, respectively). Cows fed diet D had the lowest ($P<0.01$) urinary N excretion (224 g/d) when compared to other diets. Decreasing dietary RDP levels from 11.6 to 8.3% reduced urinary N excretion by 64 g/d without affecting milk and protein yield, but diet D with 6.6% RDP decreased N excretion but also depressed milk production.

Key Words: Rumen degradable protein, Milk production, Nitrogen utilization

969 Comparison of in situ and TCA methods for fractioning amino acids in tropical forages. L. F. Miranda*¹, N. M. Rodriguez¹, R. D. Sainz², E. S. Pereira³, E. O. S. Saliba¹, and M. M. Gontijo Neto⁴, ¹Universidade Federal de Minas Gerais, Brazil, ²University of California, Davis, USA, ³Universidade Estadual Oeste Paraná, Brazil, ⁴EMBRAPA Gado de Corte, Brazil.

Rumen in situ and methods were used to fractionate essential and non essential amino acids (AA) in N fractions in foliage from leucaena (*Leucaena leucocephala*), manioc (*Manihot esculenta*), perennial soybean (*Neonotonia wightii*), ramie (*Boehmeria nivea*) and guandu (*Cajanus cajan*). Dry matter, crude protein and acid detergent fiber were determined in all forages. Fraction A (NPN) was determined as the difference

between total N and N insoluble in trichloroacetic acid (TCA), fraction C was determined as the N insoluble in acid detergent (ADIN), and fraction B was calculated by difference. Forages were also incubated in situ for 6, 18 or 48 h to derive alternative estimates of fractions A, B and C. AA profiles of the original feeds and the residues from TCA, acid detergent, and in situ incubations were determined by HPLC after acid hydrolysis or peroxidation followed by acid hydrolysis. The in vitro and in situ methods gave similar ($P > 0.05$) estimates of AA concentrations in fractions A and B of guandu, ramie and perennial soybean. The essential AA profiles of guandu residues were similar for both procedures however, for leucaena and manioc the in situ procedure gave lower results for essential AA of fraction A and higher for fraction B ($P < 0.05$). Differences among forages preclude any definitive conclusions regarding the best method to determine AA profiles of N fractions.

Key Words: fractionate amino acids, tropical forage

970 Milk from forage as affected by rumen degradable protein and corn grinding with corn silage-based rations. E. Charbonneau^{*1}, P.Y. Chouinard¹, G. Allard¹, H. Lapierre², and D. Pellerin¹, ¹Université Laval, QC, Canada, ²AAC, Lennoxville, QC, Canada.

To optimize the production of milk from forage (MF), previous studies pointed to a better adequacy between the type of concentrate and the forage served. When corn silage is used, increasing the RDP content in the diet should allow a better utilization of forages. To evaluate this concept, eight multiparous Holstein cows in early lactation were used in a replicated 4x4 Latin square design with 3-wk periods. Diets were fed as TMR and were formulated to provide similar levels of NEL and CP but differed in RDP. Corn and alfalfa silages were used. Treatments were: 1) cracked corn and treated soybean meal (low RDP) 2) cracked corn and soybean meal (medium RDP), 3) cracked corn, soybean meal and urea (high RDP), 4) ground corn, soybean meal and urea (high RDP). The first three treatments were compared on the basis of their level of RDP. Increasing the level of RDP in diets had no effect on BW or DMI, but decreased milk production from 32.8 to 30.7 kg/d ($P < 0.01$). Milk fat content (3.99%) was not affected. Milk protein content was higher with the medium RDP (3.43%) treatment than with the low or high RDP (3.32%; $P < 0.001$). MF calculated on a protein basis decreased ($P < 0.05$) as RDP increased. Milk urea increased from 13.3 to 16.6 mg/dl ($P < 0.001$) as RDP increased. This suggests that the lowest concentration of RDP was sufficient in the rumen. The last two treatments had high RDP while ground corn was compared to cracked corn. No changes were observed in BW, but DMI ($P < 0.01$) increased with ground corn. Milk production was higher (33.4 vs 30.7 kg/d; $P < 0.01$), fat content lower (3.44 vs 4.02%; $P < 0.01$) and protein content higher (3.41 vs 3.31%; $P < 0.01$) with ground corn. MF calculated on a protein basis was higher with ground corn ($P < 0.05$). Ground corn decreased ($P < 0.001$) urea in milk. Even when corn silage is used in TMR, if combined with alfalfa silage, corn grinding had beneficial effects on milk production.

Key Words: Milk from Forage, Corn Grinding, Rumen Degradable Protein

971 Effect of protein source on microbial protein synthesis in beef cattle fed barley grain-based diets. K. M. Koenig^{*1}, K. A. Beauchemin¹, and L. M. Rode², ¹Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB, Canada, ²Rosebud Technology, Ltd., Lethbridge, AB, Canada.

Four British cross heifers fitted with ruminal and duodenal cannulas were used in a 4 x 4 Latin square to evaluate the effects of protein source on ruminal fermentation, microbial protein synthesis, and nutrient digestibility. The basal diet was 90% barley grain concentrate and 10% barley silage (DM basis) with either no protein supplementation (13.6% CP), or an additional 1% CP (% of DM) in the form of urea, canola meal (CM) or blood meal (BM). Ruminal ammonia N concentration was highest for the urea supplemented diet (111 ± 15 mg N/L) but no differences were observed for the control, CM, and BM diets (59 to 78 mg N/L). Ruminal VFA concentration was highest for the BM supplemented diet, but it did not differ among the control urea, and CM diets. Canola meal and BM tended ($P < 0.15$) to increase microbial N flow by 30 and 23 g N/d or 33 and 25%, respectively, above the control diet. The response of microbial N flow to urea supplementation was intermediate between the control and true protein sources. True ruminal OM

digestion tended ($P < 0.15$) to be higher for the urea supplemented diet, however, postprandial OM digestion tended to be lower, and therefore, there was no effect of protein source on total tract OM digestion (80.3 ± 1.1%). Microbial efficiency did not differ ($P > 0.15$) between the protein sources and averaged 21.2 ± 3.0 g N/kg OM truly fermented, although numerically, microbial efficiency was 28 and 23% higher with CM and BM supplementation, respectively. There was no effect of protein source on total tract NDF (46.2 ± 4.3%) and ADF (34.0 ± 3.1%) digestibility. In conclusion, high concentrate, barley grain-based finishing diets required supplementation with rumen degradable protein to maximize microbial protein synthesis. True protein sources such as CM and BM that provide peptides and amino acids in addition to ammonia N had the greatest effect on stimulating microbial protein synthesis.

Key Words: Protein sources, Microbial protein synthesis, Barley, Beef cattle

972 Effect of protein intake on synthesis of albumin and plasma total protein in lactating dairy cows. G. Raggio^{*1}, G.E. Lobley², D. Pellerin¹, G. Allard¹, R. Berthiaume³, P. Dubreuil⁴, M. Babkine⁴, and H. Lapierre³, ¹Université Laval, QC, Canada, ²Rowett Research Institute, Aberdeen, UK, ³AAC, Lennoxville, QC, Canada, ⁴Coll. Vet. Med., U. Montreal, QC, Canada.

A better understanding of N transfer from dietary protein to milk protein by dairy cows would improve the efficiency of N utilization while decreasing the N rejected in the environment. The effect of protein intake on synthesis of plasma albumin and total protein was determined for six multicatheterized cows in a double 3x3 Latin Square design. Three isoenergetic mixed silage-based diets (1.82 Mcal/kg DM), formulated to supply incremental amounts of RUP by inclusion of an undegradable protein supplement (Pro-lak[®]): Lo-P (13.0% CP), Med-P (15.0% CP) and Hi-P (17.0% CP), were fed every 2 h. Cows on Lo-P and Hi-P were continuously infused with ²H₅ phenylalanine (d5-Phe) into the jugular vein for 9 h (1.4 mmol/h) on d 21. Blood samples were collected hourly from the arterial, portal and hepatic vessels between 3-9 h. Concentrations and isotopic enrichment of d5-Phe were measured for free plasma Phe, plasma albumin and total protein. Results are given for the Lo-P vs Hi-P. Milk production increased ($P = 0.05$; 33.5 vs 35.8 kg/d) with the Hi-P diet. Plasma albumin also increased ($P = 0.001$; 32.9 vs 34.3 g/L) but total protein remained unchanged ($P > 0.20$; 76.2 vs 78.4 g/L). Daily incorporation of d5-Phe into both total protein and albumin was linear ($R^2 > 0.98$). Neither fractional nor absolute synthesis rates of albumin (3.3 vs 3.3 %/d; 35 vs 36 g/d) and total protein (6.4 vs 6.4 %/d; 158 vs 157 g/d) were affected ($P > 0.20$) by intake of RUP. Whole body irreversible loss rate of Phe increased ($P = 0.04$) at Hi-P (158 vs 184 g/d) as did portal absorption ($P = 0.06$; 89 vs 122 g/d) and hepatic net removal ($P = 0.20$; -48 vs -81 g/d). A greater proportion of hepatic Phe removal was used for total export protein synthesis ($P = 0.20$; 16.9 vs 11.9 %) at Lo-P. These results suggest that hepatic synthesis of albumin and other export proteins is maintained in lactating dairy cows even when protein nutrition is reduced.

Key Words: Liver, Albumin, Protein intake

973 Hepatic propionate metabolism in postparturient dairy cows as affected by prepartum carbohydrate source, chromium supplementation, and insulin addition in vitro. L. C. Ruzzi^{*1}, M. S. Piepenbrink¹, K. L. Smith¹, T. R. Overton¹, J. K. Drackley², and M. T. Socha³, ¹Cornell University, Ithaca, NY, ²University of Illinois, Urbana, ³Zinpro Corporation, Eden Prairie, MN.

Our objective was to determine whether hepatic capacities for oxidation and gluconeogenesis from propionate are affected by prepartum dietary carbohydrate source, chromium-L-methionine (CrMet) supplementation, and insulin addition in vitro. Liver was biopsied on d 1 postpartum from 24 Holstein cows fed a prepartum diet containing a starch-based concentrate (NFC; 1.63 Mcal/kg NE_L, 14.5% CP, 41.3% NFC) or a diet containing a nonforage fiber source-based concentrate (NFFS; 1.59 Mcal/kg NE_L, 14.3% CP, 34.5% NFC) from 21 d before expected parturition until parturition and supplemented with CrMet once daily via gelatin capsule at dosages of 0, 0.03, or 0.06 mg/kg BW^{0.75} in a 2 (carbohydrate source) x 3 (CrMet) arrangement of treatments. Liver slices were incubated with [1-¹⁴C]propionate (10 mM) for 2 h with addition of either 0 or 10 nM of bovine insulin and capacities for conversion of [1-¹⁴C]propionate to CO₂ and glucose were measured. The

interaction of prepartum carbohydrate source and CrMet supplementation was significant ($P<0.01$) because conversion of $[1-^{14}\text{C}]$ propionate to both CO_2 (4.66, 4.49, 5.38 $\mu\text{mol/h} \times \text{g wet wt.}$) and glucose (2.24, 2.54, 3.14 $\mu\text{mol/h} \times \text{g wet wt.}$) was increased when CrMet was supplemented to cows fed the NFFS diet but conversion of $[1-^{14}\text{C}]$ propionate to both CO_2 (6.36, 6.27, 3.36 $\mu\text{mol/h} \times \text{g wet wt.}$) and glucose (4.15, 3.31, 1.43 $\mu\text{mol/h} \times \text{g wet wt.}$) was decreased when CrMet was supplemented to cows fed the NFC diet. Effects of insulin addition in vitro and its interactions with in vivo treatments on conversion of $[1-^{14}\text{C}]$ propionate to CO_2 and glucose were not significant ($P>0.15$). Overall, data indicate that effects of CrMet supplementation on hepatic propionate metabolism are diet dependent. Furthermore, hepatic capacity for propionate metabolism on d 1 postpartum is refractory to insulin addition in vitro.

Key Words: Periparturient Cow, Hepatic Gluconeogenesis, Insulin

974 Effect of substitution of soybean meal for sesame meal on apparent digestibility of dry matter and crude protein in diets for sheep. R. Barajas^{*1}, J.F. Obregon¹, E. Romero¹, and A. Estrada¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

With the objective of determinate the effect of substitution of soybean meal for sesame meal on apparent digestibility of dry matter and crude protein in diet for sheep, a total fecal collection experiment was conducted. Four Pelibuey sheep (males; BW=22.19 kg) were used in a crossover design experiment, the sheep were assigned to consume one of two diets in that consisted the treatments: 1)Diet with 22.63% CP and 3.4 Mcal of DE/kg, containing Sudan grass hay 20%, soybean meal 30%, ground corn 38%, sugarcane molasses 9%, urea 0.6%, and mineral premix 2.4%(control); and 2)Diet similar to control, but containing 30% of sesame meal substituting soybean meal (SM). Sheep were placed individually in metabolic creates(0.6x1.2 m). Experimental periods consists in 10 days adaptation period and four days for samples collection. From each diet treatment and period one kg of diet was take as sample and the the total fecal production was collected. DM and CP was assayed. DM intake was similar ($P=0.80$) across tratments (675 vs. 679 g/day). Sesame meal in diet increased ($P<0.01$) DM excreted in feces (136 vs. 205 g/day), and aumented ($P<0.05$) fecal excretion of crude protein (23.33 vs. 29.97 g/day). Apparent DM digestibility was reduce($P<0.01$) by sesame meal (79.9 vs. 69.8%), and diminished ($P=0.02$) digestibility of dietary crude protein from 84.8 to 76.2%. Digestible energy content of diets was decreased ($P<0.01$) by SM tratment (3.42 vs. 2.98 Mcal/kg). Taken as reference, the value of 95% as true digestibility of soybean meal crude protein and DE=3.88 Mcal/kg, the true digestibility of protein from sesame meal was calculate in 85% its DE content was estimate to be 2.4 Mcal/kg of DM. It is concluded, that substituting soybean meal by sesame meal decrease the digestibility of dry matter and crude protein, and reduce energy content of diet for sheep, and that true digestibility of crude protein from sesame meal is nearly to 85%, and its DE content is close to 2.4 Mcal/kg of DM.

Key Words: Sesame meal, Soybean meal, Digestibility

975 Effect of dietary protein content and alfalfa:corn silage ratios on nitrogen excretion and milk production of late lactation cows. H.H.B. Santos^{*2}, S. Lardoux¹, V.R. Moreira², and L.D. Satter^{1,2}, ¹U.S. Dairy Forage Research Center USDA-ARS,, ²Dairy Science Department, University of Wisconsin, Madison.

The objective of this study was to evaluate the effect of different dietary protein concentrations and alfalfa silage:corn silage proportions in the diet on nitrogen distribution between milk, feces, and urine of late lactation cows. Twenty-four cows (12 multiparous and 12 primiparous) were randomly assigned to a 6x6 Latin square design with 14-d periods. Treatments were arranged in a factorial design with two alfalfa silage:corn silage ratios (70:30 and 30:70) and three levels of crude protein (~15, ~16.5, and ~18%). Roasted soybeans replaced high moisture corn to increase dietary protein content. Feed intake was measured daily and analyzed for DM, CP, NDF, ADF, and marker (ytterbium) concentration. Milk yield was recorded daily and sampled at the end of each period. Urine samples were obtained at 4hr-intervals during the last day of each period and 12 rectal fecal samples were obtained during the last 3 days from each cow on every even hour of the 24-hr period. Fecal

marker and urinary creatinine concentrations were used to calculate N excretion in feces and urine.

Forage ratio	AS:CS (70:30)				AS:CS (30:70)				P ≤			
Dietary protein, %	14.9	16.5	18.1	15.4	16.9	18.5	SEM	AS vs CS	15 vs 16.5	15 vs 18	16.5 vs 18	
DMI, kg/d	19.3	19.5	20.4	18.9	19.9	19.7	0.44	0.31	0.03	0.01	0.21	
Milk, kg/d	26.5	27.9	28.4	27.7	28.2	28.0	0.62	0.21	0.01	0.01	0.72	
Milk fat, %	3.72	3.84	3.84	3.88	3.83	3.78	0.09	0.29	0.35	0.76	0.52	
Milk CP, %	3.09	3.05	2.98	2.99	3.03	3.00	0.04	0.01	0.93	0.01	0.01	
N Intake, g/d	460	516	592	465	537	582	11.7	0.38	0.01	0.01	0.01	
Milk N, g/d	131	136	136	132	138	136	3.47	0.45	0.01	0.01	0.62	
Fecal N, g/d	188	186	212	176	198	204	9.08	0.48	0.03	0.01	0.01	
Urine N, g/d	167	193	210	145	184	221	6.33	0.13	0.01	0.01	0.01	
Milk N, % NI	28.5	26.4	23.0	28.4	25.7	23.4	0.52	0.64	0.01	0.01	0.01	
Re-covered N, % NI	106.0	100.1	94.9	98.2	97.1	96.6						

Key Words: Nitrogen excretion, Alfalfa silage, Corn silage

976 Effect of substitution of soybean meal for Chop-suey beans (Vigna radiata) on apparent digestibility of dry matter and crude protein in diets for sheep. A. Estrada^{*1}, J.F. Obregon¹, O. Tovar¹, and R. Barajas¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

With the objective to determinate the effect of substitution of soybean meal for Chop-suey beans (Vigna radiata) on apparent digestibility of dry matter and crude protein in diets for sheep, a total fecal collection experiment was conducted. Four Pelibuey sheep (males; BW = 21.25 kg) were used in a Crossover design experiment, the sheep were assigned to consume one of two diets in that consisted the treatments: 1) Diet with 22.63% CP and 3.4 Mcal of DE/kg, containing Sudan grass hay 20%, soybean meal 30%, ground corn 38%, sugarcane molasses 9%, urea 0.6%, and mineral premix 2.4% (control); and 2) Diet similar to control, but containing 30% of raw ground chop-suey beans substituting soybean meal (CSB). Sheep were placed individually in metabolic crates (0.6 x 1.2 m). Experimental periods consisted in 10 days adaptation period and four days of samples collection. From each diet treatment and period one kg of diet was taken as sample and the total fecal production was collected. DM and CP was assayed. Treatments have no effect ($P = 0.52$) on DMI (635 vs. 640 g/day), DM excreted in feces (130 vs. 127 g/day), and DE of diet (3.4 vs. 3.43 Mcal/kg). Observed/expected DE was similar ($P = 0.52$) across treatments (1.00 vs. 1.04). CSB decreased ($P < 0.01$) nitrogen intake (142 vs. 107 g/day), without affect ($P = 0.58$) fecal excretion of crude protein (21.6 vs. 20.7 g/day). Apparent digestibility of CP was diminished ($P = 0.07$) by inclusion of chop-suey beans (84.7 vs. 80.5 %). The true digestibility of CP of chop-suey beans was calculated to be 93% and its value of DE 3.88 Mcal/kg of DM. This data suggest, that raw ground chop-suey beans could be used as feedstuff in finishing diet for sheep.

Key Words: Chop-suey beans, Soybean meal, protein, Digestibility, Sheep

977 Dietary inclusion of silymarin in peripartum dairy cows: Effects on milk productivity, plasma metabolite and liver tissue. D. Tedesco^{*1}, A. Tava², C. Domeneghini¹, A. Costa¹, D. Sciannimanico¹, and M. Tameni¹, ¹Dipart. di Scienze e Tecnologie Veterinarie per la Sicurezza Alimentare, Unversiy of Milano, Italy, ²Ist. Sper. Colt. Foragg., Lodi, Italy.

During the peripartum period the dairy cows animal can be subject to metabolic disorders such as ketosis and fatty liver diseases. Silymarin, a natural extract from *Silybum marianum* seeds (SM), is recognized as being a potent hepatoprotector in human disease. A total of 30 dairy cows, selected from a herd according to their previous milk production, health status, parity (≥ 2) and BCS, has divided into two groups. Fifteen were administered 10 g/day of SM extract as an oral drench from 7 d before expected calving to 15 d after calving. Milk production was

recorded daily for each animal for 305 d of lactation. The BCS was evaluated 15 d before the expected calving and at blood sampling days. Blood samples were collected 7 d before the expected calving and after 7, 14, 21, and 30 d. Liver biopsy samples were collected at d 7 and 30 post calving. Health status was evaluated daily in the first 30 d of lactation. Treatment with SM increased milk production. The a, b, and c parameters from Wood equation of both lactation curves showed significant differences during all the first 70 d of lactation ($P < 0.05$). These differences were on average from 2 to 5 kg/d for each animal. The body condition loss after calving was less evident for treated animals, statistically significant at 30 d postpartum ($P < 0.05$), when BCS values were 2.5 and 2.8 for the control and the treated group, respectively. The results for blood NEFA, BHBA, total cholesterol, HDL, LDL, TG, total bilirubin, glycemia, BUN, γ GT, were not affected by treatment. Changes were only related to the sampling days ($P < 0.05$) according to the peripartum period. Histological evaluation on liver biopsies evidenced intracytoplasmatic fatty drops of different dimensions in both samples. These drops in the treated animals were located in proximity of the centrolobular vessels, suggesting their rapid mobilization. The data demonstrate a positive effect of silymarin inclusion in the diet of periparturient dairy cows. No changes were evident in the metabolic parameters considered. A better health status was observed in the treated animals. Silymarin was kindly granted by I.D.B. Holding Indena S.p.a.

Key Words: Natural hepatoprotector, Dairy cow, Peripartum

978 Influence of soybean meal processing techniques on milk yield response of dairy cows. T. R. Dhiman^{*1}, ¹Utah State University.

Twenty-four dairy cows were used in a 3 x 3 Latin square design experiment to quantify the yield response to feeding soybean meal processed using different techniques. Each period was 4 wk. The first 2 wk in each period were considered as adaptation time to the diets and measurements were made during the last 2 wk. Cows were fed a basal diet containing 47% forage and 53% grain. The dietary protein supplement in the three treatment diets was solvent extracted soybean meal (SBM), extruded-expelled soybean meal (ESBM), or full-fat extruded soybean meal (FFSB). Protein supplement was added at 11.3% of dietary DM. All three diets had same energy, crude protein, fat, fiber, and minerals and were fed as a total mixed ration. Cows produced 34.2, 33.8, and 33.7 kg energy corrected milk (ECM) per day in SBM, ESBM and FFSB treatments, respectively. Cows in SBM, ESBM or FFSB had similar feed intake, milk yield, ECM yield, ECM/feed intake, milk fat content, milk fat yield, milk protein yield and milk urea content. Milk protein content and yield were 2.84^a, 2.78^b and 2.80^b % and 1.03, 1.01 and 1.03 kg/day in SBM, ESBM and FFSB, respectively. Conjugated linoleic acid content of milk was 0.54^b, 0.64^a and 0.77^a g/100 g of fat in SBM, ESBM and FFSB, respectively. Due to higher fat content of extruded-expelled soybean meal (9.1% fat) and full-fat extruded soybeans (20% fat) the diets containing these protein supplements (ESBM and FFSB) had 0.4 and 0.8% less supplemental fat compared with SBM treatment diet. Using the value of supplemental fat at a rate of 77 cents per kg, the value of fat provided by extruded-expelled soybean meal and full-fat extruded soybean was 7.7 and 15.4 cents per cow per day, respectively. Suggesting that the value of extruded-expelled soybean meal and full-fat extruded soybeans was 25 and 50 dollar per ton higher than solvent extracted soybean meal, respectively. Results suggest that cows fed solvent extracted soybean meal, extruded-expelled soybean meal, or full-fat extruded soybeans as a protein supplement had similar milk yield response when diets were balanced for net energy of lactation content. It is recommended that the price of protein supplement should be based not only on protein quality but also on fat content.

Key Words: Soybean, Milk, Fat

979 Rumen undegradable protein from forage grass. Pierre Groenenboom^{*1}, James Shelford¹, and Shabtai Bittman², ¹UBC Education and Research Centre, ²Pacific Agri-Food Research Centre.

Rations for lactating dairy cattle should supply adequate amounts of rumen undegradable protein (RUP) without oversupplying rumen degradable protein (RDP). Although most proteins from forage grasses are RDPs, we examined whether altering nitrogen (N) fertilizer regimes and harvest schedules can increase the percentage of RUP in forage grass.

Plots of orchardgrass were given 0, 50, or 100 kg/ha/harvest of N fertilizer. The plots were harvested three or four times a year for three years. To examine the effects of harvest schedule, harvest was delayed in some plots so that plots were cut in one of three periods within each harvest period. Harvested grass was analyzed for dry matter yield, crude protein (CP), true protein (TP), and neutral detergent fibre (NDF). Grass samples were incubated in the rumens of ruminally cannulated cows to examine dry matter and protein degradations. Decreased N fertilization and delayed harvest increased the proportion of true protein (TP) in harvested grass. Consequently, non-protein nitrogen (NPN) was reduced. NPN is very rapidly degraded in the rumen. TP consists of a range of proteins, some of which are rapidly degraded, while others may escape ruminal degradation. The increase in TP suggests an increase in RUP. Altering N availability and utilization provides opportunities to increase production efficiency and reduce environmental pollution.

Key Words: Rumen undegradable protein, Forage grass, True protein

980 Effect of nitrogen intake on nitrogen recycling and urea transporter expression in lambs. JC Marini^{*1}, JD Klein², JM Sands², and ME Van Amburgh¹, ¹Cornell University, ²Emory University.

Urea recycling in ruminants has been studied extensively in the past but the mechanisms regulating the amount of urea recycled or excreted remain obscure. In order to elucidate the role of urea transporters (UT) on nitrogen (N) recycling, nine Dorset-Finn ewe lambs (20.8±0.8 kg) were fed diets containing 1.6, 2.9, or 4.0 g N/kg DM for 21 d. Nitrogen (N) balance and urea kinetics were carried out the last 3 days of the period. Animals were then slaughtered and mucosa samples from the rumen, duodenum, ileum and cecum, as well as kidney medulla and liver were collected. Increasing N intake, linearly increased N balance (1.5, 5.1 and 5.4±0.86 g N/d, $P < 0.01$), urinary N excretion (2.4, 10 and 16.5±0.86 g N/d, $P < 0.01$) and plasma urea concentration (4.3, 20.3, 28.4±2.62 mg urea-N/dl, $P < 0.01$), but did not affect fecal N excretion (5.0±0.5 g N/d; $P = 0.93$). Urea production (3.6, 14.0 and 20.5±2.50 g N/d; $P < 0.01$), urinary urea excretion (0.7, 7.0 and 13.4±0.73 g N/d; $P < 0.001$) and urea recycled (2.9, 7.1 and 7.1±1.12 g N/d; $P < 0.01$) increased linearly with N intake. No changes due to protein intake were observed on creatinine excretion (518±82.4 mg/d; $P = 0.66$) and clearance (46±10.7 ml/min; $P = 0.56$). Urea clearance by the kidney increased linearly with N intake (14.9, 24.4 and 34.9±5.9 ml/min; $P < 0.04$) while urea clearance into the GI tract decreased (39.4, 23.6 and 19.0±4.5 ml/min; $P < 0.01$). Urea transporter B was present in all the tissues analyzed but UT-A only in kidney medulla, liver and duodenum. Among animals on the three diets, no differences ($P > 0.10$) in UT expression, quantified by densitometry, were found. Rumen wall urease activity decreased linearly ($P < 0.02$) with increasing level of N intake. Urease activity in duodenal, ileal and cecal mucosa was lower than in the rumen for all the animals in the three diets and not different from zero ($P > 0.10$) in animals on the high protein diet. Although urease activity in the tissues of lambs fed the low and medium protein diet were different than zero ($P < 0.05$), there were only 14 and 7 % of the ruminal urease activity. Urea transporter abundance in the kidney medulla and the GI tract do not reflect the increase in urea reabsorption by the kidney and transferred to the GI tract.

Key Words: Urea Recycling, 15N, Urea Transporter

981 Immunoglobulin binding in cows with *Staphylococcus aureus* mastitis. Amy Johnston-Ward^{*1}, Mulumebet Worku¹, Kevin Anderson², and Roberta Lymann², ¹*North Carolina Agricultural and Technical State University*, ²*North Carolina State University College of Veterinary Medicine*.

Binding of immunoglobulins (Igs) to polymorphonuclear neutrophils (PMN) is important to the resolution of *Staphylococcus aureus* induced mastitis infection. The objective of this study was to assess the binding of Igs to PMN from cows with chronic *S. aureus* mastitis. Blood was collected from the jugular vein of six chronically infected and six healthy cows from the North Carolina Department of Agriculture- Caswell Dairy herd. The PMN were isolated by hypotonic lysis of red blood cells and differential centrifugation. PMN were then incubated with fluorescein-labelled bovine IgG1, IgG2 or IgM as sources of exogenous Igs. Neutrophils were also incubated with fluorescein-labelled goat anti-bovine IgG, IgG2 or IgM to assess endogenously bound Igs. Binding of Igs and level of Fc receptor expression were evaluated by flow cytometric analysis. The percentage of PMN from cows with chronic *S. aureus* infection that bound IgG1 was 29, IgG2 was 60, IgM was 52, anti-IgG was 74, anti-IgG2 was 73, and anti-IgM was 73. The percentage of Igs bound to PMN from healthy cows was 15, 54, 55, 72, 70, and 62 respectively. The level of receptor expression for cows with chronic *S. aureus* infection was 40 for IgG1, 90 for IgG2, 61 for IgM, 110 for anti-IgG, 73 for anti-IgG2, and 176 for anti-IgM as compared with the healthy cows with 30, 53, 106, 123, 75, and 159 respectively. Binding of endogenous Igs was not significantly different between healthy and chronically infected cows. Binding and Fc receptor expression for IgG1 was not significantly different between healthy and chronically infected cows. Although binding of IgG2 and IgM did not differ between the two groups, the level of expression of Fc receptors for IgM and IgG2 was significantly decreased in cows with chronic *S. aureus* mastitis. Both IgM and IgG2 are critical isotypes for PMN phagocytic function. These results may have significant implications for neutrophil function during mastitis infection, which may contribute to the chronic nature of *S. aureus* infection in these cows.

Key Words: Immunoglobulin, Mastitis, Fc receptor

982 Effect of time and frequency of administration of ketoprofen during surgical castration of beef cattle. S. T. L. Ting^{*1,2}, B. Earley¹, and M. A. Crowe², ¹*Teagasc, Grange Research Centre, Dunsany, Co. Meath*, ²*Faculty of Veterinary Medicine, University College Dublin, Ballsbridge, Dublin 4, Ireland*.

The effect of time and frequency of administration of ketoprofen (K) to surgically castrated calves on cortisol, acute phase proteins, immune function, and performance was determined. Fifty Holstein x Friesian bulls (11 mo of age; BW = 300 ± 3.3 kg) were assigned to one of five treatments: 1) untreated control (C); 2) surgical castration (t = 0 min; S); 3) S following K dose at t = -20 min with 3 mg/kg BW i.v. (S + K1); 4) S following K at t = -20, and at 0 min with 1.5 mg/kg BW at each time point (S + K2); 5) as in (4), with K at 3 mg/kg at t = 24 h post treatment (S + K3). The area under the plasma cortisol against time curve was greater (P<.05) in all castrated calves than in controls; and was lower (P<.05) in S + K1 and S + K2, with intermediate levels in S + K3 compared with S calves. Peak cortisol levels were higher (P<.05) in all the castration groups than in C. There were no differences (P>.05) in interval to peak cortisol within the castration groups. On d 3, plasma haptoglobin and fibrinogen concentrations were higher (P<.05) in all the castrated animals than in C. There were no differences (P>.05) among treatments in KLH-induced interferon-γ (IFN-γ) production on d 0, 1, and 3. On d 1, Con A-induced IFN-γ production was lower (P<.05) in S and S + K3 than in C and S + K1, with intermediate levels in S + K2 calves. ADFI from d 1 to 33 was lower (P<.05) in S, S + K1, and S + K3, but not in S + K2 compared with C. ADG from d -1 to 35 was lower (P<.05) in S, S + K2 and S + K3, but not in S + K1 compared with C calves. In conclusion, surgical castration increased plasma cortisol and acute phase proteins, suppressed cell-mediated immunity, and reduced performance. K effectively reduced cortisol following castration, but there was no advantage in treating with split doses of K (S + K1 or S + K2 group). A repeated

K dose 24 h post treatment (S + K3) failed to influence the changes in acute phase proteins and immune response.

Key Words: Cattle, Castration, Ketoprofen

983 Effect of body condition loss on cholesterol concentration and occurrence of postparturient diseases in holstein cows. I. H. Kim^{*1}, G. H. Suh², and D. S. Son², ¹*Chungbuk National University, Chongju, Chungbuk, Korea*, ²*National Livestock Research Institute, Cheonan, Chungnam, Korea*.

This study was to investigate the relationship between amount of body condition score (BCS) loss from dry to early lactation period and serum cholesterol concentration and occurrence of postparturient diseases in holstein cows. Body condition scoring (using a 5-point scale with quarter-point divisions) was performed on sixty pregnant holstein cows. They were maintained in free-stall facilities, fed a total mixed ration. Cows were scored once for body condition during the dry period, near calving, and then every 1 month for early lactating 3 months. At the same time, blood samples were collected to evaluate serum cholesterol concentration. Regular reproductive health examinations were conducted by 1 veterinarian twice a month. Cows were categorized by BCS loss from dry to early lactation period into 3 groups : modest (0 to 0.75 points, n=21), moderate (1.0 to 1.25 points, n=21), or marked (1.5 to 2.5 points, n=18). Cholesterol concentration was lower (P<0.05) in marked BCS loss group (159 ± 35 mg/dl) than in modest BCS loss group (196 ± 45 mg/dl) on Month 1 after calving. Occurrence of postparturient diseases were greater (P<0.01) in moderate BCS loss group (66.7%) and marked BCS loss group (83.3%) than in modest BCS loss group (23.8%). It is concluded that serum cholesterol concentration and occurrence of postparturient diseases were related to amount of BCS loss from dry to early lactation period in holstein cows.

Key Words: Body condition score, Cholesterol concentration, Postparturient disease

984 Autoclaved ruminal fluid immediately after birth improves the growth and health of neonate dairy calves. J.B. Russell^{*1}, T.V. Muscato², and L.O. Tedeschi², ¹*ARS/USDA*, ²*Cornell University*.

Recent work (Muscato, T. V., L. O. Tedeschi, and J. B. Russell. 2002. The effect of ruminal fluid preparations on the growth and health of new-born dairy calves. J. Dairy Sci. in press) showed that ruminal fluid (RF) supplements (8 ml per d) decreased (P < 0.05) the incidence of scours in dairy calves that were consuming milk or milk replacer, and this decrease was accompanied by an increase in BW gain during the first 2 wk of life (P < 0.05). Because autoclaved ruminal fluid was also effective (P < 0.05), RF was not acting as a probiotic. When the time of dosage was decreased from 42 to 5 days, the calves still responded. A new trial was conducted to determine more precisely the minimum dosage of autoclaved RF needed to improve the health and growth of dairy calves. New-born calves were randomly allotted to 2 treatment groups (n = 12). One group served a control and it did not receive any RF. The treatment group received 4 ml of autoclaved RF in the first clostrum via stomach tube. Both groups were fed equal amounts of milk replacer (7.5 kg/d, 3 feedings/d). Calves were: 1) inspected 5 times per day for scours, 2) weighed at birth and at 2, 4 and 6 wks of age, and 3) weaned at 6 wks. Scours were defined as fresh fecal material that had a runny or watery texture and either a white or grey color. Calves given only a single dose of autoclaved RF immediately after birth had fewer scours days (0.5 versus 1.81 d/calf, P < 0.05) and gained more weight in the first 2 wk of life (5.24 versus 2.84 kg, P < 0.05). Because only a single dose was required, autoclaved RF is a practical tool for improving the health and growth of new-born calves.

Key Words: Calves, Rumen Fluid, Scours

985 Transition period in dairy cows: immune system, inflammatory conditions and liver activity. L. Calamari, F. Librandi, E. Trevisi, and G. Berton^{*1}, *UCSC, Facolta di Agraria, Piacenza, Italy*.

Some keys of success in transition period are linked to the energy metabolism, namely of lipids, and to the immune system. The immune

system cytokines seem to impair lipid metabolism in the liver. In order to improve the knowledge on this topic a trial was carried out on 10 Italian Friesian dairy cows checked from 30 days before calving to 60 DIM. DMI and milk yield were recorded daily; blood samples were collected daily around calving (-4 to 4) and twice weekly in the other phases. Piacenza metabolic profile, NEFA, BHBA, tryglicerides, creatinine, vitamin A and E, NO₃, NO₂, lysozyme, reactive oxygen metabolite substances (ROM), TBARS and total antioxidants (AT) were evaluated on plasma. According to an aggregate liver activity index (LAI), that includes liver synthesis parameters (albumin, total cholesterol and vitamin A as index of RBP) observed during the first 30 DIM, the cows were partitioned in 2 groups (S: satisfactory; U: unsatisfactory). Despite higher values of AT ($P < 0.01$) and lysozyme (n.s.) before calving, the cows of U group have shown a slightly higher incidence of troubles after calving (retained placenta, uterine diseases and digestive upsets). According to this, higher values of haptoglobin, ceruloplasmin ($P < 0.05$) and ROM ($P < 0.01$) in the first 15 DIM were found in U. Lower DMI and plasma urea ($P < 0.01$) in the first 30 DIM were also found in U. Furthermore, higher GOT values ($P < 0.05$) in the first 15 DIM and lower of albumin, vitamin A ($P < 0.001$) and cholesterol (n.s.) in the first 60 DIM were found in U group, confirming a liver impairment. Finally cows of U group have had a slightly lower milk yield. In conclusion quite common health problems of the transition period causing inflammation seem to play an important role in the liver activity and cow performances. Nevertheless it is difficult to discriminate the primary cause: i.e. is the immunity impairment first or is the stress disease that cause an impairment of liver and immune system? (Supported by MURST, Cofin. 2000).

Key Words: Dairy Cow, Liver Activity, Immune System

986 Testing measures of lameness: using behaviour to predict presence and severity of hoof lesions in dairy cattle. F Flower* and D Weary, *Animal Welfare Program, Faculty of Agricultural Sciences, University of British Columbia.*

Lameness is costly to production and compromises the welfare of dairy cows, but is often difficult to identify especially at the early stages. We determined how successful existing and novel lameness assessment methods were in predicting the presence and severity of sole lesions. Lactating Holstein cows ($n = 46$), trained to walk along a concrete alley, were assessed for lameness from video records over 7 consecutive days. Three types of methods were tested: a) composite subjective scores b) computerized analysis of cow movements and c) measures of free-stall use. Composite subjective scores were assigned to each cow using video records. Scores were based on the extent of back arch, tracking up, head bob, joint flexion and the ability to bear weight. Each of these components was also assessed separately using a visual analogue scale. Computerized movement data including heel strike, toe-off, stride length and duration, stance and swing period, gait velocity and cadence were calculated using Peak Motus motion analysis software. Vertical displacement of vertebrae were calculated to quantify back arch. Video records of free-stall use were collected over 6 weeks and used to measure time spent lying in the stall, standing in the stall, and standing with only the front two feet in the stall. The number and severity of hoof lesions were scored 10 weeks later. Of the subjective measures, the composite subjective score best predicted the presence of sole lesions, accounting for 33% of the variation in a step-wise multiple regression model ($P < 0.001$). Of the computerized movement measures, hoof speed and variation in stride height best predicted sole lesions, together accounting for 34% of the variation in lesion number ($P < 0.01$). Of the stall usage measures, standing with two feet in the stall accounted for 41% of the variation in lesion number ($P < 0.001$). Thus all three methods are able to predict the number of sole lesions, one important component of lameness in dairy cattle.

Key Words: Lameness, Behaviour Scoring, Locomotion

987 Determining the incidence of Johnes Disease in Maine dairy herds using three ELISA tests. D.P. Marcinkowski¹, G. W. Anderson¹, M. M. Bryant*¹, and D. E. Hoenig², ¹University of Maine, Orono, ²Maine Department of Agriculture, Food and Rural Resources, Augusta.

The objectives of this study were to compare the results of 3 serologic ELISA tests for Johnes Disease and determine the extent of the disease in Maine dairy herds. Six practicing veterinarians identified 25 commercial dairy herds from throughout the state. Herds were divided into 2

groups by herd size; small herds (less than 200 cows) and large herds (more than 200 cows). In the 22 small herds, up to 30 multiparous cows were sampled while in the 3 large herds up to 125 multiparous cows were sampled. A total of 1017 plasma samples were collected, representing 2.4% of the total dairy cows in the state. Plasma samples from each cow were divided into 3 aliquots and frozen for subsequent analysis. The samples were analyzed using two commercially available tests; the Tip-Test: Johnes (ImmuCell Corporation, Portland, ME), and the HerdChek-Mycobacterium paratuberculosis Antibody ELISA (Idexx Laboratories, Inc. Westbrook, ME). Samples were also analyzed at the Cornell University Veterinary Medicine Diagnostic Laboratory using a Johnes Kinetic ELISA (KELA). Results showed the percent seropositive cows to be 16.9, 3.8 and 18.7 for the Tip-Test, HerdChek and KELA respectively. Comparisons of the HerdChek versus KELA, Tip-Test versus HerdChek and, Tip-Test versus KELA showed test results disagreed in 18%, 19% and 27% of the samples respectively. Herd size did not effect the percent positive cows. These tests are valuable tools for screening individual cattle and assessing the overall risk of Johnes Disease in a herd. More definitive tests should be used when making management decisions about individual cows.

Key Words: Johnes, ELISA

988 Retrospective associations of prepartum intake, body condition score, body weight, and blood chemistry with the occurrence of retained placenta in dairy cows. H. M. Dann*, J. K. Drackley, and D. E. Morin, *University of Illinois, Urbana.*

In a previous study, multiparous Holstein cows were used to determine the effects of prepartum dry matter intake (DMI) on postpartum DMI, milk yield, blood chemistry, and liver composition. Because a high incidence of retained placenta (RP) occurred, a retrospective analysis was conducted to determine associations between RP and prepartum variables such as DMI, body condition score (BCS), body weight (BW), blood chemistry, and gestation length. Cows were dried off 60 d before expected parturition. Cows were fed a diet (1.54 Mcal NE_L/kg, 14.1% CP) from dry off to parturition at either ad libitum (A; $n=16$) or restricted (R; 80% of calculated NE_L requirements; $n=17$) intake. After parturition, cows were classified as having either expelled the placenta within 12 h (EP; $n=17$) or retained the placenta (RP; $n=16$). Seven cows fed A had RP and nine cows fed R had RP. Prepartum DMI (1.9 vs 1.1% of BW), serum glucose (60 vs 57 mg/dl), and serum insulin (8.2 vs 4.6 μ IU/ml) were higher ($P < 0.05$), and serum nonesterified fatty acids (NEFA; 156 vs 300 μ Eq/L) were lower ($P < 0.05$) for cows fed A compared to R. Prepartum intake did not affect ($P > 0.05$) serum β hydroxybutyrate (BHBA; 4.1 mg/dl), BCS (3.09), BW (738 kg), or gestation length (calved 2.7 d before expected date). No prepartum differences were detected ($P > 0.05$) for DMI (1.5% of BW), BW (738 kg), or concentrations of glucose (59 mg/dl), insulin (6.4 μ IU/ml), NEFA (228 μ Eq/L), and BHBA (4.1 mg/dl) in serum between EP and RP cows. Cows with RP had a lower ($P < 0.05$) prepartum BCS (2.74 vs 3.43) than EP cows. Cows with RP had a shorter gestation than EP (calved 4.6 vs 0.8 d before expected date; $P < 0.05$). Five RP cows had twins whereas one EP cow had twins. There was no interaction of prepartum intake (A vs R) and the occurrence of RP for prepartum DMI, BCS, BW, serum glucose, serum insulin, serum NEFA, or gestation length. Cows with low BCS during the prepartum period may have more RP regardless of prepartum DMI and associated factors.

Key Words: Body Condition, Retained Placenta, Intake

989 Correlation between liver dry matter and liver lipid concentrations in periparturient dairy cows. O. Rosendo*¹, C. R. Staples¹, and L. R. McDowell¹, ¹University of Florida.

Liver dry matter percent (DM) has been used to estimate total lipid concentrations on liver wet weight basis (TLwet) in other species than ruminants. To develop lipid concentration predictive equations from liver DM in periparturient dairy cows, data from an experiment that evaluate the effect of supplemental biotin on performance of transition cows were used. Liver samples were obtained from 40 multiparous Holstein cows at # 17, + 2, + 14, and + 28 d, relative to calving. A total of 425 liver aliquots were analyzed for TLwet (100 mg) by solvent extraction followed by chemical determination of triacylglycerol concentrations on wet weight basis (TAGwet). Liver DM was determined on a separate aliquot (100 mg) after drying for 24 h at 55 °C in a forced air oven.

A total of 150 TLwet, TAGwet, and DM averages were analyzed using correlation, regression and general linear model procedures of SAS. Concentrations of TLwet (range = 2.9-14.9%) and TAGwet (range = 0.71-10.41%) were highly correlated ($P < 0.001$) with liver DM percent (range = 20.0-36.2%). The regression coefficients for the TLwet and TAGwet simple linear equations as a function of DM (over the entire ranges of DM) were 0.42 and 0.66, respectively. The best-fitting models to describe the relationship between DM and liver lipids using the entire data set were the following second-order polynomial derived equations. For TLwet = $44.268 - (3.3625 \times \text{DM}) + (0.0717 \times \text{DM}^2)$ ($R^2 = 0.53\%$; $P < 0.0001$) and for TAGwet = $39.983 - (3.2370 \times \text{DM}) + (0.0678 \times \text{DM}^2)$ ($R^2 = 0.58\%$; $P < 0.0001$). Above liver DM of 25%, the third-order polynomial equations that follow: TLwet = $681.635 - (67.3989 \times \text{DM}) + (2.2029 \times \text{DM}^2) - (0.0235 \times \text{DM}^3)$ ($R^2 = 0.56\%$, $P < 0.0001$) and TAGwet = $639.039 - (63.6490 \times \text{DM}) + (2.0857 \times \text{DM}^2) - (0.0223 \times \text{DM}^3)$ ($R^2 = 0.61\%$, $P < 0.0001$) were the best-derived models. The use of these predictive equations for estimation of liver lipid concentrations may contribute to examine fatty liver problems in dairy herds while decreasing greatly the amount of time spent and cost of analysis involved in.

Key Words: Liver dry matter, liver lipids, correlation

990 Influence of *Lactobacillus brevis* 1E-1 on the gastrointestinal microflora of pre-weaning and weaning pigs. S Banach^{*1}, T Rehberger¹, T Parrott¹, C Maxwell², J Coalson³, and K Touchette³, ¹Agtech Products, Inc., ²University of Arkansas, ³Merrick's, Inc.

Maintaining a normal healthy intestinal microflora during the profound environmental and nutritional changes at weaning is critical to ensure optimal performance for pigs. The objective of this study was to determine the effects of feeding *Lactobacillus brevis* 1E-1 on the gastrointestinal microflora of pre-weaning and weaning pigs. Sows and gilts were randomly assigned to one of three treatments. Four litters received no milk replacer (control), five litters received milk replacer and five litters received milk replacer supplemented with 1E-1. Coliforms and *E. coli* were enumerated from esophageal, duodenal, jejunal, and ileal regions of intestinal tracts from one pig per litter at 9-13 (pre-weaning) and at 19-23 (weaning) days of age. *E. coli* and coliform populations in esophageal, duodenal and ileal regions of pre-weaning pigs were not significantly different. Pigs receiving 1E-1 had significantly lower jejunal *E. coli* populations compared to control ($P < .02$) and milk replacer ($P < .05$). Jejunal coliform populations tended to be lower for pigs receiving 1E-1 compared to control pigs ($P = .11$) but were not significantly different compared to pigs receiving milk replacer. There were no treatment effects on populations of coliforms and *E. coli* in the esophageal and duodenal regions for pigs at weaning. Pigs receiving 1E-1 had significantly lower *E. coli* populations in the jejunal region compared to control ($P < .01$) and milk replacer ($P < .10$). There were no significant treatment effects on jejunal coliform populations for pigs at weaning. In the ileal region of weaning pigs, the coliform populations neared significance for pigs receiving 1E-1 when compared to control ($P = .07$). *E. coli* populations were significantly lower for pigs receiving 1E-1 compared to control pigs ($P < .05$) and pigs receiving milk replacer ($P < .02$). These results suggest that feeding 1E-1 may provide a healthier intestinal microflora at weaning.

Key Words: Pigs, Weaning, Lactobacillus

991 Endotoxin (LPS) challenge increases plasma xanthine oxidase (XO) activity in cattle: effect of growth hormone (GH) and vitamin E (E) treatment. S. Kahl^{*} and T.H. Elsasser, USDA, Agricultural Research Service, Beltsville, MD.

In addition to its basic role in the metabolism of purine nucleotides, XO is involved in the generation of oxygen-derived free radicals and production and metabolic fate of nitric oxide (NO), an important component and regulator of the immune response to infection. Our objective was to determine the effect of LPS challenge ($3.0 \mu\text{g/kg BW}$, i.v. bolus, *E. coli* 055:B5) on plasma XO activity. We also studied the modifications of this response by daily treatment with recombinant GH (0.1 mg/kg BW , i.m., for 12 d) and E (mixed tocopherol, 1000 IU/d , i.m., for 5 d). Sixteen heifers ($348.7 \pm 6.1 \text{ kg}$) were fed a forage concentrate diet (15% CP) to appetite, and synchronized to a similar stage of the estrous cycle with two injections of PGF_{2α}. Heifers were assigned to control (C, daily corn oil and saline-bicarbonate injections), GH, or GH + E treatments. All heifers were challenged with LPS 8 d after the last injection

of PGF_{2α} (LPS1) and again 2 d later (LPS2). Blood samples were collected at 0, 1, 2, 3, 4, 6, 8, 24, and 48 h relative to LPS injections. After LPS1, plasma XO activity (mU/mL) increased ($P < 0.001$) from 7.2 at 0 h to 28.1 at 4 h, reached peak (38.2) at 24 h and returned to basal level by 48 h after LPS2. LPS1 XO responses, measured as area under the time \times concentration curve (AUC), were greater than those in LPS2 ($P < 0.001$). Total plasma XO responses to LPS (AUC, LPS1 + LPS2) were augmented over C with GH treatment ($2202 \text{ vs } 1412 \text{ mU/mL} \times \text{h}$, SEM = 226, $P < 0.05$) but diminished to C responses in GH + E. There was a linear relationship ($r^2 = 0.605$, $P < 0.001$) between total response (LPS1 + LPS2) in plasma XO activity and plasma nitrate + nitrite (stable end products of NO) concentration. Results indicate that LPS-induced increases in plasma XO activity could be amplified by previous GH treatment but attenuated by E administration. The data also suggest that E may be effective in controlling some mediators of immune response associated with increased production of NO.

Key Words: Endotoxin, Xanthine oxidase, Vitamin E

992 Measurement of Bovine inflammatory cytokines by RT-PCR using an ex-vivo whole blood assay: Relevance to endotoxin levels in animal pharmaceuticals. M. L. Scott^{*} and M. J. Myers, U.S. FDA, CVM, Division of Animal Research.

FDA requires that sterile products meet the guidelines for pyrogen levels. However, due to a lack of adequate information in food animals a very conservative approach has been set for animal drugs. The objective was to develop an in vitro method to generate data to help refine these guidelines. Blood collected from ten Holstein cows were cultured at 37°C in Ultraculture media for 0, 1, 3, 6, 12, 24, 48, and 72 hours with $1 \mu\text{g/mL}$ LPS. RNA was extracted and expression by RT-PCR used to analyze cytokine genes. Time course studies indicated that IL-6 and TNF-α hit a plateau between 1 and 3 hours. Blood from nine Holstein cows were cultured for 3hrs with LPS concentrations of 0, $1 \mu\text{g}$, 100 ng , 10 ng , 1 ng , 100 pg , 10 pg , and 100 fg . Surprisingly, IL-6 at 100 fg were 7x higher than no LPS, providing evidence that very low concentrations of endotoxin can provoke an inflammatory response. These values are greater than 10-fold more sensitive than current FDA approved pyrogen testing kits. In conclusion, the novel bioassay developed within are very sensitive and provide evidence that inflammatory responses can be triggered by very small quantities of LPS.

Key Words: Endotoxin, RT-PCR, Cytokine

993 Preparation and characterization of monoclonal antibodies to recombinant bovine CD14. E. J. Sohn^{*1}, M. J. Paape¹, and R. R. Peters², ¹Immunology and Disease Resistance Laboratory, USDA-ARS, Beltsville, MD, ²Department of Animal and Avian Sciences, University of Maryland, College Park.

Lipopolysaccharide (LPS) is the predominant factor causing pathogenesis in intramammary infections in dairy cows by Gram-negative bacteria. Cluster of differential antigen 14 (CD14) mediates cellular responses to LPS. Information on the functional role of CD14 in the intramammary response to Gram-negative bacterial infection is limited. We have previously cloned and expressed recombinant bovine CD14 (rbosCD14) in a baculovirus/Sf-9 insect cell system. The objective of this study was to produce anti-rbosCD14 mAb in order to characterize the role of CD14 in intramammary infections by Gram-negative bacteria. Ten murine mAb reactive with rbosCD14 were produced, and an ELISA using rbosCD14, anti-rbosCD14 and goat anti-mouse IgG conjugated to horseradish peroxidase was developed. The mAb were further characterized by Western blot and flow cytometry. The mAb bound specifically to CD14 derived from SF-9 cells and identified a 55 kDa polypeptide band by Western blot. Flow cytometric analysis revealed that the mAb derived from cell lines 6-6-1(IgG_{2b}) and 1-54-2(IgG₁) bound to 80% of the leukocytes in a monocyte enriched preparation from bovine blood. The anti-rbosCD14 mAb generated in this study will provide useful reagents for studies on LPS-CD14 interrelationships during experimentally induced mastitis by Gram-negative bacteria and LPS.

Key Words: Mastitis, CD14, LPS

994 Comparisons of functional capacities of blood mononuclear leukocytes (MNL) and neutrophils (PMN) from calves and heifers vaccinated with attenuated *Mycobacterium bovis* (BCG). M. Foote^{*1}, B. Nonnecke¹, W. Waters¹, T. Rahner¹, M. Palmer¹, W. Miller², M. Fowler², T. Johnson², B. Perry², and D. Hammell², ¹National Animal Disease Center, USDA, ARS, Ames, ²Land O'Lakes, Inc., Webster City.

Development and modulation of immune competency in calves during the first months of life is not well described. The purpose of this study was to characterize age-related changes in the functional capacities of PMN and MNL populations from young calves. Milk replacer-fed calves were nonvaccinated (NVAC, n=12) or vaccinated subQ (VAC, n=12) with BCG at 1 and 7 wk of age. Functions of PMN and MNL populations from blood samples collected at 0 (vaccinated), 2, 5, 6 (boosted), 7, 8 and 11 wk of the study period were evaluated *in vitro*. Yearling heifers (n=4) were vaccinated and sampled concurrently with the calves. DNA synthesis by nonstimulated calf MNL exceeded ($P < .05$) synthesis by nonstimulated adult MNL from wk 2-11. Pokeweed mitogen-induced DNA synthesis by calf MNL was lower ($P < .05$) than adult MNL at wk 0 only. Responses of VAC MNL to eliciting antigens (PPD and *M. bovis* whole cell sonicate) were evident at >2 wk after primary vaccination and frequently were not different from adult MNL demonstrating competency of adaptive-arm of the neonatal calf's immune system. Quantification of CD4, $\gamma\delta$ TCR+, and CD8 T cells in 48 h cultures by flow cytometry (wk 6 only) indicated that vaccination, age (calf vs. adult), and type of stimulation affected ($P < .05$) cell proliferation. Changes in cervical skin-fold thickness after intradermal administration of PPD (wk 11) were pronounced and comparable in VAC and adults. Nonvaccinated calves did not respond to PPD. PMN function (iodination and cytochrome C reduction) was affected by age ($P < .05$); but not vaccination. These results indicate that the calf vaccinated at 1 wk of age is capable of developing a vigorous response to antigenic challenge *in vitro* and *in vivo*. Hyporesponsiveness of the neonate's PMN and MNL populations to non-antigenic stimulation may be linked to its developmental immaturity.

Key Words: Calf, Lymphocyte, Neutrophil

995 DNA vaccination in dairy cows: I. Effect of targeting a DNA vaccine to professional antigen presenting cells using bovine CTLA-4 sequences. L. Shkreta^{*1}, B.G. Talbot¹, and P. Lacasse², ¹Sherbrooke University, Sherbrooke, QC, Canada, ²AAFC - Dairy and Swine R&D Centre, Lennoxville, QC, Canada.

The objective of this study was to determine the immune response to a DNA vaccine targeted to professional antigen presenting cells. 36 Holstein cows, 60 d prior expected calving (d 0), were randomly assigned to a 3 X 4 factorial design where the main effects were the site of immunization and the type of plasmid injected. Cows were vaccinated with the plasmid expression vector pCI alone (control), a plasmid encoding the bacterial antigen β -galactosidase (pCI- β gal) or a plasmid encoding a fusion between bovine T lymphocyte antigen 4, human IgG hinge region and β -gal (pCI-bCTLA- β gal). Animals were needle injected either in the neck and gluteus muscles, in the skin of the ear, in the mammary gland or in the supra-mammary-lymph node. Cows were immunized three times at 21 day intervals, with 1 mg of DNA per injection. Indirect ELISA was used to monitor anti- β -gal antibody responses in serum and milk. Lymphoproliferation and lymphocyte phenotype profiles were analyzed to evaluate cellular immunity. Increased antibody responses in serum confirmed the induction of specific immune responses ($P < .05$) against β -gal for both DNA vaccines with a predominance of the IgG2 isotype responses over the IgG, IgG1 and IgM isotype responses in decreasing order. The IgG1, IgG2 and IgM responses were similar, but cows injected with pCI-bgal tended to have a higher IgG response ($P = .07$) than cows immunized with pCI-bCTLA- β gal. No β -gal specific IgG, IgG1, IgG2 and IgA responses were clearly detectable in milk. The lymphocyte proliferation index (LPI) indicated that both plasmids induced ($P < .0001$) a cellular response. The LPI was higher ($P < .001$) with pCI- β gal (3.3) than with pCI-bCTLA- β gal (2.53; control=1.0). The ratio of CD4 to naive immune cells was increased by both vaccines ($P < .0001$) while the ratio of CD4 to CD8 lymphocytes

was significantly increased ($P < .01$) in pCI-bCTLA-bgal only. In conclusion, plasmid DNA vaccines encoding the bacterial antigen β -gal were able to elicit significant humoral and cellular responses in dairy cows. However, despite changes in the profile of the immune response, the overall effect was not clearly enhanced by fusing the antigen with the professional antigen presenting cell targeting sequence bCTLA-4.

Key Words: DNA vaccine

996 DNA vaccination in dairy cows: II. Effect of injection site on immune responses to plasmid DNA immunization. L. Shkreta^{*1}, B.G. Talbot¹, and P. Lacasse², ¹Sherbrooke University, Sherbrooke, QC, Canada, ²AAFC - Dairy and Swine R&D Centre, Lennoxville, QC, Canada.

The site of immunization appears to influence the immune response to plasmid DNA vaccination. The objective of this study was to evaluate the effect of immunization site on immune responses to plasmid DNA immunization. Twenty-four Holstein cows 60 d prior to expected calving (d 0) were randomly assigned to a 2 X 4 factorial design where the main effects were the site of immunization and the plasmid injected. Cows were vaccinated by needle injection either in the neck and gluteus muscle (IM), in the ear skin (ID), in the mammary gland (IMGLD) or in the supra-mammary-lymph node (ILN), with either pCI- β gal or pCI-bCTLA-4-IgG- β gal, encoding non-secreted and secreted forms respectively of the bacterial antigen, β -galactosidase. Animals were injected three times, at 21 day intervals, with 1 mg of DNA per injection. The level of β -galactosidase antibodies in the serum was evaluated at d 0 to d 110. As expected, both plasmids induced significant immune responses. Cows injected IM and IMGLD tended to have higher humoral responses than cows immunized ID or ILN. For IgG and IgG-1 isotype responses, the area under the curve for IM, ID, IMGLD and ILN, averaged 7.8, 2.7, 6.6 and 3.1 for IgG and 2.6, 1.4, 3.6 and 1.5 for IgG-1. The injection site of the DNA vaccine did not significantly affect the magnitude of the IgG2 and IgM antibody responses, although a similar trend to the IgG results was observed. The ratio of IgG2/IgG1 isotype responses indicated the predominance of IgG2 responses over IgG1 for each site of injection, being the highest for intramuscular and the lowest for intramammary gland injection. The lymphocyte proliferation index and lymphocyte phenotype profiles were not affected by the injection site. These results suggest that for DNA vaccination by needle injection in dairy cows the injection site does not appear to be a determining factor for the immune responses. Thus the vaccination site can be chosen for practical rather than immunological reasons.

Key Words: DNA vaccine

997 Recombinant bovine soluble CD14 reduces fatality of endotoxin challenged mice. J. W. Lee^{*1}, X. Zhao¹, and M. J. Paape², ¹Department of Animal Science, McGill University, Quebec, Canada, ²Immunology and Disease Resistance Laboratory, USDA-ARS, Beltsville, MD.

Endotoxin, or lipopolysaccharide (LPS), has been demonstrated to be responsible for the pathogenesis of Gram-negative bacterial infections, such as bovine coliform mastitis. The cellular response to LPS is modulated by the interaction among LPS, LPS-binding protein and CD14. The production of inflammatory cytokines, including TNF- α , by LPS-activated monocytes/macrophages leads to an overwhelming systemic response and causes death in severe cases. Accumulated evidence shows that the soluble form of CD14 (sCD14) competes with membrane-bound CD14 for LPS and inhibits cell activation. To investigate the protective effect of sCD14, recombinant bovine sCD14 (rbosCD14) was produced by transfected insect Sf9 cells and its biological function was evaluated in mice. Eighty-one 8-wk old BALB/cj female mice were randomly assigned to two groups, and injected intraperitoneally with either LPS (8 μ g/gBW, n = 41) or LPS plus rbosCD14 (6.8 μ g/gBW, n = 40). Survival rate for LPS and LPS plus rbosCD14 injected mice at 24 h was 30 and 72%. At 48 h survival rates were 7 and 37%. Results indicated that rbosCD14 was able to decrease the fatality of LPS challenged mice. These results suggest use of rbosCD14 as a therapeutic agent for neutralizing LPS during acute endotoxin shock in ruminants.

Key Words: Endotoxin, CD14, Mastitis

998 Alterations in immune parameters of cows and calves from four weeks prior to parturition through 24 hours after birth. S. T. Franklin^{*1}, M. C. Newman¹, K. E. Newman², and J. A. Jackson¹, ¹University of Kentucky, ²Venture Laboratories.

The objective of this study was to monitor immune parameters of cows beginning 4 wk prior to anticipated parturition and continuing through parturition. Likewise, immune parameters of their offspring were monitored at birth and 24 hr later. Cows were vaccinated at 4 and 2 wk prior to expected parturition and blood samples were obtained at 4 and 1 wk prior to parturition plus immediately after parturition. Blood samples from calves were obtained at birth and 24 h later. Serum for cows and calves was harvested and analyzed for serum protein, IgG1, IgG2, IgA, and IgM concentrations and rotavirus neutralization titers. Whole blood was used for determination of packed cell volume, white blood cell counts, and cell differentials. Cows were milked immediately after calving. Colostrum production was measured and quality was monitored using a colostrometer. Calves subsequently were fed 1.84 L by nipple bottle. Colostrum samples were frozen for later determination of concentrations of IgG1, IgG2, IgA, and IgM as well as rotavirus neutralization titers. In serum of cows, IgG2 was the predominant Ig. IgG1 decreased in serum over time and was the predominant Ig in colostrum. Serum titers against rotavirus increased ($P = 0.0001$) over time in cows. The percentages of eosinophils and mononuclear leukocytes in blood decreased ($P = .0001$) over time whereas the percentages of neutrophils and total white blood cell counts were greatest ($P = .0001$) at parturition. In calves, serum protein concentrations were greatest ($P < 0.05$) in winter at 24 h reflecting greater concentrations of Ig in colostrum in winter compared to summer. Also, IgG1 was the main Ig in serum of calves, followed by IgM. Improved understanding of the immune system of cows and calves during the periparturient period may allow for mechanisms for enhancing disease resistance.

Key Words: Immune function, Calves, Periparturient

999 Evaluation of a starch-oil composite versus phosphate buffered saline (PBS) as a vehicle for lipopolysaccharide (LPS) induced immune activation in growing pigs. J. W. Frank^{*1}, G. L. Allee¹, R. D. Boyd², F. C. Felker³, and M. A. Mellencamp², ¹University of Missouri - Columbia, ²PIC USA, Inc., Franklin, KY, ³National Center for Agricultural Utilization Research, USDA/ARS, Peoria, IL.

Twenty barrows (d 0 BW = 60 kg) were used in a four-day trial to determine if LPS could be delivered in a chronic manner. LPS was dispersed into FanteskTM, a starch-oil composite, or PBS and the effect on rectal temperature and feed intake monitored. Pigs were allotted to 1 of 4 treatments: 1) Fantesk without LPS (FAN), 2) FAN with 15 ug LPS/kg BW (FAN-15), 3) FAN with 30 ug LPS/kg BW (FAN-30), and 4) PBS with 15 ug LPS/kg BW (PBS-15). Pigs were weighed on d 0 and 4 and injected on d 1. Feeders were weighed daily at 0800 h. Acute feed intake response is reported as the percentage of intake relative to ADFI 48 h prior to injection (baseline). Rectal temperatures were taken at #2, 0, 2, 3, 4, 5, 6, 7, 8, 10, 12, 24, 36, and 48 h relative to injection. No treatment differences were observed for d 4 BW, ADG, or G:F. FAN pigs had greater ADFI compared to pigs receiving LPS in either vehicle (2.97 vs. 2.43 kg/d, $P < 0.005$). Acute feed intake differences relative to baseline were observed for the LPS treatments 0 to 24 h (47.4%, $P < 0.001$), 0 to 48 h (69.4%, $P < 0.01$), and 0 to 72 h (78.5%, $P < 0.05$) after injection. However, rapid recovery of feed intake relative to baseline was observed 24 to 48 h (88.7%, $P < 0.69$) and 48 to 72 h (96.2%, $P < 0.38$). Time x treatment interactions were observed for rectal temperatures. From 2 to 6 h after injection, pigs receiving LPS had higher rectal temperatures than FAN pigs ($P < 0.001$). Rectal temperatures of PBS-15 pigs tended to be lower than FAN-15 pigs 8 h after injection (39.7 vs. 40.4 °C, $P < 0.14$). No other differences were observed when comparing FAN-15 to PBS-15 or FAN-15 to FAN-30. The use of Fantesk did not prolong the effects of LPS on ADG, ADFI, G:F, or the acute feed intake responses; however, the starch-oil composite maintained elevated rectal temperatures 8 h after injection with LPS compared to the phosphate buffered saline solution.

Key Words: Pigs, LPS, FanteskTM

1000 Regulation of immunoglobulin binding and Fc receptor expression on bovine neutrophils. M Worku^{*1}, K Campbell¹, and M Paape², ¹North Carolina Agricultural and Technical State University, ²Immunology and Disease resistance Laboratory ARS USDA.

A heterogeneous population of Fc receptors is recognized on bovine neutrophils (PMN). The effect of bacterial endotoxin (LPS), Dexamethasone and Sodium Butyrate on immunoglobulin binding and Fc receptor expression on bovine PMN was analyzed by flow cytometry. Bovine blood PMN from four clinically healthy cows was isolated by differential centrifugation and hypotonic lysis of red blood cells. Viability was assessed by Trypan blue dye exclusion, purity was determined by differential cell counts of Wrights stained smears and concentration using a coulter cell counter. Isolated PMN were treated with LPS (1000, 100 or 10ng/ml), Dexamethasone (0.25mg/ml, 0.15mg/ml or 0.8mg/ml) or Sodium Butyrate (160uM, 80 uM or 40uM) or maintained in buffer for 1 hour, 37°C. Cells were then incubated with purified bovine IgG1, IgG2 or IgM for 30 Min at 4°C. Cells were then washed and incubated with fluorescein conjugated goat anti bovine immunoglobulin antibody for 30 minutes at 4°C. Endogenously bound IgG and IgM were assessed by incubating PMN with fluorescein conjugated goat antibody to bovine IgG2 and IgM respectively for 30 min at 4°C, the percentage of fluorescent PMN and the log mean fluorescent channel were used to assess Ig binding and Fc receptor expression. Both Ig binding and Fc receptor expression for all classes of Igs was significantly decreased by treatment with Dexamethasone. Endogenously bound IgM was significantly higher in the presence of Sodium butyrate when compared to untreated cells. Bacterial LPS at 100ng/ml significantly increased the expression of Fc receptors binding IgG2. Thus in bovine PMN Fc receptor gene expression can be differentially modulated for dissection of receptor regulation and function and the identification of therapeutics.

Key Words: Bovine, Neutrophil, Immunoglobulin

1001 Flow cytometric evaluation of the effects of Sodium Butyrate on apoptosis of bovine neutrophils. M Worku^{*1}, K Campbell¹, and M Paape², ¹North Carolina Agricultural and Technical State University, ²Immunology and Disease resistance Laboratory ARS USDA.

Bovine blood neutrophils (PMN) from four clinically healthy cows were suspended in Dulbecco's minimal essential medium and incubated at 37°C for 0, 2 or 6 hours in medium alone, with 100ng/ml bacterial endotoxin, 160uM Sodium Butyrate, 16uM Actinomycin D, a mixture of Sodium Butyrate and bacterial endotoxin or a mixture of Sodium Butyrate and Actinomycin D. To label necrotic and apoptotic cells, PMN were resuspended in incubation buffer containing equal proportions of Propidium Iodide and Annexin-V-FITC and incubated in the dark at 4°C for 10 minutes. Samples were then analyzed by flow cytometry. The percentage of electronically gated PMN with associated green fluorescence was used as an indicator of apoptosis. The results were analyzed using SAS statistical analysis software. Compared to PMN maintained in medium alone (11 percent), both Sodium Butyrate and Actinomycin D slightly increased the proportion of apoptotic PMN (15 percent). Bacterial endotoxin significantly increased apoptosis of bovine PMN (27 percent). This increase was inhibited in the presence of Sodium Butyrate (18 percent). Sodium Butyrate did not significantly affect the response to Actinomycin D (15 percent). Apoptosis of bovine PMN in response to bacterial endotoxin can be inhibited by the action of Sodium Butyrate.

Key Words: Apoptosis, Neutrophil, Bovine

1002 Interferon- γ (IFN) and tumor necrosis factor- α (TNF) secretion by blood mononuclear leukocytes (MNL) from young and adult cattle vaccinated with attenuated *Mycobacterium bovis* (BCG): modulation by 1,25-(OH)₂ vitamin D₃. B Nonnecke^{*1}, W Waters¹, M Foote¹, R Horst¹, M Fowler², and B Miller², ¹Natl. Anim. Dis. Ctr., Ames, IA, ²Land O'Lakes Inc., Webster City, IA.

Interferon and TNF are critical in the development of an effective immune response. Vitamin D, essential in short-term calcium homeostasis and recently shown to modulate proliferation and function of lymphocytes from adult cattle, may be an effective modulator of the calf's immune system. The present study examined effects of maturity (i.e.

calf vs. adult), antigen sensitization, and VitD on IFN and TNF secretion by bovine MNL. Heifers (VA, n=4) and 1-wk-old calves (VC, n=6) were vaccinated with BCG and boosted six weeks later. Ten weeks after primary vaccination, MNL from vaccinates and nonvaccinated, age-matched calves (NVC, n=4) were evaluated in vitro for their capacity to produce IFN and TNF. Cells were nonstimulated (NS) or stimulated with mitogen (PWM) and antigen (PPD) in the presence of VitD (0, 1, and 10 nM). Cytokines in culture supernatants harvested at 20, 44, and 68 h were quantified by ELISA. Calf MNL produced ($P < .10$) more IFN and TNF than adult MNL in NS cultures, however, adult MNL produced more IFN ($P < .05$) than calf MNL in PWM stimulated cultures. Secretion of TNF in PWM stimulated cultures was unaffected ($P = .36$)

by animal maturity. MNL from vaccinates (young and adult) produced more ($P < .01$) IFN than MNL from NVC, whereas, MNL from VC produced more TNF ($P < .01$) than MNL from VA or NV calves. VitD had no effect on cytokine concentrations in PPD stimulated cultures but in PWM stimulated cultures caused a dose-dependent decrease ($P < .05$) in IFN secretion and increase ($P < .05$) in TNF secretion. Incubation time affected ($P < .05$) cytokine concentrations. TNF levels were greatest at 20 and 44h, whereas IFN levels were greatest at 68h. These results indicate that age and antigen exposure affects cytokine secretion by bovine MNL and suggest that VitD can modulate secretion of both cytokines.

Key Words: Calf, Vitamin D, Cytokine

Graduate Paper Competition CSAS Graduate Student Competition

1003 A bioeconomic model of the broiler chicken supply chain. M. J. Zuidhof^{*1}, R. J. Hudson², T. Joro², and J. J. R. Feddes², ¹Alberta Agriculture, Food and Rural Development, ²University of Alberta.

A dynamic, deterministic bioeconomic model of the broiler supply chain has been developed with the objective of assisting the poultry industry with complex decisions. Because of biological variability and complex industry structure it is often difficult to optimize decisions, which may be defined as decisions that yield maximum economic benefit to the supply chain. The model spans five sectors of the broiler supply chain: feed, hatching egg production, hatchery, broiler production, and processing. Biological productivity is based on the genetic potential of each strain of bird used in the model. The model operates on a daily time step, and accrues production and associated costs daily. In the broiler sector, production costs are accrued until the time of processing, after which costs are held constant. Prior to the onset of lay in the breeders, actual costs of chick production are undefined, so the model draws on a user supplied chick price. After 250 d of simulation, the model uses simulated chick cost, which drops with increasing breeder age as costs are spread over larger chick numbers. The cost reported on the last day of simulation represents the predicted costs if breeders are kept for the entire production cycle. The model is set to simulate 66 wk of production, a standard Alberta broiler breeder cycle length. Costs are reported in formats that are meaningful to each sector of the supply chain, and as the total cost per kg of meat produced by the supply chain. This is useful for analyses of the effects of specific supply chain management decisions, such as the choice of genetic strain, on costs at the level of each sector. This is important because although a decision may be optimal for the supply chain as a whole, it may not be optimal for all participants in the supply chain.

Key Words: Bioeconomic model, Supply chain, Optimization

1004 Exposing sows and their litters to recorded gruntings at fixed intervals: Effects on piglet growth, sow performance and nursing behavior. K Fiset^{*1}, J.P Laforest¹, S Robert², and C Farmer², ¹Laval University, Quebec, Quebec, Canada., ²Agriculture and Agri-food Canada, Dairy and Swine R&D Centre, Lennoxville, Quebec, Canada.

The impact of exposing lactating sows and their litters to recorded gruntings played at different intervals was studied. Yorkshire \times Landrace gilts were divided in three groups: 1) no playbacks (CTL, n=14), 2) 35-min intervals (M35, n=19), and 3) 40-min intervals (M40, n=16). Recordings were played from day 110 of gestation to day 27 of lactation. Nursing behavior (incidence of nursings without milk ejection (NWM) and nursing interval) was observed on days 6, 18 and 26 of lactation. Litters were uniformized to 10 ± 1 at 48 h postpartum, and piglets were weighed weekly. Sow feed intake was recorded throughout lactation. Sows were slaughtered on day 28 of lactation and their mammary glands were excised and weighed. There was a treatment \times day interaction ($P \leq 0.05$) on nursing interval. On day 6 of lactation, the nursing interval tended to be lower in M40 than in CTL sows (33.2 ± 1.3 vs 37.2 ± 1.4 min; $P = 0.058$), while M35 did not differ from other treatments (34.9 ± 1.0 min; $P > 0.10$). Yet, the nursing interval was not affected by playbacks on days 18 (38.8 ± 0.9 min) and 26 (44.6 ± 0.9 min) of lactation in any of the treatments ($P > 0.10$). The incidence of NWM was greater on days 6 ($P = 0.015$) and 18 ($P = 0.02$) compared to day

26 of lactation in all groups, with mean values of 14.9 ± 1.4 , 13.5 ± 1.3 and 9.0 ± 1.3 %, respectively. The percentage of NWM did not differ significantly ($P > 0.10$) between treatments. Yet, on day 6, M40 sows had a 29 % greater incidence of NWM than CTL sows. Piglet growth, sow feed intake and weight of the mammary glands were not affected by treatments ($P > 0.10$). In conclusion, exposing sows and their piglets to recorded gruntings played at 40-min intervals throughout lactation tended to reduce nursing interval in early lactation only, without affecting performance.

Key Words: Swine, Lactation, Nursing interval

1005 Anatomical measurements of the digestive tract and nutrient digestibility in the Asian Bear Cat (*Arctictis binturong*). C. Crapo^{*1}, A. Moresco², S. Hurley¹, T. Hanner¹, and C. Kadzere¹, ¹North Carolina Agricultural & Technical State University, ²Carnivore Preservation Trust.

The Asian Bear Cat or binturong (*Arctictis binturong*) is classified as a carnivore in the Viverridae family and inhabits the South East Asian rainforest canopy. In its natural habitat the binturong has been observed to ingest a significant amount of fruits. Quantitative data regarding its dietary habits, nutrient digestibility, and utilization are limited. Thirty-five adult binturongs (4-16yrs) at the Carnivore Preservation Trust were included in a 50-day dietary study to include feed intake, nutrient excretion, nutrient digestibility, metabolic profiles, and physical examinations. The observed dental formula of the binturong was similar to that of a dog with three incisors (I) on the upper and lower jaw, one canine (C) on the upper and lower jaw, three premolars (PM) on the upper jaw and two on the lower jaw, and two molars (M) on the upper jaw and three molars on the lower jaw [$2(I \ 3/3 \ C \ 1/1 \ PM \ 3/2 \ M \ 2/3) = 36$; n=38] with incidence of variability between individual animals. The anatomy of the gastrointestinal tract (GIT) was examined during the necropsy of two, genetically unrelated, specimens. The average length of the small intestine was 130cm and the large intestine was 58cm, with an average total length of the GIT from the pyloric sphincter to the anus of only 188cm. This is slightly more than twice the average binturong's body length, from the tip of the nose to the base of the tail, which is approximately 76cm. Necropsies revealed that the binturong have no cecum, resembling the GIT of the mink, a member of the Mustelidae family. However, the length of the binturong's GIT is relatively shorter than that of the mink. The absence of the cecum may explain the observed expulsion of whole, and partially undigested fruit and vegetable matter in the feces. The characteristics of the GIT suggest that the binturong may be unable to digest and utilize fruits as efficiently as most monogastric animals with a cecum do. Considering that the binturong is known to ingest fruits in its natural habitat, it is possible that such fruits serve as a main source of water and that binturongs may require the ingestion of a large volume of fruits and other feeds to meet its nutritional requirements.

Key Words: *Arctictis binturong*, gastrointestinal anatomy, nutrition

1006 Expression of peroxisome proliferator-activated receptor (PPAR γ) mRNA in adipose and muscle tissue of German Holstein and Charolais cattle. P. Huff^{*1,2}, J. Wegner¹, M. Ren¹, F. Lozeman², R. Weselake², and K. Ender¹, ¹Research Institute for the Biology of Farm Animals, Dummerstorf Germany, ²University of Lethbridge, Lethbridge, Alberta Canada.

PPAR γ activity is known to regulate adipogenesis and lipid metabolism-related gene transcripts. The role, however, of PPAR γ in different adipose depots and muscle in secretion type (German Holstein) and accretion type (Charolais) cattle is still unclear. We used 20 animals for semi-quantitative RT-PCR to measure PPAR γ mRNA in subcutaneous (SC), perirenal (PR), omental (OM), and intramuscular (IM) adipose depots as well as longissimus muscle (LM). IM was dissected from muscle tissue in LM. No significant differences in PPAR γ were observed between different cattle breeds for each respective tissue, whereas between respective tissues, expression differed based on breed. In German Holstein no differences were observed between SC, PR, and OM depots while IM was lower ($P < 0.05$). The lowest ($P < 0.05$) expression was observed in LM. In Charolais OM PPAR γ was higher ($P < 0.05$) than SC and PR whereas IM and LM was the lowest ($P < 0.05$) also in this breed. To characterize the role of PPAR γ in bovine adipogenesis correlations were performed among PPAR γ , carcass characteristics, and adipogenesis-related genes. A low expression of muscle PPAR γ in German Holstein was correlated significantly ($P < 0.05$) with a high deposition of fat (SC, $r = -0.83$; PR, $r = -0.86$; and OM, $r = -0.89$) and a high body weight ($r = -0.99$). A high expression of PPAR γ in the IM depot was correlated with a high SC leptin receptor expression respectively in both German Holstein and Charolais ($r = 0.94$, $r = 0.98$). In Charolais a relationship was observed within the PPAR γ expression in the different depots. The high expression of PPAR γ in OM was correlated with a lower expression in SC ($r = -0.86$) and IM ($r = -0.99$). The different fat content of both cattle breeds may therefore be regulated by PPAR γ in a depot-specific manner.

Key Words: Adipose tissue, Muscle tissue, PPAR γ

1007 Effects of feeding blends of grains naturally-contaminated with *Fusarium* mycotoxins on growth, serum chemistry and hematology of starter pigs. H.V.L.N. Swamy^{*1}, T.K. Smith¹, E.J. MacDonald², H.J. Boermans¹, N.A. Karrow¹, and W.D. Woodward¹, ¹University of Guelph, Guelph, ON, Canada, ²University of Kuopio, Kuopio, Finland.

An experiment was conducted to determine the effect of feeding blends of grains naturally-contaminated with *Fusarium* mycotoxins to starter pigs and to test the efficacy of a polymer extracted from yeast cell wall as a dietary treatment for *Fusarium* mycotoxins. A total of 150 starter pigs (initial weight of 9.3 kg) were fed 5 diets (6 pens of 5 pigs per diet) for 21 days. Diets included: (1) a control (0.3 ppm deoxynivalenol, DON and 26.68 ppm fusaric acid, FA), (2) a blend of 17% contaminated grains (2.2 ppm DON, 36.22 ppm FA), (3) a blend of 24.5% contaminated grains (2.9 ppm DON, 49.28 ppm FA), (4) a blend of 24.5% contaminated grains + 0.20% yeast cell wall polymer (MTB-100, Alltech Inc.) (2.8 ppm DON and 20.93 ppm FA), and (5) a pair-fed control group for comparison with group receiving 24.5% contaminated grains. The feeding of contaminated grains resulted in a significant linear decline in weight gain and feed consumption, and a linear increase in serum albumin to globulin ratio. Serum urea concentrations and gamma glutamyltransferase activity responded quadratically to the level of contamination. When compared to the pair-fed controls, serum concentrations of total protein and globulin were reduced in animals fed 24.5% contaminated grains. The dietary supplementation of the polymer significantly reduced gain to feed ratio in animals fed 24.5% contaminated grains. The feeding of contaminated grains did not alter serum immunoglobulin concentrations, hematology, peripheral blood differential leukocyte count, and the percentage of CD4/CD8 double positive, CD4 single positive, and CD8 single positive T-lymphocytes and B-lymphocytes. It was concluded that the feeding of grains naturally-contaminated with *Fusarium* mycotoxins can alter serum chemistry in starter pigs. The use of a pair-fed treatment group permitted the differentiation between the nutritional and systemic effects of *Fusarium* mycotoxins.

Key Words: Pigs, *Fusarium*, Deoxynivalenol

1008 Bacterial inoculant applied with or without hydrolytic enzymes to barley at harvest: Effects on fermentation and nutrient retention in silage. H. Zahiroddini^{*1,2}, J. Baah¹, and T.A. McAllister¹, ¹Agriculture and Agri-Food Canada, Lethbridge, AB, ²University of Tehran, Karaj, Iran.

Including hydrolytic enzymes with a bacterial silage inoculant was proposed to accelerate fermentation and improve barley silage quality. This was investigated in a 2×2 factorial study using 96 laboratory-scale (3-L) silos. Whole barley forage was chopped, wilted to 35% DM and treated with water (control), inoculant (Agri-Sile[®]), enzyme mixture (primarily cellulase and amylase activities) or inoculant + enzymes (Silage-Pro[®]) prior to ensiling. Triplicate silos of each silage (denoted C, I, E, and I+E, respectively) were opened after 0.5, 1, 2, 3, 4, 7, 14 and 112 d for chemical and microbiological analyses. Silos were weighed after capping and before opening for estimation of DM loss. Inoculant increased the rate of decline of silage pH: I and I+E attained pH 4.0 by d 3, whereas C and E were at pH 4.2 and 4.25, respectively, at d 14. At d 112, soluble carbohydrate concentrations (g/kg DM) were lower ($P < 0.05$) in I and I+E (22.9 and 22.4, respectively) than in C (29.7) and E (32.7). Crude protein contents were higher ($P < 0.05$) in I and I+E (132 and 126 g/kg DM, respectively) compared with C and E (117 and 118 g/kg DM), and less NH₃-N (as % of total N) was present (3.74 and 4.49% in I and I+E, vs 7.50% in C and 6.68% in E; $P < 0.01$), suggesting reduced proteolysis with inoculant. At d 112, C and E had more ($P < 0.01$) acetate and total (TB) and lactic acid-producing (LAB) bacteria than did I or I+E. In both C and E, TB and LAB were present at (log₁₀ cfu/g) 8.3 and 8.0, respectively; in both I and I+E, TB numbered (log₁₀ cfu/g) 5.1 and LAB 4.9. Lactate concentrations (g/kg DM) were higher ($P < 0.05$) in I+E (106.5) than in E (91.9) or C (83.7), and intermediate (96.0) in I. Losses of DM during 112 d of ensiling were 8.1, 3.5, 4.3 and 1.2% in C, E, I and I+E, respectively. The bacterial inoculant clearly enhanced fermentation and retention of DM and nutrients in barley silage; the presence of enzymes may be beneficial.

Key Words: Barley Silage, Inoculants, Fermentation

1009 Predicting phytate content of Ontario soybean samples by near infrared reflectance spectroscopy. S.D. Leech^{*}, E.V. Valdes, and C.F.M. de Lange, University of Guelph, Guelph, Ontario.

Phosphorus availability in swine and poultry feed ingredients is inversely related to the proportion of phosphorus present in the phytate form. An alternative to current phytate determination techniques is near infrared reflectance spectroscopy (NIRS). The objective of this study was to evaluate NIRS as a rapid and accurate means to determine the phytate content in Ontario soybean samples. A total of 108 samples were collected representing 17 varieties and 13 growing locations over a two year period. Analysis for phytate content was conducted according to AOAC procedures and checked for repeatability and accuracy using sodium phytate standards. Phytate content (%) averaged 1.07 (SD 0.20) in 1999 and 1.27 (SD 0.26) in 2000. Individual calibrations were developed based on the year of collection (1999, 2000 and 1999&2000). Samples were selected for calibration based on phytate content or reflectance profiles while remaining samples were used for validation. Various calibration procedures were evaluated based on mathematical treatment of reflectance data (smoothing, scatter correction and use of derivatives) and statistical analysis (principal components combined with repeated sampling and cross validation - MPLS - or stepwise regression). The best fit, based on the standard error of cross-validation (SECV) and the standard error of prediction (SEP), was obtained when using MPLS with a second derivative math treatment and no scatter correction. Model statistics for 1999 samples (SECV=0.13; SEP=0.13) and 2000 samples (SECV=0.16; SEP=0.09) indicate the ability of NIRS to predict phytate content. Calibrations developed for 1999&2000 samples produced low SECV (<0.13) with higher SEP (>0.17), however the combination of both years produced the highest SD to SECV ratio (1.9) indicating a stronger equation. Results confirm that with a larger number of samples representing the entire range of phytate content NIRS can be used as a rapid method to predict phytate content in soybeans.

Key Words: Phosphorus, Phytate, Soybeans, Near infrared reflectance spectroscopy

1010 Degradation of cell wall polysaccharides by a combination of carbohydrase enzymes: In vitro and in vivo studies. X. F. Meng*, F. O. Omogbenigun, C. M. Nyachoti, and B. A. Slominski, *Department of Animal Science, University of Manitoba, Winnipeg, MB, Canada.*

Non-starch polysaccharides (NSP) in feedstuffs of plant origin affect nutrient utilization by non-ruminant animals mainly due to the antinutritive effects associated with water-soluble and viscous polysaccharides and nutrient encapsulating effect of the cell walls. In vitro incubation studies were carried out to determine if various carbohydrase enzyme complexes contained appropriate activities to target NSP of soybean meal, canola meal and peas. A more pronounced depolymerization of the NSP was achieved when selected enzyme preparations were used in concert. When compared to the control (non-enzyme) treatment, the degree of NSP hydrolysis and/or disruption of the cell wall structure averaged 19.5, 34.0 and 24.7% for soybean, canola meal and peas, respectively. Effective enzyme combinations were studied further in di-

gestibility trials with poultry and swine. In the broiler chicken assay, the digestibility of NSP increased from 2.0 to 16.9% in birds fed enzyme supplemented soybean/canola meal/peas/wheat based-diet. In a subsequent, 3-wk growth performance trial, an improvement ($P<0.05$) in body weight gain (646 vs 682g) and feed conversion ratio (1.43 vs 1.39) was noted with enzyme supplementation. In adult roosters fed the coarsely ground canola seed, the digestibility of NSP increased from 11.1 to 30.1% for the enzyme supplemented sample and resulted in an improvement ($P<0.05$) in energy utilization (4133 vs 4735 kcal/kg DM). In the pig trial, ileal NSP digestibility averaged 10.2 and 26.0% for the control and enzyme supplemented wheat/soybean/canola meal/peas-based diets, respectively. This was followed by the same magnitude of difference ($P<0.001$) in dry matter digestibility (62.5 vs 71.3%). Only a trend towards improved ADG (231 vs 251g; $P=0.145$) and FCE (1.87 vs 1.66; $P=0.08$) with enzyme supplementation was noted.

Key Words: Non-starch polysaccharides, Carbohydrase enzyme, Non-ruminants

Dairy Foods Cheese and Sensory

1011 A survey of California specialty cheese consumers' opinions and shopping habits. B. A. Reed*¹ and C. M. Bruhn², ¹*University of California Cooperative Extension, Glenn County,* ²*Center for Consumer Research, University of California, Davis.*

To improve marketing effectiveness for small-scale farmstead cheese producers, the shopping habits and opinions of specialty cheese consumers were gathered by telephone and focus group interviews in three locations. Volunteers were recruited from specialty cheese counters in up-scale grocery stores in Northern California. Of the 47 consumers surveyed by telephone, 9% purchased specialty cheeses several times per week, another 38% purchased cheeses weekly. Specialty cheese purchases represented 75% of all cheese purchases for 48% of those interviewed. Of those interviewed, 26% bought more than 0.45 kg of cheese in any given purchase. All of the consumers (100%) reported eating cow's milk, 96% ate goat or sheep milk cheese, 98% ate aged hard cheese, 94% ate veined cheeses, 81% ate soft surface-ripened cheeses. Respondents purchased European specialty cheeses most frequently (57%) followed by California specialty cheese (32%). Thirty four of the volunteers interviewed by telephone also participated in focus groups. Buying locally produced foods was very important to 38% of focus group participants, while buying foods directly from family-owned farms was rated as very important by 15% of participants. Buying foods that have potential health benefits was rated as very important by 53% of participants. Although specialty cheese consumers considered themselves food experimenters and not afraid to sample new cheeses, generally they would not purchase a new cheese without tasting it first. Consumers relied heavily on specialty grocery staff recommendations for guidance in cheese selection and valued food descriptions that included origin, flavor, texture, recommended uses and food and wine pairings. When shopping, consumers appreciated unlimited tasting opportunities and did not want to feel hurried when making a cheese selection. Few consumers mentioned price when discussing purchase decision criteria unless making purchases for a family. Consumers place a high value on perceived freshness and quality. Cheese makers should take time to do in-store sampling, distribute their product to stores that place a high emphasis on customer service and be sure the cheese sales staff are well educated about the unique properties of their product.

Key Words: Specialty cheese, Consumers, Focus groups

1012 Cheese making properties of milk enriched with β -casein. Sylvie Haché* and Daniel St-Gelais, *Food Research and Development Centre, Agriculture and Agri-Food Canada, St-Hyacinthe, Quebec.*

In this study, the impacts of milk enriched with β -casein on bacterial growth, coagulation properties and composition of Cheddar cheese like-product were investigated. Enriched milk was adjusted to 2.67 (EM1), 2.86 (EM2), or 3.04% (EM3) of casein with a β -casein powder. Fresh milk (2.49% casein) was used as a control (CM). The casein to fat ratio for cheese milks was adjusted to 0.67, 0.69, 0.72 and 0.74, respectively with fresh cream. The evolution of population of proteolytic (PRT⁺)

and non-proteolytic (PRT⁻) strain of lactococci in all cheese milks was determined on M17 agar. Coagulation properties were determined with a formagraph and by using a turbidity method. Cheeses obtained from control and enriched milks were analysed for moisture, protein, fat and ash. During cheese ripening, the evolutions of proteolysis (WSN) and firmness were determined. The experiment was replicated six times. A factorial design was used to compare different treatments. Results indicated that the growth of lactococci was not affected by β -casein concentration in cheese milks. Rennet curd formation was affected by the β -casein in enriched milks. Coagulation time increased with β -casein concentration. The moisture (41.1%) and ash (3.4%) contents were higher, whereas the protein content (23.2%) was lower in control cheese than in cheeses enriched with β -casein (39.7, 3.0 and 24.6%, respectively). In addition cheese yields increased with β -casein concentration. During cheese ripening, the evolution of proteolysis was similar for all cheeses. Firmness for all cheeses decreased continuously but was lower in control cheese. Cheese could be produced from milk enriched with β -casein. However, cheese production must be modified.

Key Words: Enriched milk, Cheese, β -casein

1013 Impacts of salt on the composition, proteolysis and functional properties of Mozzarella cheese. Annie Caron*¹, Daniel St-Gelais¹, and Pierre Audet², ¹*Food Research and Development Centre, Agriculture and Agri-Food Canada, St-Hyacinthe, Quebec,* ²*Agropur, Granby, Canada.*

In this study, the impacts of different salting procedures during Mozzarella cheese production on the composition, distribution of salt and moisture, proteolysis, and some functional properties were investigated. For the control Mozzarella (CM) cheese the fresh curd after stretching and forming was immersed in a salt brine solution (19% NaCl; 10 h at 4°C). The experimental Mozzarella (EM) cheese was salted on curd before stretching (1.2% NaCl), during stretching (5% NaCl) and finally in brining (19% NaCl; 30 min at 4°C). Mozzarella cheeses were produced from milk enriched to 3.7% of total proteins with an UF milk retentate. The protein to fat ratio was adjusted to 1.33. All cheeses were stored at 6°C for 14 d. Cheeses were analyzed for moisture, proteins, fat, ashes, calcium, salt, and residual rennet (RR) activity. The distribution of salt, moisture, proteolysis, melted cheese firmness and spreading cheese property was determined from surface (S) to centre (C). The experiment was replicated four times. The moisture (46.5%), salt (1.0%) and ash (2.9%) contents were lower, whereas the protein (26.6%), fat (21.9%), calcium (0.79%) contents were higher in CM than in EM cheeses (48.5, 1.5, 3.2, 25.1, 21.3 and 0.62%, respectively). The RR activity was higher in CM (8.0%) than in EM cheeses (6.6%). In general, the protein and fat losses in whey and in water during stretching were higher for EM than for CM cheeses. During storage, the salt and moisture distribution from surface to centre was more uniform in EM than in CM cheeses. The proteolysis was higher in CM than in EM cheeses, mainly on surface cheeses. The melted cheese firmness was higher, whereas the spreading properties were lower in CM than in EM cheeses. By modifying the

salting procedures during Mozzarella cheese production it is possible to change proteolysis and functional properties.

Key Words: Mozzarella cheese, Functional properties, salt

1014 Effect of pre fermentation of different portions of milk retentate on Prato cheese composition and proteolysis. J.R.F. Dornellas, L.M. Spadoti, C.R. Cunha, and S. Massaguer-Roig*, *Universidade Estadual de Campinas, Campinas, SP, BRASIL.*

Prato cheese is the second most consumed cheese in Brazil. It is a washed, semi cooked curd cheese similar to Gouda and Edam cheeses. Research on semi hard cheeses manufacture with milk ultrafiltration (M UF) reported on the literature has used partial concentration. Among the M UF advantages are production maximization, economy on water consumption and effluent treatment, better products standardization and eventual yield increase. However M UF cheeses have on their composition whey proteins, which affects proteolysis. The objective was to study the effect of pre fermentation of different portions of the retentate, with lactic starters, on chemical composition and proteolysis of Prato cheese obtained by M UF with a volumetric concentration factor of 3:1. Milk was concentrated at 55°C in a UF unit with Carbosep mineral membranes, of 20 000 Daltons cut off, at inlet and outlet pressure of 2.0 and 1.0 bar. Cheese was manufactured by the traditional process with enzymatic coagulation (Bela Vista Calf Rennet-90% chymosin) at 35°C/40 min., curd cutting, 20% whey withdrawal, direct curd cooking by hot water (80°C) addition, molding, pressing and curing at 7°C. Experimental conditions in fermentation of zero, 10 and 20% of the retentate up to pH 5.0 (treatments 2, 3 and 4) previously to coagulation and compared to a cheese manufactured with non UF milk (treatment 1). Experimental design was a random block with three replications. Cheeses were compared with respect to gross composition and proteolysis. All four treatments presented a similar composition behavior. Treatments 3 and 4 presented lower pH and higher acidity and also a significantly larger ($p < 0.05$) proteolysis index with respect to treatments 1 and 2. However treatments 1 and 2 did not present a significant difference ($p > 0.05$) between them, and the same happened with treatments 3 and 4. On treatments 3 and 4 the retentate pre fermentation took 12 hours which allowed the activation and growing of the lyophilized starter with consequent larger production of proteolytic enzymes responsible for the secondary proteolysis, and also resulted in more intense acidification with a resulting lower pH and favoring chymosin action resulting in a larger primary proteolysis.

Key Words: Cheese, Ultrafiltration, Proteolysis

1015 Composition, protein and fat recovery and yield evaluation on Prato cheese manufactured with Ultrafiltration concentrated milk. L.M. Spadoti, J.R.F. Dornellas, C.R. Cunha, and S. Massaguer-Roig*, *Universidade Estadual de Campinas, Campinas, SP, BRASIL.*

Prato cheese is the second most consumed cheese in Brazil. It is a washed, semi cooked curd cheese similar to Gouda and Edam cheeses. Semi hard cheese manufacture with ultrafiltered milk (UF M) tends to promote a yield increase, however technological problems such as flavor and texture defects can occur. Reported research has indicated that such defects can be minimized by means of pre fermentation of a portion of the retentate. The objectives of this research were to evaluate the gross composition, the protein and fat recovery, the yield, and the adjusted yield on Prato cheese manufactures with non concentrated milk (treatment 1), and with UF M up to a volumetric concentration ratio of 3:1 and different portions of retentate pre fermentation (zero, 10 and 20%) (treatments 2, 3 and 4). Milk was concentrated at 55°C in a UF unit equipped with Carbosep mineral membranes, of 20 000 Daltons Molecular Weight cut off, at inlet and outlet pressure of 2.0 and 1.0 bar. Cheese was manufactured by the traditional process with enzymatic coagulation (Bela Vista Calf Rennet-90% chymosin) at 35°C/40 min., curd cutting, 20% whey withdrawal, direct curd cooking by hot water (80°C) addition, molding, pressing and curing at 7°C. Retentate portions were fermented up to pH 5.0 previously to coagulation. Experimental design was a random block with three replications. All four treatments presented a similar composition behavior and did not present a significant difference ($p > 0.05$) for cheese protein recovery and yield. Fat cheese recovery was significantly smaller ($p < 0.05$) for treatments 2 which is in agreement with the results obtained for adjusted yield, which also was significantly smaller ($p < 0.05$) for treatment 2 but did

not present significant differences among the other treatments. The results obtained indicated that UF M at the studied conditions did not present an advantage with respect to yield. However, this technique application can result in other advantages such as industry installed capacity maximization and economy with water consumption and effluent treatment.

Key Words: Cheese, Ultrafiltration, Yield

1016 Characterization of compositional and rheological properties of fresh cheeses made in the state of Chihuahua, Mexico. D. L. Van Hekken*, M. H. Tunick¹, F. J. Molina-Corral², J. E. Call¹, P. M. Tomasula¹, J. B. Luchansky¹, and A. A. Gardea², ¹USDA, ARS, Eastern Regional Research Center, Wyndmoor, PA, ²Centro de Investigacion en Alimentacion y Desarrollo, Cuauhtemoc, Mexico.

The demand for Hispanic-style cheeses is increasing and an understanding of their basic quality characteristics is required in order to help manufacturers increase production and extend shelf-life. This study establishes the compositional and rheological characteristics of fresh cheeses made primarily by the Mennonite communities in Chihuahua, Mexico, from either raw or pasteurized milk. Samples of cheese were obtained within days of manufacture from 13 different producers (10 raw and 3 pasteurized milk cheeses). As expected, compositional and rheological properties of the fresh cheese varied among manufacturers. Overall compositional averages for the pasteurized and raw milk cheeses were similar; 31.3% fat, 24.4% protein, and 40.5% moisture. All cheeses tested negative for *Listeria monocytogenes*, *Escherichia coli* O157:H7, *Campylobacter* spp., and *Staphylococcus enterotoxin*. Aerobic and anaerobic microbial counts ranged from 3 to 8 log₁₀ CFU/g for pasteurized milk cheese and 7 to 9 log₁₀ CFU/g for raw milk cheese. Rheological data obtained from a Torsion Gelometer and a universal testing machine showed that the pasteurized cheeses tended to be harder, more rigid, and less springy than the raw milk cheeses. Viscoelastic properties obtained using a dynamic analyzer were similar for both types of cheese. Establishing the basic chemical, microbiological, and physical properties of Hispanic-style cheeses is the first step in understanding the unique quality traits and exploring ways to expand their utilization.

Key Words: Hispanic cheese, Raw milk, Rheology

1017 Effect of frozen storage on the proteolysis and rheology of soft goat milk cheese. D. L. Van Hekken*, M. H. Tunick¹, and Y. W. Park², ¹USDA, ARS, Eastern Regional Research Center, Wyndmoor, PA, ²Agricultural Research Station, Fort Valley State University, GA.

Soft goat milk cheese is a highly valued dairy food with limited availability in the market due to the seasonal milk supply. Freshly-made cheese is frozen occasionally to extend the availability of the cheese, but it is not a wide spread practice because the effects of long term freezing on the texture and shelf-life of the cheese have not been evaluated. In this two year study, the effects of 3 mo of frozen storage on the degree of proteolysis and rheological properties of soft goat milk cheese were evaluated. Cheese was obtained from a grade A goat dairy in Georgia and either stored at 4°C for up to 4 wks or stored at -20°C for 12 wks and then thawed and stored at 4°C for up to 4 wks. Proteolysis was monitored using SDS-PAGE and rheological properties were measured using a universal testing machine and a dynamic analyzer. Paired fresh and frozen cheeses had the same degree of proteolysis (3 to 8% decrease in beta-casein) after 4 wks of refrigerated storage. Fresh cheese had a fragile texture and freezing for three mo did not result in major changes in texture, although the curds were slightly harder, less cohesive, and chewier than fresh cheese. Freezing did not alter the springiness or viscoelastic properties of the cheese. Both fresh and frozen cheeses showed a decrease in cohesiveness after 4 wks of aging at 4°C. With the market for soft goat cheese increasing, freezing of the fresh curd could allow US goat producers to supply domestically manufactured soft cheeses throughout the year.

Key Words: Goat milk cheese, Frozen storage, Rheology

1018 Melt and color changes of heated Hispanic-style cheeses. D. W. Olson*, D. L. Van Hekken, and M. H. Tunick, *USDA, ARS, Eastern Regional Research Center, Wyndmoor, PA.*

Consumer interest in Hispanic-style cheeses is increasing, but functional property data that would assist the food processing industry in their utilization are limited. Hispanic-style cheeses are typically fresh cheeses with high moisture contents and a wide range of melting properties. The ability of various types of commercially available American-made Hispanic-style cheeses (Cotija, Oaxaca, Quesadilla, Queso Blanco, and Queso Fresco) to melt and their changes in color when heated were evaluated. Extent of melt was determined by the Schreiber Melt Test, which measures the spread of cheese after heating at 232°C for 5 min. Quesadilla and Oaxaca melted more than the other varieties. Queso Fresco and Queso Blanco had minimal melt. A Hunter Lab MiniScan XE was used to determine the L*, a*, and b* values of the cheeses before and after heating at 130°C for 75 min or 232°C for 5 min. The L* values before heating for Cotija, Queso Blanco, and Queso Fresco ranged from 85 to 94, and Oaxaca and Quesadilla ranged from 73 to 80 indicating that the former cheeses were whiter than the latter. More browning for each type of cheese occurred after heating to 130°C for 75 min compared to 232°C for 5 min leading to an increase in the a* values for the 130°C heat treatment and to a larger decrease in L* values for the 130°C compared to the 232°C heat treatment. As both melt and browning are related to specific production steps, procedures can be identified to alter undesired functional properties such as excessive browning. Understanding the melt and color changes of specific types of heated Hispanic-style cheeses helps the food processing industry in selecting the best type of cheese to give prepared foods the desired texture and appearance.

Key Words: Hispanic-Style Cheeses, Color, Melt

1019 Reversibility of pH-induced changes in the texture and serum phase of cultured cream cheese. M. Almena-Aliste*, M.L. Gigante², and P.S. Kindstedt¹, ¹*University of Vermont, Burlington VT/USA*, ²*State University of Campinas, Campinas/SP/Brazil*.

Previously, a model system was developed to increase or decrease the pH of cream cheese through exposure to a volatile base or acid. Increasing the pH in this manner significantly decreased the firmness of cream cheese. The objectives of this study were to determine whether pH-induced changes in firmness are reversible when the pH is reversed, and whether the serum phase is affected by pH cycling. Cultured cream cheese was obtained from a commercial manufacturer within 10 d after manufacture. The cheese was sectioned into thin samples (10x40x65 mm) that were randomly exposed to ammonia vapor for periods ranging from 1 to 10 min to increase the pH in ten increments. After equilibration at 4°C for 3 d, the samples were analyzed for firmness and the amount and viscosity of expressible serum were determined. Next, specimens from the treatment with the highest pH value were randomly exposed to HCl vapor for periods ranging from 1 to 10 min to decrease the pH in ten increments. After equilibration at 4°C for 3 d, the samples were analyzed for firmness and the amount and viscosity of expressible serum were determined. The entire experiment was repeated twice. Firmness values decreased in a linear manner ($R > .90$) by $> 70\%$ with increasing pH from 4.6 to 6.1. Upon reversal of cheese pH, firmness increased in a linear manner ($R > .84$), displaying a high degree of reversibility. Amount of expressible serum decreased in a linear manner ($R > .84$) by $> 60\%$ with increasing pH from 4.6 to 6.1. Upon reversal of cheese pH, amount of expressible serum increased in a linear manner ($R > .83$), displaying a high degree of reversibility. Consequently, firmness and amount of expressible serum were strongly correlated ($R > .83$). In contrast, the viscosity of expressible serum was not affected by pH. The data are consistent with the view that the firmness of cream cheese decreased with increasing pH because of increased casein-water interactions which altered the mechanical properties of the casein-fat matrix of the cheese.

Key Words: Cream cheese, Texture, Serum phase

1020 Microstructure of Feta cheese made using different cultures as determined by confocal scanning laser microscopy. Ashraf Hassan*, Joseph Frank, and Milena Corredig, *The University of Georgia, Athens, GA, USA.*

The objective of this work was to develop a methodology to observe the microstructure of feta cheese using confocal scanning laser microscopy. Low fat cheese and cheese containing exopolysaccharide-producing cultures were made. The protein network was observed using the reflectance mode of the confocal microscopy. Fat was stained by Nile red dye diluted with whey obtained from the same batch of tested cheese. This procedure avoided soaking specimen in dye dissolved in distilled water (to prevent changes in osmolality) or in lipophilic solvent (to avoid changes in fat size or shape). Capsule-forming slow acid producing and noncapsule-forming fast acid producing nonropy cultures were used in making nonfat and full fat feta cheese. More even distribution of fat with a larger number of smaller globules was observed in feta cheese made with noncapsule-forming culture compared to that made with the capsule-forming culture. A compact structure in nonfat cheese was associated with the use of noncapsule-forming culture which contrasted with the open structure observed in cheese made with the capsule-forming culture. Fractured structure was apparent after 10 days of storage of nonfat cheese made with the noncapsule-forming culture. Larger protein aggregates were observed in cheese made with capsule-forming culture compared to those found in cheese made with the noncapsule-forming culture.

Key Words: Feta cheese, Confocal scanning laser microscopy, Microstructure

1021 Effects of various ingredients on a model process cheese. A.L. Dees* and E.A. Foegeding, ¹*North Carolina State University.*

The process cheese industry desires to increase formula flexibility by incorporating various alternative ingredients into process cheese. For example, incorporation of whey protein ingredients could reduce the amount of casein used in process cheese formulations. The purpose of this study was to understand effects of various ingredients & how they affect texture and meltability of cheese. Among those studied were native whey protein, lactose, mono- and disodium phosphate, and polymerized whey protein concentrate (pWPC). Cheese analogs contained mono- and disodium phosphate, lactose and 1 of 4 different whey protein ingredients. Cheese analogs were made by heating & mixing for 21min in a Stephan mixer with end point temperatures of 80C or 85C. The pWPC was prepared by heating WPC at 90C, pH 8.0, for 30-60 min. Properties of pWPC were determined by viscosity measurements. Cheese analogs were characterized by yield stress and meltability measurements. Addition of lactose at 0% to 4.44% and mono- and disodium phosphate between 2% to 2.8% had no effect on the yield stress or meltability of cheese heated to 80C. Differences were observed when cheese was heated to an end point of 85C. The higher temperature increased yield stress 80% and reduced meltability from a Schreiber number of 9 to 5. These findings resulted in a final control formulation of 3.75% lactose and 2.8% emulsifying salts. Of three protein concentrations tested for polymerization, 5.0% protein had low viscosity, while 5.5% protein produced a texture similar to jelly. Generally, 6% protein formed a gel. Heating time varying between 30-60 min and sodium citrate varying between 0.5 - 1.0mM were not significant factors affecting viscosity of pWPC. All pWPC samples were pseudoplastic. A 13% substitution of casein with native WPC in a cheese analog resulted in no change in yield stress or meltability. Whereas a 13% substitution of casein with 5.5% protein pWPC in a cheese analog increased the yield stress 18% and decreased meltability to a Schreiber number of 10 to 8.

Key Words: process cheese analog, polymerized whey protein

1022 Comparison of shelf-life of fresh and frozen soft goat milk cheeses in relation to the extent of proteolytic and lipolytic properties. Y. W. Park*, A. Kalantari¹, V. Gutta¹, R. Gundelly¹, and J. H. Lee¹, ¹*Fort Valley State University, Fort Valley, GA 31030.*

Although freezing may extend storage life of cheeses, few reports are available on the feasibility of such practice on goat milk cheeses, especially for enhancing the year-round uniform supply and marketability of

the products. Three lots of fresh plain soft goat milk cheeses were purchased from a commercial grade A goat dairy, and divided them into two experimental groups. One group was stored as fresh at 4°C for 0, 14, and 28 days, and the other group was frozen for 3 months, then thawed, and stored at 4°C for 0, 14, and 28 days. The experiment was replicated three times, and pH, acid degree values (ADV), total protein and water soluble N (WSN) were determined for all treated samples to compare the shelf-life of the fresh with those of the frozen-stored cheeses with respect to the extents of proteolysis and lipolysis. The pHs for the overall pooled data of the fresh and frozen cheeses were; 4.57 and 4.88, respectively, indicating that cheeses aged as fresh had lower pHs than frozen-thawed ones. The overall pooled WSN contents of fresh and frozen cheeses were: 5.39 and 10.48, suggesting that there was a significant ($P<0.01$) increase in WSN for 3 month frozen-stored cheeses compared to the fresh ones. The respective WSN contents of fresh and frozen cheeses for the 0, 14, and 28 days of aging were: 2.97, 6.08, 7.11, and 9.61, 10.2, 11.6, showing that the frozen-storage significantly ($P<0.01$) elevated proteolysis of the cheeses. The ADV values of fresh and frozen cheeses for the corresponding aging periods were: 0.424, 0.545, 0.660, and 0.930, 0.757, 1.102, revealing that more lipolysis occurred in frozen-stored cheeses than fresh ones. The lipolysis was accelerated with time after 14 days storage at 4°C. The 3 months frozen-stored cheeses elevated proteolytic and lipolytic properties relative to the freshly stored ones, while further investigations may be necessary if these elevations are attributable to the freezing and thawing effect rather than frozen-storage.

Key Words: Soft goat cheese, Freezing, Storage

1023 Effect of pre fermentation of different portions of milk retentate on Prato cheese composition and melting capacity. J.R.F. Dornellas, L.M. Spadoti, C.R. Cunha, and S. Massaguer-Roig*, *Universidade Estadual de Campinas, Campinas, SP, BRASIL.*

Prato cheese, largely consumed in Brazil, it is a washed, semi cooked curd cheese similar to Gouda and Edam cheeses. Research on semi hard cheeses manufacture with milk ultrafiltration (M UF) has used partial concentration and pointed several advantages as well technological problems that can occur such as flavor and texture defects. Also has indicated that such defects can be minimized by means of pre fermentation of a portion of the retentate (R). The objective was to study the effect of pre fermentation of different portions of the R, with lactic starters, on chemical composition and melting capacity (MC) of prato cheese obtained by M UF with a volumetric concentration ratio of 3:1. Milk was concentrated at 55°C in a UF unit equipped with Carbosep mineral membranes of 20 000 Daltons MW cut off, at inlet and outlet pressure of 2.0 and 1.0 bar. Cheese manufactured by the traditional process with enzymatic coagulation (Bela Vista Rennet-90% chymosin) at 35°C/40min., curd cutting, 20% whey withdrawal, direct curd cooking by hot water (80°C) addition, molding, pressing and curing at 7°C. Experimental conditions consisted in fermentation of zero, 10 and 20% of the R up to pH 5.0 (treatments 2; 3 and 4) previously to coagulation and compared to a cheese manufactured with non UF milk (treatment 1). Cheeses were compared with respect to gross composition and MC. The pH and MC were evaluated during 45 days. Experimental design was a random block with three replications. All four treatments presented a similar composition behavior. The pH did not present significant changes ($p>0.05$) with respect to time, however treatments 1 and 2 presented higher pH when compared to treatments 3 and 4. All four treatments presented a significant increase ($pH<0.05$) on MC with respect to time. Treatments 3 and 4 presented a significant difference ($p<0.05$) among them and also with respect to treatments 1 and 2. Treatments 1 and 2 did not present significant difference ($p>0.05$) among them, being the MC of both significantly larger ($p<0.05$) than treatments 3 and 4 after 25 days of curing. Treatments 3 and 4 presented a pH always around or below 5.0 which seems to be the factor responsible for the observed difference on its MC.

Key Words: Cheese, Ultrafiltration, Melting

1024 Effect of post-manufacture modulation of cheese pH on the aging behavior of Mozzarella cheese. M.A.S. Cortez*¹, M.M. Furtado¹, M.L. Gigante², and P.S. Kindstedt³, ¹Federal University of Vicosa/CAPEs, MG/Brazil, ²State University of Campinas, Campinas, SP/Brazil, ³University of Vermont, Burlington, VT/USA.

Previously, a post-manufacture method to increase or decrease the pH of cheese was used to evaluate the effect of pH on characteristics of aged

Mozzarella cheese. In those studies, the melting characteristics and calcium distribution of aged cultured Mozzarella cheeses changed rapidly (i.e., within 24 h) and dramatically in response to pH changes. The objective of the present study was to evaluate the effect of changing the pH of Mozzarella cheese immediately after manufacture on cheese characteristics during aging. On two separate occasions, cultured low moisture part-skim Mozzarella cheeses were obtained from a commercial manufacturer on the day after manufacture. The cheese was shredded, mixed and divided into subsamples that were exposed to either ammonia vapor to increase the pH by ca. 0.3 pH units, HCl vapor to decrease the pH by ca. 0.2 pH units, or no exposure (control). The subsamples were then vacuum packaged and stored at 4°C for up to 40 d. On day 5, 12, 22, and 40 after manufacture, control and treatment subsamples were chosen randomly and analyzed for apparent viscosity (AV), free oil, water soluble Ca and water soluble N. The effects of pH treatment, storage time and their interaction were evaluated by ANOVA according to a split-plot design. Apparent viscosity was affected significantly by pH treatment, storage time and their interaction. Cheese with increased pH had the highest AV values and cheese with decreased pH had the lowest AV values throughout the study. Water soluble Ca was significantly affected by pH treatment. Cheese with increased pH had the lowest water soluble Ca values and cheese with decreased pH had the highest water soluble Ca values throughout the study. Free oil and water soluble N increased significantly during storage but were not significantly affected by pH treatment. The data suggest that modulation of cheese pH immediately after manufacture caused a rapid shift in calcium distribution which altered the cheese structure and modulated the development of melting characteristics during aging.

Key Words: Mozzarella cheese, Calcium distribution, Functional characteristics

1025 Seasonal differences in the concentration of free amino acids and volatile compounds of Roncal cheese. Maria Ortigosa¹, Noemi Munoz¹, Paloma Torre¹, and Jesus M. Izco*², ¹Dpto. Ciencias Medio Natural, Universidad Publica de Navarra, Spain, ²Dairy Products Technology Center, Cal Poly University, San Luis Obispo, CA.

The objective of this work is to identify the free amino acids (FAA) and volatile compounds in Roncal cheese throughout the entire campaign and to define any possible correlation or interaction between them. Roncal cheese is made in Navarra (Northern Spain) with raw, Lacha ewe's milk during the seasons of winter, spring and summer. It must be aged for at least four months before marketing. Cheeses with 4 and 8 months of ripening corresponding to the three seasons of the preparation period were sampled. Analysis of FAA was performed by HPLC and the volatile compounds were extracted by purge and trap and analyzed by GC-MS. Four month-cheeses made in summer showed higher concentration of total FAA (3319 ± 11 mg/100g DM) than those made in winter or spring (2593 ± 5 and 2340 ± 9 mg/100g DM respectively). The major FAA quantified in Roncal cheese were Glu, Leu, Val, Lys, Phe, Pro and Ile, which accounted for 12.9, 10.2, 7.0, 6.7, 4.6, 3.9 and 3.0% of the total FAA, respectively. The volatile compounds present in Roncal cheese comprised 8 hydrocarbons, 13 alcohols, 2 aldehydes, 9 ketones, 6 acids, 5 esters, 3 sulfur-containing compounds and a miscellaneous group. Alcohols were the largest group, comprising the 21% of the volatile compounds identified in Roncal cheese. Accordingly, a total of 57 volatile compounds were detected. However, the number of compounds identified in cheeses with 8 months of ripening increased to 70. A positive correlation was found between some FAA and volatile compounds, e.g. the cheeses made in summer showed higher concentration of Val, Leu and Met, and therefore, of the alcohols formed by Strecker degradation of these amino acids (2-methylpropan-1-ol, 3-methylbutan-1-ol and propan-1-ol, respectively). Ethanol can be formed by degradation of Ala. However no correlation between the levels of these two compounds in the different seasons was found, probably because ethanol is formed primarily by fermentation of lactose. Valuable information to characterize Roncal cheese and the compounds affecting its flavor has been obtained in this work. Differences in its composition among the lactation periods of winter, spring and summer have been recorded.

Key Words: ewe's milk cheese, amino acids, volatile compounds

1026 Effect of frozen storage on microbial changes in soft goat milk cheese compared with fresh ones. A. Kalantari¹ and Y. Park^{*1}, ¹Fort Valley State University, Fort Valley, GA 31030.

Effect of 3 months frozen-storage on microbiological populations of commercial soft goat milk cheeses were compared with those of fresh ones in relation to the shelf-life of the products. Three lots of soft goat cheeses were purchased from a local farmstead grade A goat dairy, and divided into two treatment groups as fresh and frozen-stored groups. The fresh cheeses were placed at 4°C refrigeration for 0, 14, and 28 days, and frozen cheeses were stored for three months, then thawed and placed in a refrigerator as the same way as the fresh ones. Microbial counts of total bacteria, *E. coli* and coliform, *Staphylococcus aureus*, and yeast and mold were assayed using 3M petrifilm plates techniques according to the manufacturer's recommended procedures. Total bacterial cell counts (TBC) of the fresh and frozen goat cheeses for 0, 14, and 28 days storage at 4°C were: 10.4, 1.91, 2.19 x 10⁵, and 5.53, 0.296, 0.062 x 10⁵, respectively, indicating that TBC was significantly (P<0.01) reduced by aging time and also by frozen-storage. The respective yeast counts of the fresh and frozen cheeses for the corresponding aging periods were: 14.1, 14.6, 30.7 x 10⁵, and 0.03, 2.43, 0.876 x 10⁵, showing that an opposite trend to TBC was observed in yeast count, where the latter counts were generally increased with aging time. There were no detectable levels of *E. coli* and coliform in both fresh and frozen cheeses, nor were found those of *Staphylococcus aureus*. Mold counts of the fresh cheeses significantly (P<0.05) decreased with storage at 4°C, and frozen-storage also caused a significant reduction in mold count. It was concluded that freezing and/or frozen-storage for 3 months significantly reduced all microbiological populations tested, while lipolytic and proteolytic properties appeared to be elevated.

Key Words: Goat soft cheese, Microbiological counts, Frozen-storage

1027 Swiss cheese properties related to culture usage rate and warm room time . H. Ruiz-Espinosa, V.B. Alvarez, W.J. Harper, T. Ji*, and P.D. Courtney, *The Ohio State University.*

Swiss cheese manufacturing procedure was investigated. Small-scale rindless Swiss cheeses were made with different starter culture inoculation levels. *Streptococcus thermophilus* and *Lactobacillus helveticus* levels were 33%, 66% and 100% of recommended usage rate for commercial plants while the *Propionibacterium freudenreichii* subsp. *shermanii* inoculation level was kept constant at 100%. Cheeses were held for two different times in the warm room (WR). The cheeses were kept in WR at 25°C for 14 and 21 days, and then ripened at 4°C for 70 days. The cheese samples were analyzed for composition, pH, texture profile analysis, meltability, free amino acids, microbial growth and eye development. Different starter culture rates and WR times did not affect cheese composition. However, eye formation and pH were affected. The pH decreased as culture rates increased from 5.43 at 33% to 5.27 at 100% in WR for 14 days. Similar pH trends occurred in WR for 21 days. The culture rates and different WR treatments influenced to the growth of lactic acid bacteria and propionic acid bacteria. Cheeses processed with 100% culture rate for 21 days in WR liberated more free amino acids, an average equivalent value of leucine of 30.0 mmol/kg cheese, than the one for 14 days in WR. Overall results indicate that the effect of WR treatment time and culture usage rate did not affect small-scale cheesemaking significantly. Aging was the most significant source of variation on the analyzed parameters. The texture parameters, including hardness and cohesiveness tended to decrease, but cohesiveness, pH, meltability and free amino acids content increased during aging.

Key Words: Swiss cheese, Starter culture, Ripening time

1028 Use of starter cultures in milk of mexican white cheese. F. A. Rodríguez-Almeida^{*1}, R. Terrazas¹, H. García¹, O.M. Cano¹, J.A. Jiménez¹, and M.C. Olivas², ¹Universidad Autónoma de Chihuahua, Chihuahua, México, ²CBeta No. 90, Cd. Cuauhtémoc, Chihuahua, México.

Three commercial starter cultures added to milk of mexican white cheese were compared to a control to evaluate their effects on organoleptic characteristics (38, 53 and 72 d after cheese processing) and on undesirable microbiological counts (36 and 71 d after cheese was made). Thirty liters of raw milk were used per piece of cheese, with three replicates per treatment (MA4001: *Streptococcus lactis*, *S. cremoris*, *S. lactis*

subsp. *diacetylactis* and *S. thermophilus*; MA011: *S. lactis* and *S. cremoris*; SACCO 0.19: *S. thermophilus* and *Lactobacillus lactis*; and control). Characteristics of milk were: acidity, 14 to 18°D; fat, 4 to 4.6%; reductase, 10 to 12 h; mastitis and antibiotics, negative; density, 1.0295 to 1.0324; and total solids, 12.9 to 13.2%. Two to four days after cheese was processed, was packed into vacuum plastic bags for 38, 42 or 53 d. Microbiological counts were on total, presumptive and fecal coliforms, *E. coli*, *Staphylococcus aureus*, aerobic mesophiles, fungi and yeast. Panel tests were performed by 18 non-trained panelists that were familiar with mexican white cheese: one to evaluate general characteristics of cheese (flavor, texture, color and acceptance), and another one to evaluate similarities on flavor, texture and color to traditional mexican white cheese. Friedman's non-parametric test was used for statistical analyses. Adding starter cultures to milk reduced microbiological counts at 36 d on total and presumptive coliforms (p=.06), and *S. aureus* (p=.03), compared to the control. All microbiological counts at 71 d were reduced (p<.08), except fungi and yeast (p=.24). At 36 d, MA4001 gave the best results, but at 71 d all starters gave similar results. At 38 d, MA4001 and MA011 were superior (p=.001) to SACCO 0.19 and the control for color; at 53 d were superior (p=.01) for all sensory variables, except texture (p=.16), which was accomplished by day 72 (p=.08). Adding starter cultures to milk of mexican white cheese resulted in improvement of organoleptic characteristics and reductions of undesirable microbiological counts on cheese.

Key Words: Starter Cultures, Organoleptic Characteristics, Mexican White Cheese

1029 Differentiation of cheese type and maturity: Comparison of a new SE-HPLC method with the RP-HPLC method. C. J. Coker¹, K. A. Johnston¹, R. A. Crawford¹, R. L. Motion², H. Singh³, and L. K. Creamer^{*1}, ¹New Zealand Dairy Research Institute, Palmerston North, NZ, ²Forest Research Institute, Rotorua, New Zealand, ³IFNHH, Massey University, Palmerston North, New Zealand.

The unique character of most cheese types develops gradually during ripening and reflects the effect of manufacture and storage of the cheese on the quantity and activity of the enzymes present. The effect of these enzymes can be measured by analysing the resultant peptides, and these peptide profiles can differentiate cheese types objectively.

To date only RP-HPLC (a complex separation method relying on both peptide hydrophobicity and size) has been used successfully (Smith and Nakai, 1990) for this purpose. However, the peptide profiles contain a large number of peptide peaks that pose significant data-handling problems. Another method, SE-HPLC (TSK G2000 SWXL, 36% CH₃CN, 0.1% TFA in water) that separates on peptide size (molecular mass), has been successfully applied to protein hydrolysates and results in a simpler peptide profile.

In order to compare these two methods rigorously, three similar cheese types (Swiss, Elsberg and Gouda) were manufactured, ripened and sampled periodically. The water-soluble fraction from each sample was analysed by each method. The relationships among the peak areas were assessed by principal component analysis (PCA) using both the correlation and covariance matrices.

Analysis of the RP-HPLC data with PCA of covariance or correlation matrices differentiated cheese type using the first three principal components (PC1-PC3). However, maturity differentiation was only possible for young cheeses. Similar analysis of the SE-HPLC data was relatively simple and the covariance form of PCA differentiated the three cheese types at all stages of maturity using the PC1-PC3.

Thus, a combination of SE-HPLC of the WSF and PCA of the covariance matrix was the best of the methods investigated for differentiating similar cheese types at all stages of maturity and for assessing cheese maturity. The method was robust and it was relatively easy to obtain a data set for statistical analysis. By contrast, RP-HPLC of the WSF was more difficult to manage because of the large number of peaks with similar elution times. However, it had the advantage of indicating which peaks (peptides) were important in the assessment of cheese maturity or type.

Key Words: Cheese ripening, Principal component analysis, HPLC

1030 Use of dynamic rheological data for prediction of meltability of Gaziantep cheese with various fat contents. Talip Kahyaoglu*¹ and Sevim Kaya¹, ¹University of Gaziantep.

Gaziantep cheese is unripened and semi-hard cheese, which is produced traditional in the southeast part of Turkey. Meltability is an important functional characteristic of Gaziantep cheese due to its use as an ingredient in the traditionally prepared food. The objective of this study was to measure the meltability of Gaziantep cheeses containing various amount of fat. Dynamic rheological method and Arnott test were applied to evaluate meltability. Gaziantep cheese was manufactured with various levels of fat contents (50.4, 33.4, and 13.5 %). Meltability was assessed by an empirical method, Arnott test. For determination of dynamic rheological data, viscoelastic measurements were performed with a rheometer HAAKE RheoStress RS coupled with a Peltier/Plate TCP/P temperature control unit (HAAKE GmbH, Karlsruhe) using a cone and plate system (d:35 mm, α : 2°). Circulator DC10 was used to control temperature within range 10-70°C. The storage modulus (G'), loss modulus (G'') and phase angle (δ) were measured during a temperature sweep varying from 10 to 70°C at a constant stress of 200 Pa and 1 Hz. For all samples, increasing temperature resulted in a decrease in G' and increase in the phase angle (phase lag) δ . Since $\tan(\delta) = G''/G'$ when the $G'' = G'$, $\tan(\delta)$ equals to 1.0. This means that solid and liquid characters are the same extent at this point is called as crossover temperature. This temperature might be accepted as the beginning of the melting. Melting temperatures were 56.1, 59.2, and 67°C for full-fat, reduced-fat and low-fat cheese, respectively. From the results of both methods, it was found that increasing the fat content decreased the melting temperatures. The good correlation was found between melting temperatures obtained by dynamic rheological data and meltability of Gaziantep cheese as determined by empirical melting test.

Key Words: Fat reduced cheese, Meltability, Dynamic rheological method

1031 Effect of high pressure treatment of Swiss cheese starter organisms on growth and activity in a sterile slurry system. W. J. Harper*¹, N. Akin², and G. Y. Kim³, ¹The Ohio State University, Columbus, Ohio, ²Sekuk University, Konya/Turkey, ³Kangwon National University, Chuncheon, Korea.

Lactobillus helveticus and *Propionibacterium freundenreichii* in combination were treated at 0, 200, 500 and 800 MPa in an aqueous solution and then added to a sterile slurry system pre-acidified to pH 5.6 with lactic acid and ripened at 30 deg C. The slurries were evaluated at 0, 2, 4, 6, 8, 10 and 14 days for growth in selective media, free amino acid content and head space volatile compound differences at 0, 6 and 14 days with an electronic nose, using a Mass Spectrometer as the sensor system. Numbers of *Lb. helveticus* decreased by 3, > 4 and >4 log cycles after treatment at 200, 500 and 800 MPa respectively. Upon addition to the slurry, the *Lb. helveticus* showed recovery after 2, 4 and 4 days for the organisms treated at 200, 500 and 800 MPa respectively. A 4 log cycle increase in the slurry was noted after high pressure treatment in all cases. Numbers of *P. freundenreichii* were not affected by the high pressure treatment. The increase in numbers after addition to the slurry system was greater for those organisms treated at 500 and 800 MPa than the control or the sample treated at 200 MPa. Free amino acids values increased during ripening at different rates depending upon treatment of the starter organisms. The initial rate of increase was greater during the first 6 days for the sample treated at 200 and 500 MPa, whereas the high free amino acid content was highest in the control after 14 days of incubation. Treatment at 800 Mpa resulted in a marked reduction in free amino acid values. Aroma, as detected by the electronic nose, was different among the slurries and each treatment showed a different aroma pattern during the incubation period. Cluster analysis showed 50% similarity among all slurries. The slurries grouped into three clusters: (a) all slurries at 0 days, and 200 Mpa treatment at all days, (b) slurries made from the starter combination treated at 500 and 800 Mpa after 6 and 14 days of ripening and (c) the control starter combination after 6 and 14 days of ripening. Comparing 0 and 800 Mpa treatment, the slurries made with the starter combination treated with 800 Mpa treatment showed a higher abundance of those mass units that were most significant in differentiating the slurries.

Key Words: *Lactobacillus helveticus*, *Propionibacterium freundenreichii*, High pressure processing

1032 Lactic acid bacteria from natural biofilm of Tina, a wooden vat, potential contributors to Ragusano cheese fermentation. L. Corallo¹, P.S. Cocconcelli², R. Gelsomino¹, P. Campo¹, S. Carpino*¹, and G. Licitra³, ¹Consorzio Ricerca Filiera Lattiero- Casearia, Ragusa, Italy., ²Ist. di Microbiologia e Centro Ricerche Biotecnologiche, Università Cattolica, Piacenza e Cremona, ³D.A.C.P.A., Catania University, 95100 Catania.

The purpose of the present work is the study, by means of molecular techniques and electron microscopy analysis, of the bacterial strains composing the natural biofilm of Tina, and the investigation on release of bacterial cells from biofilm to milk during the first phase of Ragusano cheese production. The samples were collected from the inner surface of Tina (500 cm²) by means of sterile swabs. The Tina analysed in the course of the present work was used for processing milk collected from pasture feed cows and was used daily for milk fermentation and cheese production. Small pieces (4 mm²) of the internal wooden surface of Tina were collected using sterile blades and used for the electron microscopic analyses. Randomly selected colonies (300), of Gram positive, catalase negative organisms isolated from Rogosa and M17 agar plates, were cultured in MRS and M17 broth, respectively, incubated overnight at 30°C. For bacterial cell release experiments from biofilm, the Tina was filled with sterile milk and gently mixed as generally performed during Ragusano cheese production. Samples (50ml) were collected after 15 and 90 min, serially diluted and plated on M17 5% lactose. Strain identification by means of RAPD typing was achieved as described by Baruzzi et al. (2000), with minor modifications. To achieve the taxonomic identification of the strains from Tina biofilm, the DNA was extracted as above described and 16 S rRNA genes were amplified using P1 and P6. The first aim of this study was to characterize the bacterial community on the inner surface of the Tina, a wooden vat used for the traditional production of Ragusano cheese. This microbiota undergoes cyclic changes of the environmental conditions: at the beginning of the production process raw milk is added in the vat, and after the addition of rennet maintained at 37C - 38C for 90 min. The presence of a significant amount of lactic cocci in the biofilm adhered to the inner wood surface of Tina was confirmed. The bacteria identified were *Lactococcus lactis* subsp. *lactis*, *Streptococcus Thermophilus*, *Streptococcus Waius*.

Key Words: Lactic bacteria, Ragusano cheese, wooden vat

1033 Impact of nisin producing culture, liposome-encapsulated nisin and *Lactobacillus casei* Cheddar cheese ripening. R.-O. Benech*, E. Kheadr, C. Lacroix, and I. Fliss, Centre de recherche STELA, Université Laval.

This study aimed to evaluate the effects of incorporating liposome-encapsulated nisin Z, nisin Z producing *Lactococcus lactis* subsp. *lactis* biovar. *diacetylactis* UL719, or *Lactobacillus casei-casei* L2A into cheese milk on textural, physicochemical and organoleptic attributes during ripening of Cheddar cheese. For this purpose, cheeses were made using a selected nisin tolerant cheese starter culture. A study of cheese proteolysis, free fatty acid production and rheological parameters was carried out during six months of ripening. Hydrophilic and hydrophobic peptides evolution during cheese aging was monitored using Reversed Phase-HPLC. Cheeses were organoleptically evaluated after six months. The results revealed that incorporating nisin-producing strain into cheese starter culture induced cheese proteolysis and lipolysis and had a little effect on cheese rheology. Moreover, production of hydrophilic and hydrophobic peptides was greater in this cheese than in control cheese and a bitter taste could be detected after six months ripening. Incorporating *Lb. casei* into cheese made with nisinogenic culture appeared to have a debittering effect and to improve cheese flavour quality. On the other hand, cheeses with added *Lb. casei* and liposome-encapsulated nisin Z exhibited the highest flavour intensity and ranked first for organoleptic characteristics.

Key Words: nisin Z, liposome, ripening

1034 Study of β -lactoglobulin-xanthan gum complexation by small-angle laser light scattering. S.I. Laneville^{*1}, C. Sanchez², S.L. Turgeon¹, J. Hardy², and P. Paquin¹, ¹*Dairy Research Center STELA, Laval University, Quebec, Canada*, ²*Institut National Polytechnique de Lorraine-ENSAIA, Vandoeuvre-lés-Nancy, France*.

The objective of this work was to determine the time evolution of β -lactoglobulin-xanthan gum (β lg-X) mixtures during electrostatic complexation under shearing (2000 rpm, laminar flow). Three β lg-X ratios were studied: 2:1, 5:1 and 15:1. The interaction was induced by adding glucono δ -lactone acid to obtain a final pH \sim 4.5. The development of the emerging complexes was observed throughout acidification (every 60s for 15h) by small-angle static light scattering. Results were analyzed in terms of the time-evolution of the turbidity and of the scattered intensity $I(q)$ in the q range 0.01-10.4 μm^{-1} . Turbidity was used to determine the critical pH for soluble complexes formation (pH_c) and for the development of intermolecular complexes that leads to macroscopic phase separation (pH_φ). pH_c=5.74 \pm 0.02 was independent of β lg-X ratio, and since pH_c>5.3 (the isoelectric pH of β lg) it could be inferred that the interaction started at charged patches on the protein surface. pH_φ increased with β lg-X ratio from 5.11 to 5.43, indicating that at higher ratios, complexes were neutralized sooner since more protein was available for reaction. The evolution of $I(q)$ showed that after an increase in the total number of particles, a cessation of domain growth occurred for ratios 2:1 and 5:1, probably due to the attainment of an electrostatic equilibrium in the mixture, which did not allow any further aggregation. For ratio 15:1 a second coarsening was observed in which large particles grew at the expenses of smaller ones possibly by flocculation or coalescence. The internal structure of the complexes was determined by measuring the cluster fractal dimension (d_f) from the slope at large q values with a $I(q) \sim q^{-d_f}$ power-law. The d_f evolution showed that loose and amorphous fractal structures were formed (d_f =1.8 \pm 0.1) which then reorganized into more compact complexes. This transition took place close to pH_φ and may correspond to the isoelectric point of the complexes, where opposite charges are maximal and stronger interactions arise. Final d_f values increased with β lg-X ratio from 2.27 to 2.40. At higher ratios more protein is bonded to the xanthan molecule, due to mass action equilibrium, thus weaker interactions may occur allowing the protein to gradually rearrange into denser structures.

Key Words: Protein-polysaccharide interaction, Fractal dimension, Light scattering

1035 Emulsion stabilizing properties of chitosan in presence of whey protein isolate: effect of characteristics of chitosan and emulsification process. S. Laplante, S.L. Turgeon, and P. Paquin, *Dairy Research Center, Laval University*.

The stabilizing potential of 4 different chitosan preparations (CN) was compared in a model emulsion containing 0.5%(w/w) whey protein isolate (WPI) in 0.2M acetic acid (pH6.0), with 10%(v/v) canola oil. The main characteristics of CN were: CNI (78%DD, 1494KDa); CNHI (78%DD, 694KDa); CNHI2 (78%DD, 319KDa); and CNHK (68%DD, 749KDa). To verify the underlying mechanisms of interfacial stabilization (coadsorption of individual biopolymer species vs. adsorption of WPI-CN complex), we respectively compared the effect of a 2-step emulsification process (CN and WPI added sequentially before each homogenization) with the 1-step with WPI/CN mixture. Emulsion stabilities were compared using turbidity (T) and droplet diameter (D) measurements at 0 and 21 days of setting at 21°C. Rheological parameters (yield stress (τ_0), consistency index (K), from Casson model) and droplet surface potential were also examined. Because 0.1% CN was the minimal requirement for effective emulsion stabilization, this condition was chosen for a more discriminative comparison of CN. The stability of lipid dispersion after 21 days, as revealed by T, followed this order: CNI > CNHK > CNHI > CNHI2 whereas D followed: CNI \leq CNHI \leq CNHK < CNHI2. Concerning rheological parameters, K remained comparable for all CN. However, τ_0 increased in this order: CNI, CNHI < CNHI2 < CNHK, suggesting stronger droplet flocculation from CNHI to CNHI2. The highest τ_0 observed for CNHK may be linked to chain entanglements, as D was comparable to CNHI emulsion. Finally, surface potential measurements of CN revealed positive zeta potential in the decreasing order: CNI, CNHI > CNHK > CNHI2. From those results, we conclude that stabilizing properties of CN are more affected by molecular weight (Mw) than by degree of deacetylation (%DD), the best stabilizing effect being obtained with CNI (highest Mw). However,

the absence of significant effect from emulsification processes suggests that complexed as well as individual biopolymer species are responsible for interfacial emulsion stabilization.

Key Words: Chitosan, Emulsion, Stability

1036 Manufacture of hard "requeijao" cheese with reduced fat content using whey protein concentrate. F. M. Soares and L.M. Fonseca^{*}, *University of Minas Gerais, Brazil*.

Hard "requeijao" is a traditional Brazilian cheese with high fat content. Basically, it is a cheese obtained as a result of heating a mixture of caseinate and cream, usually with addition of emulsifier salts, until the adequate texture is obtained. The objective of the present work was to elaborate a new technology for production of hard "requeijao", with reduced fat content. Whey protein concentrate (WPC), 80% protein, was used as a fat substitute in the "requeijao" made with 25% reduction in fat content, and was added at levels of 0.2%, 1.0% and 2.0% (wt. of WPC/wt. of caseinate and cream). These three different treatments were compared to a fourth treatment, that is, a control group with regular fat content. The hard "requeijao" was manufactured in industrial batches, and each treatment was repeated six times. The samples were analyzed in the first week of manufacture for composition, and an affective test with hedonic scale was applied after microbial testing of the product for fecal coliforms and Staphylococcus aureus, according to Brazilian legal requirements. The affective test with hedonic scaling was applied to at least thirty people for each time, and the results were submitted to an analysis of variance with comparison of means using Duncan test. Different treatments and repetition of batches were used as fixed factors. The results of composition showed that the only difference among the treatments and the control group was the fat content, with respectively, 27%, 19%, 20%, and 20% for the control group, treatment with 0.2% WPC, 1.0% WPC, and 2.0% WPC. The results of the sensory evaluation showed that, although there were no statistical differences between the treatments with fat reduction, only the treatment with addition of 1.0% WPC was statistically equal to the hard "requeijao" with regular fat content. The results show that it is feasible the manufacture of hard "requeijao" by using WPC as a fat substitute at level of 1.0%.

Key Words: Requeijao, Whey Protein Concentrate, Reduced Fat

1037 Brazilian commercial pasteurized fluid milks flavor judging by the ADSA score card methodology. G.S.B. Aires and S. Massaguer-Roig^{*}, *Universidade Estadual de Campinas, Campinas, SP, BRASIL*.

Flavor evaluation and criticism, of commercial pasteurized fluid milks samples, by the ADSA score card methodology (ADSA SCM) from some small and medium scale milk processors from Sao Paulo State, Brazil, and training of a group of undergraduate and graduate students as judges of milk evaluation by the ADSA SCM, to identify and grade flavor criticism in commercial milk samples were the objectives of this work. Forty commercial pasteurized milk samples, randomly collected at the retail outlets, and evaluated within their sell by date, from nine milk processors from Southeast State of Sao Paulo (Brazil) were flavor evaluated by the ADSA SCM. All milks were packaged in low density polyethylene plastic foil pouches, HTST plate heat exchanger pasteurized according to Brazilian legal standards (72-75°C/15 to 20 sec.). According to Brazilian law a Milk processing facility (MPF) can be a Micro MPF (McMPF) and a Mini MPF (MnMPF) which are enterprises that process and packages up to 3000 l/day of fluid milk. McMPF only process its own milk. Above 3000 l/day it is a MPF. Inspection can be Municipal (MI), State (SI) or Federal (FI). The nine processors were: one McMPF MI; one MnMPF MI; one MPF MI; one MnMPF SI; two MPF SI; three MPF FI. The commercial milk samples were sensorial evaluated during four consecutive weeks, two days a week and five different samples a day, by a 10 judges panel, trained by 18 consecutive weeks which consisted in recognizing and grading the flavor defects, and sample classification in basic categories; with prepared standard flavor defects using the ADSA SCM, according to Nelson & Trout (1964), Shipe et al. (1978) and Bodyfelt (1988). The panel was constituted by Food Engineering undergraduate students from CREUPI and Food Technology graduate students from UNICAMP. The main flavor defects were: 85 % flat flavor and 67,5 % light induced oxidized flavor. Most of the samples were classified as fair or poor, which reveals that although the commercial milks evaluated comply with sanitary, physical chemical, microbiological and

legal standards, more attention is needed from milk processors to milk flavor characteristics.

Key Words: Milk, Flavor, Defect

1038 The effect of milkfat on the sensory threshold of three impact odorants of strawberry flavor. S. Gaddamu, N. Slaughter, K. Adhikari*, and I. Gruen, *Department of Food Science, University of Missouri.*

The in-mouth release and subsequent perception of flavor compounds changes depending on the composition of the matrix, particularly fat content, because most flavor compounds are fat-soluble. The main objective of this study was to determine the effect of milkfat on the sensory threshold of three impact odorants of strawberry flavor. Dairy mixes containing either 4% or 10% milkfat, 5% sucrose and 10% milk solids-not-fat were used as the experimental matrices to determine the threshold of ethyl-3-methyl-3-phenylglycidate, α -ionone and *cis*-3-hexenol. A paired difference test was performed using a panel of 22 judges to find threshold values of the three compounds. Seven concentration levels of each compound were paired with blanks. The order of serving was randomized within each pair and also among the concentration levels. Two replicates were carried out for each compound. Results were analyzed by plotting % correct response (y-axis) against the concentration of the compounds (x-axis). A logistic regression model (sigmoidal curve) was used for curve fitting and the concentration value corresponding to 66.7% correct response was calculated. The threshold concentrations for ethyl-3-methyl-3-phenylglycidate, α -ionone and *cis*-3-hexenol, were 360, 680 and 500 ppb, respectively, for the 4% fat mixes. For the 10% fat mixes, these values were 460, 600 and 190 ppb, respectively. The higher threshold concentration for the water-insoluble, aromatic ethyl-3-methyl-3-phenylglycidate in the 10% fat mix indicates a slower release at higher fat levels, and is explainable by the greater affinity to the lipid phase in the dairy mixes. While α -ionone is also an aromatic compound, it is slightly more water-soluble than ethyl-3-methyl-3-phenylglycidate and showed a slightly slower release in the 4% fat mix, although the difference was not very large. The higher threshold concentration of *cis*-3-hexenol, an aliphatic compound, which is slightly soluble in water, in the 4% fat mix indicates a slower release compared to the 10% fat mix. Chemical analyses will be performed to determine the solubility and the liquid-air partition coefficients of these flavor compounds in 4% and 10% fat emulsions to correlate to the results of the sensory threshold test.

Key Words: strawberry flavor, threshold, milkfat

1039 Odor profile of typical Sicilian cheeses: Maiorchino, Pecorino, Provola dei Nebrodi and Ricotta infornata. S. Mallia¹, S. Carpino*¹, E. Lavin², G. Di Rosa¹, G. Licitra³, and T.E. Acree², ¹*Consorzio Ricerca Filiera Lattiero Casearia, 97100 Ragusa, Italy*, ²*Cornell University, Geneva, NY 14853*, ³*D.A.C.P.A., Catania University, 95100 Catania, Italy*.

Odor-active volatiles present in cheese products may be important markers of both cheese quality and diversity. Developing methods to identify odor-active compounds and evaluate their sensory impact on artisanal cheeses will impact both quality control and authentication protocols for these cheese products. In this study, the aroma volatile profiles of four native Sicilian artisanal cheeses were assayed using Headspace Solid Phase Microextraction (HSPME) and Gas Chromatography Olfactometry (GCO) dilution analysis (Charm analysis) (Acree et al., 1984), in order to identify the odor-active compounds in the cheeses and to rank their relative odor potencies. Selected compounds with high potency

were subsequently quantified in the cheese headspace using HSPME GC/MS calibrated to SPME (Deibler, 2001), static headspace and solvent injected standards. Maiorchino, Pecorino, Provola dei Nebrodi and Ricotta infornata cheeses were studied. Thirty-one different odors were detected in the cheeses by GCO analysis with 26 of these identified by GC/MS, published retention index matches (FlavorNET, Arn & Acree, 1998) and running authentic standards. SPME dilution analysis found ethyl hexanoate, ethyl butyrate, (E)-2-nonenal, methional, 1-octen-3-one, 2-nonanone, dimethyl disulfide, dimethyl trisulfide, nonanal and butyric acid as having the highest odor-potencies in the cheeses. Butyric and acetic acids were the only FVFA's to produce odor responses in GCO analyses. Pecorino and Maiorchino cheeses were found to have the most diversified odor profiles, which included the odor-active terpenoids α -pinene, sabinene, linalool, L-carvone, citronellol and geranyl acetate. These terpenoids were not found in the Provola dei Nebrodi and Ricotta infornata cheeses. Selected compounds from the list of most potent odorants were quantified via headspace analysis.

Key Words: Sicilian Cheese, HSPME, GCO

1040 Effect of the utilization of an adjunct starter culture on the volatile compounds and sensory characteristics of a Spanish raw ewes' milk cheese. Maria Ortigosa¹, Jesus M. Izco*², Cristina Arizcun¹, and Paloma Torre¹, ¹*Dpto. Ciencias Medio Natural, Universidad Publica de Navarra, Spain*, ²*Dairy Products Technology Center, Cal Poly University, San Luis Obispo, CA*.

The aim of this work is to evaluate the effect caused by the utilization of an adjunct starter culture on the volatile compounds and sensory characteristics of an ewes' milk cheese. Three cheese batches were made, one with raw milk (batch C), another with pasteurized milk (batch P), and a third with pasteurized milk in which an added adjunct starter culture (*Lb. casei* + *Lb. Plantarum*) in addition to the commercial starter was utilized (batch F). Cheese was made according to the protocol for Roncal cheese with Denomination of Origin. Cheeses were sampled at 1, 120 and 240 days of ripening. The volatile components were extracted by purge and trap and analyzed by GC-MS. Cheeses aged for 120 and 240 days underwent sensory analysis by a panel of at least eight expert assessors. Eighty-six components belonging to the following chemical families were identified: hydrocarbons, fatty acids, esters, sulfur-containing compounds, ketones, aldehydes, and especially alcohols. Pasteurization decreased the quantity of some alcohols, aldehydes and ketones. Trimethylpyrazine increased in cheese made with pasteurized milk. Pyrazines formed by the heat treatment have been related to chocolate and coffee flavors in cheese. In fact, cheese P obtained higher number of sensory perceptions of this sensory descriptor grouping than the rest. Significant differences ($p < 0.05$) for characteristic odor, aroma and flavor were recorded between 4 month-cheeses from batches C and P. However, 8 month-cheeses from batches C and F showed similar scores between them and higher than those obtained by batch P. This could be caused by higher concentration of some acids (2-methyl propanoic and 3-methyl butanoic) and esters (methanoic acid, methyl ester; methanoic acid, butyl ester and heptanoic acid, ethyl ester) in C and F. Pasteurization of milk has influenced the concentration of certain volatile compounds, affecting adversely the characteristic flavor of cheese. However, the utilization of *Lb. casei* + *Lb. Plantarum* as adjunct starter culture in addition to the commercial starter improves the flavor when using pasteurized milk to make this kind of cheese.

Key Words: ewe's milk cheese, volatile components, adjunct starter culture

Food Safety

1041 The use of immunoaffinity columns for the isolation of ractopamine from edible tissues of food animals. W. L. Shelver* and D. J. Smith, *USDA/ARS/Biosciences Research Laboratory, Fargo, ND*.

Ractopamine (PayleanTM) (RAC) is a beta-adrenergic leanness-enhancing agent recently approved for use in finishing swine. The currently available determinative method for RAC in tissues employs a lengthy cleanup procedure. Our objective was to determine the utility of a RAC immunoaffinity column (IAC) as a simple cleanup method for

RAC in muscle, liver, and kidney. RAC and ractopamine glucuronide (RAC-G) fortified tissues were homogenized in phosphate buffered saline (pH 7.2), passed through a 1-mL RAC IAC, and the IAC washed with 10% methanol to remove non-bound material. RAC and RAC-G were eluted with 50 mM glycine, pH 2.8. Recoveries of RAC and RAC-G from cattle muscle, liver, and kidney were 82.1 7.6, 87.8 1.9, and 92.5 0.4 %, respectively (n=3). Recoveries of RAC and RAC-G from sheep muscle, liver, and kidney were 91.8 0.2, 91.7 0.3, and 92.7 0.6 % respectively (n=3). Subsequent HPLC with fluorescence detection indicated that IAC

has potential as a one-step cleanup procedure because RAC was baseline separated from a small amount of co-extracted material. The IAC was rugged; with glycine as the eluent IAC columns were stable for greater than 20 uses over a 3-month period. In conclusion, RAC IAC has the potential to decrease solvent use and greatly simplify RAC analysis in incurred tissues.

Key Words: Ractopamine, Immunoaffinity column, analysis

1042 Decline of PCB concentration in milk of accidentally highly contaminated cows. G. Piva^{*1}, M. Morlacchini², T. Bertuzzi¹, and F. Rossi¹, ¹Facoltà di Agraria, Piacenza, Italy, ²CERZOO, San Bonico, Piacenza, Italy.

Six pregnant heifers, coming from a herd with a history of high concentration of PCB into the milk, were fed a low-PCB diet since the 6th month of pregnancy. After parturition cows were milked for at least 190 d with a maximum of 270 d. Diet was made of: corn silage (31.7% of DMI), dehydrated alfalfa (13.3% of DMI), grass hay (3.7% of DMI) and concentrate (51.3% of DMI). The average DMI was 23.12 kg/d. Milk production was recorded and samples of milk and blood were taken and analyzed for PCB (18, 28, 31, 52, 44, 101, 149, 118, 153, 138, 180 and 194 congeners) content using a GC-MS technique. The average milk yield (kg/d) of the 6 cows was 26.0, 22.5, 23.2, 24.5, 28.9, 29.3. The maximum permitted (by Italian law) PCB concentration of 100 ng/g of fat was reached after 144-209 d of lactation. One animal after 204 days had a PCB concentration of 102 ng/g fat. If log₁₀ of PCB concentration (ppb) in milk fat is regressed against days in milking (DIM) the following significant equation was obtained: log₁₀ PCB (ng/g of milk fat) = 2.796 - 0.00474 DIM; r² 0.72; P<0.01. At the end of the trial the animals were slaughtered and xenobiotic concentration determined. The PCB content of liver ranged 0.35-1.2 ppb and was negatively correlated with average PCB blood levels (r = -0.84; P<0.05). In kidney the lower concentration of PCB detected was 2.29 ppb while the maximum one was 10.18 ppb. Body fat was more heavily contaminated with a maximum level of 460.66 ppb. PCB concentration in kidney fat and tail fat was strongly correlated (r = 0.97; P<0.01). A strong differences between cows for PCB content of organs and fat was observed.

Key Words: PCB, Dairy cows, Milk

1043 Excretion of aflatoxin M1 in milk of dairy ewes treated with different doses of aflatoxin B1. G. Battaccone, A. Nudda, A. Cannas, A. Cappio Borlino, and G. Pulina*, Dipartimento di Scienze Zootecniche - University of Sassari, Sassari, Italy.

Two trials were carried out to evaluate the carry-over of aflatoxin B1 (AFB1) into aflatoxin M1 (AFM1) in sheep milk. In the first trial, four dairy ewes in early lactation received a single dose of 2 mg of pure AFB1. Individual milk samples were taken in the following five days to measure AFM1 concentration. The average excretion of AFM1 in milk followed an exponential decreasing pattern with two intermediate peaks at 24 h and 48 h, suggesting the presence of three excretion compartments. No AFM1 was detected in milk 96 h after dosing. The mean carry-over of AFB1 into AFM1 was 0.032%, with high individual variability (SD = 0.017%). In the second trial, sixteen dairy ewes in mid-lactation were divided in four groups that received different daily doses of AFB1 (0, 32, 64 and 128 µg in control, T1, T2 and T3 groups respectively) for 14 days. Pure AFB1 was administered to each animal divided in two daily doses. Individual milk samples were collected at 12, 24, 36, 48, 72, 96, 144, 216, and 312 h after the first administration during the intoxication period and every 24 h for 7 days after this period. AFM1 was detected in the milk of all animals of the treated groups even in the first milking after the administration of AFB1. In all treated groups, milk AFM1 concentration increased from 12 h to 144 h after the beginning of administration. Then decreased, reaching a stable concentration at 216 h and 312 h after the first administration. No AFM1 was detected in milk 3 days after the last administration of AFB1. Milk AFM1 concentration measured at steady-state condition was significantly affected by the AFB1 dose (0.031, 0.095 and 0.166 µg/L in T1, T2 and T3 groups respectively), while the carry-over (AFM1/AFB1 ratio) was not significantly affected. Its mean value was 0.112%. In both trials the carry-overs were lower than those reported for dairy cattle and goats, suggesting a better ability of sheep to degrade AFB1.

Key Words: Aflatoxin, Milk, Sheep

1044 Isolation of *Clostridium botulinum* (types A, B & E) in sediments from coastal areas of the north of Iran. H. R. Tavakoli*, Nutrition and Food Hygiene Dept; Faculty of Hygiene, Univ. of Baghyatollah Medical Sciences, Tehran.

Clostridium botulinum has long been recognized as an etiological agent of food borne botulism and has been shown to be distributed widely in fresh water, brackish water and marine environments. This bacterium has been reported as an important food safety hazard. The aim of this study was to obtain information about *C. botulinum* distribution and contamination levels in sediments in order to ascertain the risks associated with consumption and processing of fish from these waters. Two hundred and seventy samples of sediments from coastal areas of "Gilan" and "Mazandaran" states of Iran were collected and analysed. Suspension of samples were prepared and then centrifuged at 5000 RPM for 20 min. The supernatants were inoculated into 10 ml cooked meat media (C.M.M.). After incubation for 2-4 days at 30C, grown specimens were gram stained and checked microscopically. For complementary test, specimens from above mentioned media were inoculated into Egg yolk agar media containing trimethoprim and sulphamethoxazole. After centrifugation, the supernatants were divided into three portions: one portion remaining untreated, one heated to demonstrate the labile nature of the toxin (control), and one trypsinised to demonstrate the presence of inactive protoxin. Samples (0.5 ml) were inoculated intraperitoneally into mice (182) and controlled for 4 days to detect positive samples. Polyvalent (A, B and E) and monovalent standard antitoxins were used to toxin type detection. The present study revealed that the prevalence of *C. botulinum* (types A, B and E) in sediments from different areas of Gilan and Mazandaran were 3.6% and 4.6% respectively, and mean prevalence of *C. botulinum* in sediments from north regions of Iran was 4.1%. It is also demonstrated that *C. botulinum* type E is predominant type seen in aquatic environments of the coastal areas of Iran. This is the first report of *C. botulinum* distribution in the sediments from coastal area of Iran. The potential hazards of types A, B & E is clearly indicated thus revealing a risk of extended storage of raw or mildly thermally processed sea foods and the need to protect these products from temperature abuse until their final use.

Key Words: *Clostridium botulinum*, Coastal areas sediments, Food safety

1045 HACCP - Have another cup of coffee and pray? N. Unger^{*1}, J. Shelford¹, D. Fraser¹, A. Moore², B. Skura¹, D. Weary¹, and F. Brunger¹, ¹University of British Columbia, Vancouver, BC, ²BC Ministry of Agriculture, Food and Fisheries.

Dairy Farmers of Canada developed an on-farm HACCP-based food safety program for dairy producers and the project evaluated the material; costs and time commitments; effects on milk and meat quality; and producers opinions of the program. Fifteen volunteers underwent training, implementation and validation. Questionnaires, interviews and participant observation were used to gather data. Of the fourteen farms validated, five passed, five conditionally passed and four failed. Producers spent an average of 11 hours setting up the program and about 10 minutes maintaining daily records. The average initial program cost was \$1,068 and annual costs were estimated at \$1,404. Some producers felt that the program was positive, while others thought it was unnecessary. Most wanted the program simplified and had difficulty understanding the new concepts. Everyone wanted compensation for implementing the program and some were concerned that the various programs being developed would become too expensive to maintain. Other issues were resistance to change, writing extralabel prescriptions, testing new animals for inhibitors, and addressing meat safety. Furthermore, the program needs to add pesticide storage, annual equipment checks and veterinary treatment protocols and validators are going to need extensive training and a complete validation protocol. The program needs to work with all stakeholders in the industry (e.g. veterinarians and equipment dealers), to be implemented uniformly across Canada and to develop a communication plan from producers to consumers. The program is an excellent tool to reduce food safety risks; but, it needs to reduce inconsistencies, gain producer acceptance and ensure credibility from producers to consumers.

Key Words: HACCP, Canadian Quality Milk, Best Management Practices

1046 Food safety in the retail ice cream (soft serve) market. I. Okpala*¹, ¹Michigan State University, Lansing, MI, ²Michigan Department of Agriculture, Lansing, MI.

In 1983, the Michigan legislature adopted changes in the Frozen Desserts Act, Act 298, Public Acts of 1968, as amended, which eliminated the need for the Michigan Department of Agriculture (MDA) to license, sample and inspect those facilities which manufactured frozen desserts in a food service setting. Since all food service establishments are licensed and inspected by the local health department, this decision was based on the fact that a food service facility should not be inspected by two regulatory agencies. Local health departments were not provided with the resources necessary to deal with the added responsibility and very little work has been done to monitor the quality of soft serve products manufactured at food service establishments. Many local health agencies do not have laboratories in which food products can be analyzed and have not set up sampling and inspection procedures for the frozen dessert part of food service establishments. MDA, therefore continues to license, inspect and sample those establishments not covered by the Public Health code. In cooperation with local health departments, a soft serve risk assessment survey was conducted. The results of the sampling and survey will be used to: 1) to determine and characterize the type and baseline levels of microbiological organisms which are found in soft serve desserts, 2) assess the effectiveness of sanitation practices currently used in soft serve production and to determine if establishment practices have an impact on these levels, and 3) to justify the changes that the Michigan Department of Agriculture made to the state dairy laws.

1047 Prevalence and distribution of *Campylobacter* spp. in a swine slaughter and processing facility. R Pearce¹, R Dudley², F.M. Wallace*², J.E. Call², and J.B. Luchansky², ¹The National Food Centre, Teagasc, Dunsinea, Castleknock, Dublin, Ireland, ²USDA, Agricultural Research, Eastern Regional Research Center, Wyndmoor, PA.

The objective of this study was to establish the prevalence and distribution of *Campylobacter* spp. in a swine slaughter and processing facility. Samples obtained over the course of three visits included composite carcass samples (30), representing 360 swine carcasses, obtained at selected points along the slaughter process, matching composite rectal samples (30), and non-matching individual colon samples (60). In addition, samples were collected on the same three visits from equipment used in the slaughter and processing operations. A preliminary study to determine the most efficient recovery method showed that direct plating onto Campy-Line agar (CLA) recovered *Campylobacter* spp. at a significantly higher ($P < 0.05$) rate when compared to three other recovery methods. Using CLA, *Campylobacter* spp. were detected on 33% (10/30) of carcasses immediately after stunning, 0% (0/30) after flaming/polishing, 3% (1/30) immediately before chilling and 0% (0/30) after overnight chilling. The pathogen was recovered from 63% (19/30) of the composite rectal samples which were collected from carcasses immediately after stunning, and 58% (35/60) of the individual colon samples which were collected following carcass evisceration. *Campylobacter* spp. were detected on dehairing equipment used in the slaughter process but were not detected on equipment used in the processing operation. The results of this study show that direct plating onto CLA is an effective recovery method for *Campylobacter* spp. Additionally, the results indicate that the prevalence of *Campylobacter* spp. is reduced as hog carcasses progress through the slaughtering process.

Key Words: *Campylobacter*, Swine, Prevalence

1048 Evaluation of bacteriophage DC22 for control of *Escherichia coli* O157:H7. S.J. Bach*¹, T.A. McAllister¹, D.M. Veira², V.P.J. Gannon³, and R.A. Holley⁴, ¹Agriculture and Agri-Food Canada, Lethbridge, AB, ²Agriculture and Agri-Food Canada, Kamloops, BC, ³Health Canada, Animal Diseases Research Institute, Lethbridge, AB, ⁴University of Manitoba, Winnipeg.

The effectiveness of DC22, an *Escherichia coli* O157:H7-specific bacteriophage, for controlling *E. coli* O157:H7 was investigated in vitro, using the Rumen Simulation Technique (Rusitec) and in vivo, with experimentally inoculated wethers. In Exp. 1, fermentations were established in eight Rusitec vessels using ruminal inoculum confirmed negative for *E. coli* O157:H7. Each vessel was inoculated with 10^4 CFU/mL of *E. coli* O157:H7 strain 3081, then 8 h later with 10^5 PFU/CFU of DC22 or an equivalent amount of SM buffer as a control ($n = 4$). Both *E. coli* O157:H7 and phage DC22 were enumerated 4 and 12 h after inoculation of DC22, and daily thereafter for 7 d. In the DC22-treated vessels, *E. coli* O157:H7 was eliminated within 4 h of challenge, whereas the bacterium persisted in the control vessels for up to 168 h ($P < 0.05$). In Exp. 2, 12 wethers were inoculated orally with 10^8 CFU of *E. coli* O157:H7 strain E318N, then 2 d later, with 10^5 PFU/CFU of DC22 or an equivalent amount of SM buffer ($n = 6$). Fecal samples were collected for enumeration of *E. coli* O157:H7 and DC22 following inoculation and following DC22 challenge, then daily for 8 d, then twice weekly for 3 wk. Treatment with DC22 did not affect ($P > 0.05$) levels of *E. coli* O157:H7 shed by the wethers during the 30-d period. Levels of DC22 recovered from feces decreased rapidly following inoculation, suggesting the phage did not replicate lytically in the ovine gut. Although 10^5 PFU of DC22/CFU *E. coli* O157:H7 was adequate for eliminating *E. coli* O157:H7 in the Rusitec ($P < 0.05$), this dose did not effect maintenance of the phage in the gastrointestinal tract of the wethers in levels sufficient to cause lysis of *E. coli* O157:H7. Non-specific adsorption of DC22 may have reduced its availability to lyse *E. coli* O157:H7. Bacteriophage DC22 was not effective for controlling fecal shedding of *E. coli* O157:H7 by sheep.

Key Words: Bacteriophage, *E. coli* O157:H7, Sheep

1049 Antimicrobial activity of ginkgo biloba and Origanox on *Escherichia coli* O157:H7 and *Salmonella agona*. H. Nasri, S. A. Ibrahim*, T. N. Evans, T. Jordan, C. W. Seo, and G. Shahbazi, North Carolina A&T State University, Greensboro, NC.

The Pathogen Reduction Program of the U.S. Department of Agriculture Food Safety and Inspection Service recommends antimicrobial treatments including herb extracts to reduce or inactivate pathogenic bacteria in foods. Ginkgo Biloba (GB) and Origanox (OX) have been used in foods as functional ingredients. However, they have never been used as antimicrobial agents. Therefore, the objective of this study was to evaluate the effect of GB and OX on the survival and growth of *Escherichia coli* O157:H7 and *Salmonella agona* in BHI broth. Prior to media sterilization select concentrations of GB and OX extracts were added separately into the broths. *E. coli* O157:H7 (380-94), and two strains of *Salmonella agona* (F5567, H6115) were inoculated to provide a final inoculum level of 2.5×10^2 CFU/ml. Samples were incubated at 37°C for 6 hours. Samples were withdrawn every 2 hours and surface plated on EMB agar and TSBYE agar for the enumeration of *E. coli* and *Salmonella*, respectively. Results showed that the addition of 1.25% GB and 0.1% OX significantly inhibited the growth of pathogenic bacteria ($P < 0.05$). During the 6 hours storage period, populations of bacteria increased by 6.0 log CFU/ml in control samples while bacterial populations in treated samples only increased by 2.0 log CFU/ml. These results indicate the potential applicability of GB and OX as antimicrobials in foods.

Key Words: *Salmonella agona*, Ginkgo biloba, Origanox

Physiology Estrus Synchronization

1050 Postpartum suppression of ovarian activity with a Deslorelin implant enhanced uterine involution in lactating dairy cows. F.T. Silvestre*¹, J.A. Bartolome¹, S. Kamimura¹, A. C. M. Arteche¹, S.M. Pancarci¹, T. Trigg², and W.W. Thatcher¹, ¹University of Florida, Gainesville, FL, USA, ²Peptech Animal Health, North Ryde, Australia.

Ovarian follicular activity, presence of a CL and uterine involution were evaluated for cows treated with a non-degradable Deslorelin (DES) implant

(5 mg; $n = 10$) or a control group ($n = 9$) that did not receive an implant. All cows were assigned randomly to treatments on 6-25-2001 and received DES implants between 1d to 4d postpartum (PP). Cows

had normal parturitions without dystocia, retained fetal membranes, or milk fever. Ultrasound (US) was used to monitor number of ovarian follicles (Class 1, ≤ 5 mm; Class 2, 6-9 mm; Class 3 ≥ 10 mm, and number of CL) ipsilateral and contralateral to the previous pregnant horn (PH) on days 21, 28 and 35 after enrollment. Diameters of uterine horns at 4 cm past the intercornual ligament and cervix were measured by US, in addition vaginal endoscopy evaluated cervical discharge and color on days 14, 21, 28 and 35 after enrollment. The DES implant increased Class 1 follicles ($10.6 \pm 0.51 > 5.3 \pm 0.52$; $P < 0.01$) and decreased the number of Class 2 ($0.0 \pm 0.19 < 0.9 \pm 0.2$ $P < 0.01$) and Class 3 follicles ($0.0 \pm 0.19 < 1.3 \pm 0.20$; $P < 0.01$). DES implant decreased the number of CL ($0.0 \pm 0.09 < 0.45 \pm 0.1$; $P < 0.01$). Ovarian activity was suppressed due to the DES implant group based upon a lack of Class 2 and 3 follicles that are dependent upon gonadotrophin secretion. Uterine horn diameter was influenced by DES implant ($P < 0.01$), PH ($P < 0.01$), DES implant*PH ($P < 0.10$) and day*PH ($P < 0.02$). DES implant inserted at 1-4 days PP reduced size of the PH (see table). Cows with the DES implant had a lower frequency of a purulent discharge from the cervical os. In conclusion, suppression of ovarian activity during the early PP period stimulated rate of uterine regression in clinically normal cows. Such a treatment warrants further study relative to improving uterine health and fertility in both clinically normal and abnormal cows.

Day Control PH (cm) Des Implant PH (cm)

14	3.17 \pm 0.16	2.60 \pm 0.17
21	2.93 \pm 0.16	2.15 \pm 0.17
28	2.66 \pm 0.16	2.16 \pm 0.17
35	2.54 \pm 0.16	2.23 \pm 0.17

Day Control PH (cm) Des Implant PH(cm) 14 3.17 0.16 2.6 0.17 21 2.93 0.16 2.15 0.17 28 2.66 0.16 2.16 0.17 35 2.54 0.16 2.23 0.17

Key Words: Deslorelin implant, uterine involution, follicle development

1051 Effect of bovine somatotropin on ovarian function and pregnancy in nonlactating dairy cows. S Kamimura*, T.R. Bilby, S.M. Pancarci, A. Guzeloglu, and W.W. Thatcher, *University of Florida*.

The use of bST has been associated with a decrease in reproductive efficiency. However, it was reported that bST injection in combination with the Ovsynch timed insemination program (TI) stimulated pregnancy rate at first insemination in lactating cows. Objective of this study was to characterize effects of bST on ovarian function and pregnancy in nonlactating dairy cows. Cows (n=59) were injected on d#10 (d0 = TI) with GnRH (100 μ g, im, Cystorelin[®]; Merial Ltd) followed 7d later (d-3) by an injection of PGF₂ α (25mg, im, Lutalyse[®]; Pharmacia Corp.). At 48 h after injection of PGF₂ α , GnRH (d-1) was administered, and 38 cows were inseminated 16 h later. The cycling group (n=21) was not inseminated. On d0 and d11, cows received either bST (500mg, sc, Posilac[®]; Monsanto Co.; n=41) or no bST (n=18). Ovaries were evaluated by ultrasound on d0, d7 and d16 to characterize number of class 2 (6 # 9 mm) and 3 (>10 mm) follicles and corpora lutea (CL) length (mm). A follicular cyst was detected on d0 in 7 cows and in 5 additional cows on d7. CL regression prior to d16 was observed in 2 cows. These 14 cows were not slaughtered. A total of 45 cows (14 cyclic and 31 TI) were slaughtered on d17 and uteri of cyclic and TI cows were flushed with 40 ml of PBS to recover uterine flushings and verify presence of conceptus. BST effect on ovarian function of 47 noncystic cows was evaluated using repeated measures analysis of mixed model SAS. The 12 cystic cows were evaluated independently. Conceptuses were recovered from 4/21 bST cows (19%) and 6/10 (60%) control cows ($P < 0.01$); conceptus were 49.7 ± 7.0 cm in bST treatment and 24.5 ± 5.0 cm in control ($P < 0.02$). Number of class 2 and 3 follicles, and size of largest follicle did not differ between treatments. Treatment with bST stimulated CL weight at slaughter ($5.8 > 5.1$ g; $P < 0.01$) and CL length ($25.2 \pm 0.5 > 23.5 \pm 0.7$ mm) as measured by ultrasound on d7 and d16. The incidence of follicular cysts was not influenced by bST treatment. In summary, bST treatment decreased pregnancy rate and increased CL length, CL weight, and conceptus length in nonlactating dairy cows.

Key Words: Somatotropin, Pregnancy, Nonlactating dairy cows

1052 Effect of a deslorelin implant in a timed AI protocol on follicle development, luteal activity and reproductive performance of dairy cows. J.E.P. Santos*¹, J. Bartolome², R.L.A. Cerri¹, S.O. Juchem¹, T.E. Trigg³, and W.W. Thatcher², ¹University of California Davis, ²University of Florida, ³Peptech Animal Health, Australia.

After blocking for lactation, BCS, and milk production, 596 Holstein cows were assigned randomly to one of two treatments at 303 DIM. Cows received PGF₂a (Pharmacia Co.) injections at 303 and 443 DIM. At 583 DIM, cows received a GnRH (Merial Ltda.) injection followed 7 d later by a PGF₂a injection. At 48 h after the last PGF₂a, cows received either a GnRH injection (100 ug of Gonadorelin) or a GnRH agonist (Deslorelin, 450 or 750 ug) and were timed AI (TAI) 12 to 16 h later. Blood samples were collected at -24, -10, and 11 d relative to the day of AI for progesterone (P4) determination. Pregnancy was diagnosed by ultrasound at d 27 after AI and reconfirmed 14 d later. Follicular populations and presence of CL were determined for open cows at d 27 after AI. Open cows were resynchronized with initiation of the Ovsynch protocol at d 27 after AI. At the day of the PGF₂a during resynchronization, follicular populations and presence of CL were determined. Continuous and binomially distributed data were analyzed using the GLM and the LOGISTIC procedures of SAS, respectively. Conception rates (CR) for DES and GnRH did not differ ($P > 0.15$) at days 27 (33.4 vs 37.9%) and 41 (30.3 vs 31.2%). Pregnancy losses from d 27 to d 41 were less for the DES group (6.7 vs 15.7%; $P < 0.03$). Plasma P4 (ng/ml) on d 11 after AI was similar for DES and GnRH (9.75 vs 9.67; $P < 0.90$). In open cows, compared with GnRH, DES reduced the number of follicles sized 6 to 9 mm (0.9 vs 2.0; $P < 0.001$) and 10 to 19 mm (0.5 vs 1.2; $P < 0.001$) at d 27 after AI. Size of the largest follicle 48 h prior to the resynchronized TAI in cows diagnosed open at d 27 was smaller for DES treated cows compared with GnRH (12.3 vs 14.3 mm; $P < 0.03$). DES increased the re-insemination interval for open cows found in estrus after the first AI compared with GnRH (25.1 vs 21.4; $P < 0.001$). Conception rate to the re-synchronized TAI was decreased in DES treated cows (10.8 vs 26.2%; $P < 0.01$). Replacement of GnRH with a Deslorelin implant (450 ug) for a TAI protocol reduces pregnancy loss, but inhibits follicle development and decreases fertility in the subsequent estrous cycle.

Key Words: Reproduction, Timed AI, Deslorelin

1053 Effect of presynchronization on conception rate to a timed artificial insemination protocol in lactating dairy cows. C. Navanukraw*¹, L.P. Reynolds¹, A.T. Graziel-Bilska¹, D.A. Redmer¹, and P.M. Fricke², ¹Department of Animal and Range Sciences, North Dakota State University, Fargo, ND, 58105-5727, ²Department of Dairy Science, University of Wisconsin-Madison, Madison, WI, 53706.

Presynchronization using two injections of PGF₂ α (PGF) 14 d apart beginning 26 d before Ovsynch has been shown to increase conception rate to timed artificial insemination (TAI) in lactating dairy cows compared with Ovsynch alone (J. Dairy Sci. 84:1646; 2001). To assess presynchronization using two injections of PGF 14 d apart beginning 28 d before Ovsynch, nonpregnant lactating Holstein cows (n=257) >60 days in milk (DIM) were blocked by parity (1st vs. >1st parity) and DIM (>60-100 vs. >100 DIM) and were randomly assigned within block to one of two treatments: Ovsynch (n=128) received 50 mg GnRH (d -10), 25 mg PGF (d -3) and 50 mg GnRH (d -1) beginning at a random stage of the estrous cycle; Presynch (n=129) received two injections of PGF (25 mg/injection) 14 d apart beginning 28 d before Ovsynch (i.e., on d -38 and -24 of the Ovsynch protocol). All cows received TAI (d 0) 18 h after the second GnRH. Transrectal ultrasonography was used to assess ovulatory response to each GnRH (first 109 cows) and also to assess pregnancy status 42 d after TAI (all cows). Cows were considered synchronized if the CL regressed after the PGF of the Ovsynch protocol and a follicle >10 mm in diameter disappeared within 48 h after the second GnRH. Although the proportion of cows ovulating after the first and second GnRH did not differ between treatments (41.1 and 69.6 vs. 35.9 and 81.1% for Ovsynch vs. Presynch, respectively; $P = 0.58$ and 0.17; n=109), conception rate was greater ($P < 0.08$) for Presynch vs. Ovsynch (48.1 vs. 37.5%; n=257). Parity, DIM, or body condition score at TAI did not affect conception rate. These data support the use of this modified Presynch protocol to increase conception rate of lactating dairy cows receiving TAI. Supported in part by Hatch projects ND01705 to DAR and LPR and WIS04222 to PMF.

Key Words: Ovsynch Presynch, TAI, Lactating Dairy Cows

1054 Effect of a single progesterone injection on ovarian follicular cysts in lactating dairy cows. T. B. Hatler*, S. H. Hayes, A. M. Nugent, D. W. Yelton, and W. J. Silvia, *University of Kentucky, Lexington.*

The objective was to evaluate the influence of a single injection of progesterone on ovarian follicular cysts and examine subsequent occurrence of new cyst formation or ovulation. Ovarian follicular cysts (follicle diameter ≥ 20 mm) were detected via palpation per rectum as part of routine reproductive management of nonpregnant, lactating Holstein and Jersey cows. The ovaries of cystic cows were examined by transrectal ultrasonography three times weekly to monitor formation of new follicular cysts. Venous blood samples were collected daily for quantification of progesterone. Newly formed follicular cysts were subjected to treatment between 3 and 9 days after attaining a diameter of 20 mm. Treatment consisted of an intramuscular injection of 200 mg of progesterone (P4, n=15 cysts) or corn oil vehicle (V, n=7 cysts). Blood sampling and ultrasonography continued until ovulation occurred or a new follicular cyst formed. Progesterone treatment increased circulating concentrations of progesterone at 1 ($P < 0.01$; 1.03 vs. 0.24 ng/ml) and 2 ($P < 0.01$; 0.67 vs. 0.25 ng/ml) days post-treatment. Progesterone treatment reduced the lifespan of the cyst (number of days the diameter of the cyst ≥ 20 mm) by 12 days ($P < 0.01$; 29 vs. 17 days). Treatment tended to alter the frequency of subsequent follicular events ($P < 0.10$). Ovulation occurred after 6 of 15 cysts were treated with P4. Ovulations occurred 11.8 ± 1.8 days after treatment. In no case was V treatment followed by ovulation. New cysts replaced 9 of 15 P4-treated cysts, whereas a new cyst replaced 7 of 7 V-treated cysts. These new cysts reached cystic diameter at 19.6 ± 3.5 and 19.1 ± 3.0 days after treatment, respectively. In conclusion, a single injection of 200 mg of progesterone early in the life of an ovarian follicular cyst shortened its lifespan and in some cases, was followed by ovulation of a new follicle. Research was supported by USDA (00-35203-9174).

Key Words: Ovarian follicular cyst, Progesterone treatment

1055 Ovarian follicular activity in lactating Holstein cows supplemented with monensin. S. K. Tallam^{*1}, T. F. Duffield¹, K. E. Leslie¹, R. Bagg², and J. S. Walton¹, ¹*University of Guelph, Guelph, Ontario, Canada,* ²*Elanco Animal Health, Division Eli Lilly Canada Inc., Guelph, Ontario, Canada.*

The effects of monensin on postpartum ovarian follicular development, reproductive performance, feed intake and milk production were studied in multiparous Holstein cows. Cows were randomly assigned either a control TMR diet (C, n=19) at NRC requirements or the same diet including 22 ppm monensin (M, n=18). The diets were offered *ad libitum* from 21 days prior to the anticipated date of calving until the cows were either confirmed pregnant (Day 40 of pregnancy) or were > 180 days postpartum. Monensin had no effect on development of the first postpartum dominant follicle or the numbers of smaller follicles. Control cows had a greater number of class 4 (> 15 mm) follicles than the M group ($P < 0.05$). The first postpartum dominant follicle ovulated (M, 72.2%; C, 68.4%), regressed (M, 11.1%; C, 21.1%) or became cystic (M, 16.7%; C, 10.5%) with no effects of diet. The first postpartum ovulation occurred earlier (M, Day 27.2 ± 2.1 ; C, Day 32.4 ± 1.5) in monensin-fed cows than in the control group ($P < 0.05$) with no diet effects on the diameter of the ovulating follicle (M, 17.3 ± 2.2 mm; C, 21.0 ± 2.0 mm). Treatments did not differ in the proportion of cows with 2 or 3 waves of ovarian follicular development per cycle nor in the number of follicles of all classes during the breeding period. Times to ovulation following prostaglandin $F_{2\alpha}$ administration (M, 92.4 ± 3.6 h; C, 94.8 ± 3.9 h) were not different between M and C. Pregnancy rates after TAI based on ultrasound diagnosis on day 28-35 after service showed no diet effects. Cows receiving the monensin diet had lower ($P < 0.05$) milk protein and fat concentrations although milk fat and protein yields were not different ($P > 0.05$) between diet groups. This study suggests earlier resumption of normal ovarian follicular activity resulting in earlier ovulation in monensin-fed than in control cows.

Key Words: Postpartum, Follicular development, Monensin

1056 Use of milk letdown after prostaglandin $F_{2\alpha}$ to initiate OVSYNCH in lactating dairy cows. B.R. Keith*, J.S. Walton, K.E. Leslie, and W.H. Johnson, *University of Guelph, Guelph, Ontario, Canada.*

Milk letdown (ML) occurs in response to luteolysis induced by $PGF_{2\alpha}$ injection, and may be used as a test to determine stage of the estrous cycle. The objective of this study was to evaluate if initiating OVSYNCH (GnRH-7d- $PGF_{2\alpha}$ -2d-GnRH-24hr-AI) at the most beneficial time of the cycle (day 5-9), on the basis of this test, would improve pregnancy rates (PR). Lactating Holstein cows between 55 and 70 DIM were used to evaluate the ML test and PR after OVSYNCH when initiated on the basis of the test result. PG+OV cows (n=60) were treated with 500 μ g cloprostenol (PG) and had one teat cannulated to test for ML. Cows with ML were started on OVSYNCH 10 days later, and those without started 3 days later. Cows in the SA+OV group (n=64) were injected with physiological saline and observed for ML. This group was started on OVSYNCH 10 days after saline. Milk samples were collected 3 times/week to determine progesterone concentrations. ML was an indicator of luteolysis with a specificity of 90% and a sensitivity of 83%. The positive and negative predictive values were 83% and 90%, respectively. Pregnancy rates were 48% for PG+OV and 52% for SA+OV ($P > 0.05$). When data from both groups were combined PR was greater in cows that started OVSYNCH in Stage 2 of the estrous cycle (day 5-9, 67%) than all other stages (Stage 1: day 1-4, 35%; Stage 3: day 10-16, 45%; Stage 4: day 17-21, 42%; $P < 0.05$). The proportion of animals with ovulation at GnRH #1, luteolysis at $PGF_{2\alpha}$, and ovulation at GnRH #2 were all greater in the PG+OV group (77% vs 55%, 85% vs 67%, and 97% vs 84%, respectively; $P < 0.05$). These data indicate that the ML test indicates luteolysis with sufficient precision to improve the response to OVSYNCH, however this did not alter PR compared to starting the protocol randomly throughout the cycle. Initiating OVSYNCH between day 5 and 9 of the cycle increased PR.

Key Words: $PGF_{2\alpha}$, GnRH, OVSYNCH

1057 Effects of experimentally-induced clinical mastitis on estrous behavior, luteal function, and establishment of pregnancy during early lactation of dairy cows. M.E. Hockett^{*1}, N.R. Rohrbach, R.A. Almeida, H.H. Dowlen, K. Lamar, S.P. Oliver, and F.N. Schrick, ¹*The University of Tennessee, Knoxville, Tennessee.*

The objective of the current study was to determine if experimentally induced clinical mastitis prior to ovulation resulted in altered estrous expression or decreased pregnancy rates. Estrus was synchronized in Jersey and Holstein cows during early lactation by two prostaglandin (Lutalyse, 25 mg i.m.) injections 14 d apart. Cows were inoculated with *Streptococcus uberis* in two mammary quarters 4 d prior to the second injection of prostaglandin. Control cows remained unchallenged. Cows from all groups were monitored for estrous behavior at least four times daily and artificially inseminated at estrus and 12 h later. Blood samples and rectal temperatures were obtained every 2 d for 20 d beginning immediately prior to bacterial inoculation. Sera were analyzed for concentrations of progesterone and cortisol. Pregnancy status was determined by ultrasonography 30 d following insemination. Intramammary challenge increased daily somatic cells over time following bacterial challenge in PRE cows, but not in CON cows ($P < 0.0001$). Mean rectal temperatures were also elevated in challenged cows compared to CON (39.2 ± 0.4 vs. $38.0 \pm 0.4^\circ\text{C}$, respectively; $P = 0.04$). Fewer cows with mastitis infections during the preovulatory period exhibited signs of estrus behavior (12.5 vs. 66.7%; $P < 0.02$). Days until estrus were increased in mastitis cows (27.1 ± 5.2 vs. 7.0 ± 4.4 d; $P < 0.06$) compared to controls. Concentrations of cortisol were higher ($P = 0.01$) following bacterial challenge compared to unchallenged control animals. Pregnancy rate did not differ on first service opportunity; however, first service opportunity occurred 20 d later in mastitis cows. These results suggest that clinical mastitis prior to onset of estrus interfered with expression of estrus, which would result in increased days to first service and increased days open.

Key Words: estrus, mastitis, pregnancy

1058 Supplementing transition cows with organic trace minerals or calcium propionate-propylene glycol drenching: Implications for reproductive performance. D. Monardes^{*1}, A. R. Melton², I. D. Peeler², J. H. Bame², O. A. Peralta², W. S. Swecker², R. L. Nebel², and D. J. Tomlinson³, ¹University of Chile, Santiago, ²Virginia Polytechnic Institute and State University, Blacksburg, ³Zinpro Corp., Eden Prairie, MN.

Requirements of trace elements and vitamins for optimal reproductive performance have not been well characterized. Additionally, fertility is influenced by the number of estrous cycles that occur between parturition and first insemination. The objective of this study was to evaluate milk yield, days to first ovulation, days to first expressed estrus and possible metabolic responses to the administration of a mixture of calcium propionate, propylene glycol and mineral salts at calving and 30 days after calving, in contrast to the administration of a mineral supplement 4-PLEX (Zinpro Corp.) daily from calving until 60 days post partum. Cows ($n = 54$) were assigned randomly by calving date and parity. The control group (C) received 3 liters of a saline solution at calving. The drenched group (D) received 3 liters of a mixture of calcium propionate, propylene glycol, water and mineral salts at calving and 30 DIM. The daily supplemented group (4P) received one gel cap bolus containing 14 grams of 4-PLEX from calving until 60 DIM. Milk samples were taken 3 times weekly (Monday, Wednesday and Saturday) to measure the progesterone levels in milk (mP4) as a monitor of ovarian activity. A HeatWatch[®] transmitter (DDx Inc., Denver, CO) was applied by 10 DIM to monitor standing behavior associated with estrus. Days to initial mP4 rise (30.2, 32.6 and 31.1 d for C, D, and 4P) and first standing activity (47.4, 47.1 and 53.5 d for C, D, and 4P) were not different between groups. Number of standing events and duration of estrus did not differ between groups but did increase from the first estrus, 2.7 mounts during 2:25 h, to 4.1 mounts during 4:08 h for the second estrus. Milk yield was also not influenced by either mineral supplementation or drenching with a mixture of calcium propionate, propylene glycol and mineral salts.

Key Words: Ovarian activity, Trace minerals, Dairy cattle

1059 Effects of experimentally-induced clinical mastitis during the preovulatory period on endocrine function, follicular growth and ovulation in lactating dairy cows. M.E. Hockett^{*1}, N.R. Rohrbach, R.A. Almeida, S.P. Oliver, and F.N. Schrick, ¹The University of Tennessee, Knoxville, Tennessee.

The objective of the study was to determine if experimentally-induced clinical mastitis prior to ovulation altered endocrine function, follicular growth, and ovulation. On day 8 of a synchronized estrous cycle, primiparous and multiparous Jersey cows (days 60 to 90 in milk) were challenged with *Streptococcus uberis*. Prostaglandin (PG; Lutalyse, 25mg i.m.) was administered 4 d postchallenge. Forty-eight h after PG injection, blood samples were collected every 15 min for 8 h to determine LH pulse frequency and collection continued every 2 h until ovulation to determine cortisol, estradiol-17 β , and presence of LH surge. Ovaries were scanned by ultrasonography every 6 h to monitor ovulation. Cows developing clinical mastitis ($n = 12$) had elevated rectal temperatures, somatic cell counts, and mammary scores vs controls ($n = 12$; $P < 0.05$). Due to differences in expression of estrus, cows were subdivided into 4 groups: control, TRT-EST (infected cows that displayed estrus; $n = 4$), TRT-NOEST (infected cows that did not display estrus; $n = 8$), and NOMAS (cows that were inoculated with bacteria but did not develop mastitis; $n = 4$). Ovulation rate was higher for CON (100%), NOMAS (100%) and TRT-EST (100%) than for TRT-NOEST (0%) cows ($P < 0.0001$). Control, TRT-EST and NOMAS cows required similar time from PG to estrus and ovulation. Size of the ovulatory follicle (presumed ovulatory follicle in TRT-NOEST) was similar at ovulation for all groups (for TRT-NOEST mean time of ovulation for all other groups was used). Maximum concentrations of LH and LH pulse frequency were higher for CON, TRT-EST, and NOMAS compared to TRT-NOEST ($P = 0.0017$ and $P = 0.0011$, respectively). Concentrations of estradiol-17 β increased over time in CON, NOMAS, and TRT-EST cows, but did not increase in TRT-NOEST ($P < 0.0001$). Clinical mastitis before estrus may result in reduced reproductive performance by inhibition of estrous expression and ovulation through alterations in the hypothalamo-pituitary-ovarian axis.

Key Words: estradiol-17 β , luteinizing hormone, mastitis

1060 Effect of bST and reproductive management on reproductive and lactational performance of Holstein cows. J.E.P. Santos^{*1}, S.O. Juchem¹, R.L.A. Cerri¹, C. Dei², W.W. Thatcher³, and C. Bilby², ¹University of California Davis, ²Monsanto Company, ³University of Florida.

Holstein cows, 800, were blocked according to parity and milk production and randomly assigned to one of four treatments in a 2x2 factorial design at 37 \pm 3 DIM. Treatments consisted of either bST (B; 500 mg/14 d; Monsanto Co.) starting at 63 \pm 3 DIM or no bST (C), with cows submitted to insemination after either a timed artificial insemination (TAI) protocol or estrus detection (ED). Cows received two injections of PGF2a (Lutalyse, Pharmacia & Upjohn Co.) at 37 \pm 3 and 51 \pm 3 DIM. At 63 \pm 3 DIM, cows received an injection of GnRH (Factrel, Fort Dodge Inc.), followed 7 d later by PGF2a. Cows in the ED groups were inseminated after observed in estrus during the 7 d following the last PGF2a. Cows in the TAI treatments received a second GnRH injection 48 h after the last PGF2a and were inseminated 12 to 18 h later. Pregnancy was diagnosed by ultrasound at 303 d after AI and reconfirmed 14 d later by rectal palpation. Coccyeal blood was collected for progesterone analysis at the moment of the second PGF2a, first GnRH, and 48 h after the third PGF2a injections. Lactation performance was followed for the first 13510 DIM. Body condition was scored at 37 \pm 3, 73 \pm 3, and 103 \pm 3 DIM. Continuous and binomial data were analyzed using the PROC MIXED and the LOGISTIC procedures of SAS, respectively. Preliminary data from 249 cows are presented. Treatment with bST increased yields (kg/d) of milk (44.8 vs 41.1; $P < 0.05$) and tended to increase yields of 3.5% FCM (44.6 vs 41.1, $P < 0.06$), fat (1.55 vs 1.44; $P < 0.08$), and true protein (1.28 vs 1.19; $P < 0.10$) during the first 135 DIM. Estrus detection rate for cows in the ED groups was similar for B and C cows (88.1 vs 87.2%; $P < 0.98$). Body condition score was similar for B and C cows (3.22 vs 3.21; $P < 0.84$). Conception rate at d 30 after AI was, respectively, 58.1, 46.7, 45.9, and 40.6% for EDB, EDC, TAIB, and TAIC, and it tended to be higher for EDB than TAIC ($P < 0.07$). Pregnancy rate at d 30 after AI was 43.9, 35.0, 45.9, and 40.6%, for EDB, EDC, TAIB, and TAIC, respectively; and pregnancy loss from d 30 to 44 after AI was 9.5, 16.7, 15.0, and 22.2% for EDB, EDC, TAIB, and TAIC, respectively.

Key Words: Bovine somatotropin, Reproductive management, Milk production

1061 Effect of resynchronization with GnRH on day 21 after artificial insemination on conception rate and pregnancy loss in lactating dairy cows. R.C. Chebel^{*1}, J.E.P. Santos¹, S.O. Juchem¹, R.L.A. Cerri¹, K.N. Galvao¹, and W.W. Thatcher², ¹University of California Davis, ²University of Florida.

Holstein cows on two commercial dairy farms were artificially inseminated 21 d prior to the date of enrollment in the study. Cows (585) were assigned to one of two treatments in a randomized complete block design. At the beginning of the study, DIM, milk and BCS were all similar between treatments ($P > 0.15$). At dairy 2 all cows received bST every 14 d, starting at 655 DIM. Treatments consisted of either resynchronization (RES) with an injection of 100 ug of GnRH (Merial Ltd.) or no treatment (Control, CON) on d 21 after AI (study day 0). On study day 7 pregnancy was diagnosed by ultrasonography and reconfirmed 14 d later by palpation. Cows diagnosed as non-pregnant at study day 7 in the RES and CON groups received an injection of PGF2a (Pharmacia & Upjohn Co.) or GnRH, respectively. The Ovsynch protocol was then finalized in both treatment groups. Ultrasonography of the ovaries was performed at study days 0 and 7. A coccyeal blood sample was collected at the moment of enrollment in the study for measurements of plasma progesterone, and BCS was taken at the same time. Plasma progesterone above 2.3 ng/ml was indicative of pregnancy at d 21. Continuous and binomial data were analyzed by the GLM and LOGISTIC procedures of SAS, respectively. First service conception for RES and CON was similar at d 28 (33.1 vs 33.6%, $P < 0.80$) and 42 (27.0 vs 26.8%; $P < 0.98$) after the initial AI. Progesterone concentration on d 21 affected conception rate at d 28 ($P < 0.0001$). Plasma progesterone on d 21 in cows classified pregnant was higher for cows that maintained pregnancy from d 21 to d 28 (11.9 vs 10.7 ng/ml; $P < 0.03$) and to d 42 (11.9 vs 10.9 ng/ml; $P < 0.07$). Pregnancy loss from d 28 to 42 averaged 17.0% and it was similar for RES and CON ($P < 0.74$). Conception rates in the subsequent AI were 28.0% and 26.5% for RES and CON ($P < 0.77$). Pre-treatment with GnRH at day 21 after AI did not affect conception rates to either first service or the re-synchronized

second service. Use of GnRH for resynchronization of open cows prior to pregnancy diagnosis permits an earlier programmed re-insemination of open cows.

Key Words: Reproduction, Pregnancy loss, GnRH

1062 Path analysis of metabolic and endocrine risk factors for repeat breeder cows. N. Moss^{1,2}, I.J. Lean^{*1,2}, S.W.J. Reid³, and D.R.H. Hodgson², ¹*Bovine Research Australasia*, ²*University Of Sydney*, ³*University of Glasgow*.

We investigated interactions between metabolic and endocrine factors at first insemination and conception requiring > 1 (CONC>1) and > 2 insemination (CONC>2) in a prospective cohort study. Holstein cows (n=709:224 primiparous; 485 multiparous) from 7 non-seasonal calving herds in NSW and 3 seasonal calving herds in Victoria, Australia were used. Herds were principally pasture-fed, supplemented with concentrates and conserved forages. Mean milk production at first service was 30.5 L (inter-herd range 24.5-36.5 L). Biographic and disease data were collected. Cows were body condition scored within 10 days before calving and again at first insemination. Cows were blood sampled at first insemination. Serum albumin, total protein, calcium, phosphorus, urea, NEFA, cholesterol and BOHB and plasma concentrations of glucose, progesterone and LH were determined. Pregnancy was determined 45-75 days after last insemination.

Path analysis was used to determine relationships between explanatory variables and CONC>2. Much of the variability in CONC>2 was explained by CONC>1. Other key pathways (all P<0.1) included: i) CONC>2 in the previous lactation, through extended dry periods (odds ratio (OR)= 9.35), and CONC>1 (OR=2.27); ii) CONC>2 in the previous lactation resulting in higher BCS at calving ($\beta=0.15$) leading to increased BCS loss between calving and first insemination ($\beta=0.84$), lower blood albumin (OR=1.53) and higher BOHB, through lower blood glucose (OR=0.46) at first service, and CONC>1 (OR=1.16); iii) Parity>5 leading to low BCS at first service (OR=3.39) resulting in low serum cholesterol (OR=2.15) and CONC>1 (OR=1.61); iv) Periparturient disease increasing BOHB ($\beta=0.67$) and risk of low albumin (OR=1.62) at first service, both increasing milk fat:protein at first service ($\beta=0.22$, $\beta=0.50$) which in turn directly increased risk of CONC>2 (OR=1.07). Of the final model, 43% of the explained variability in CONC>1 was accounted for by metabolites that reflect negative nutrient balance.

Key Words: Repeat Breeder, Path Analysis, Nutrition

1063 Comparison of Ovsynch vs estrous detection in anovulatory and ovulatory lactating dairy cows. A. Guemen*, J. N. Guenther, and M. C. Wiltbank, *Department of Dairy Science, University of Wisconsin-Madison*.

Transrectal ultrasonography was used to determine the percentage of anovulatory cows and the maximal size of anovulatory follicles in lactating dairy cows (n = 316) in a commercial dairy. Ovaries were evaluated at 47-53 d postpartum (pp) and again 7 d (54-60d pp) later. A total of 20.2% (64 of 316) of cows were anovulatory with no detectable luteal tissue by ultrasonography or circulating progesterone. A greater (P<0.01) percentage of primiparous cows were anovulatory than multiparous cows (28% vs. 15%, respectively). Most (78%) anovulatory cows had large follicles (> 15 mm diameter) with 22% having smaller follicles (9-14 mm). Only 20% of anovulatory cows would be considered cystic (follicles > 25 mm) with most (58%) anovulatory cows having follicles larger than normal ovulatory size but not cystic (15-25 mm). In the second part of this study ovulatory and anovulatory cows were randomly assigned to be bred by normal detection of estrus (visual detection and Kamar device) during the next 21 days or to receive the Ovsynch protocol (GnRH-7d- PGF-2d-GnRH) and timed AI (16-18 h after 2nd GnRH). Cows had ovaries scanned weekly during the 21 d time period to detect ovulations. Of the anovulatory cows receiving Ovsynch, 88% (29/33) ovulated to the first GnRH and 94% (31/33) ovulated to the second GnRH as compared to 42% (13 of 31) spontaneous ovulation of anovulatory cows assigned to the estrous detection group. Conception rate (CR) was similar in the Ovsynch and estrous detection groups for ovulatory (37% [43/117], 39% [38/97] respectively) or anovulatory cows (10% [3/30], 22% [2/9] respectively). Pregnancy rate also was not different for Ovsynch and estrous detection groups for ovulatory (37% [43/117], 28% [38/135] respectively) and anovulatory cows (10% [3/30], 6% [2/31] respectively). Thus, 20% of lactating dairy cows were not cycling at 60 d pp with most having follicles larger than ovulatory size

but generally not cystic size. Most (94%) of these anovulatory cows ovulated following Ovsynch but had lower CR than ovulatory cows.

Key Words: Avovulatory, Ovsynch, Dairy cows

1064 Estradiol cypionate in postpartum dairy cattle: effect on reproduction and milk production. J. M. Haughian*, R. Sartori, A. Gümen, J. N. Guenther, and M. C. Wiltbank, *University of Wisconsin, Madison*.

Estradiol cypionate (ECP) is a long-acting estradiol-17 β commonly used as a uterine evacuant to treat calving-related uterine disorders in lactating dairy cattle. There is evidence to suggest that ECP treatment may inhibit postpartum (PP) follicle development and delay the time to first ovulation. This trial, conducted on a 1200-cow commercial dairy, was designed to evaluate the effect of administering ECP in the early PP period on cycling status (cycling or anovulatory) at 30 to 40 d PP, reproductive efficiency, and milk production in lactating dairy cattle. Lactating Holstein cows were divided by parity, primiparous (n = 159) and multiparous (n = 97); then randomized for treatment with 0, 4, or 10 mg of ECP on d 5 to 8 PP. Cycling status was determined by two ultrasound examinations, the first at 30 to 33 d PP and the second 7 d later. Individual reproduction records and daily milk yield values from 10 to 90 d PP were also analyzed. Treatment with ECP had no effect on the percentage of anovulatory primiparous cows (18.3% overall) at 40 d PP; however, a greater percentage of multiparous cows treated with 10 mg of ECP were anovulatory (48%) at 40 d PP compared to cows treated with 0 mg (13%) and 4 mg (26%). Days to first service and days to conception were not different amongst treatment groups. Daily milk yield for primiparous cows treated with 0 mg was 4.2% and 4.5% greater than 4 and 10 mg treatments, respectively. Multiparous cows treated with 4 mg of ECP had 10.1% and 4.3% greater milk yield compared to 0 and 10 mg treatments, respectively, and cows treated with 10 mg had 4.1% greater milk yield than 0 mg. In summary, cycling status of primiparous cows, days to first service, and days to conception were unaffected by ECP treatment; however, ECP increased the percentage of multiparous cows that were anovulatory at 40 d PP. Surprisingly, early PP treatment with ECP had a significant positive or negative effect on milk yield depending on parity of the cow receiving treatment.

Key Words: ECP, Postpartum cows, Milk yield

1065 Factors affecting the intensity and duration of estrus of Holstein and Jersey cattle. R. L. Nebel*, J. H. Bame, and R. E. Pearson, *Virginia Polytechnic Institute and State University, Blacksburg, VA/USA*.

Estrous behavior of lactating cows and heifers as measured by a radiotelemetric system (HeatWatch®, DDx Inc., Denver, CO) was monitored over a 7 yr period (October 1994 to January 2002). The system provides 24-hour, totally automated surveillance of mounting activity. Individual characteristics associated with estrus recorded by the system were time and duration of each standing event (STD). Duration of estrus, defined as the time interval from first to last STD, and number of STD for heifers, cows, and combined were analyzed with models that included combinations of breed, parity (heifer vs. cow or 1, 2, or 3+), year, season, time of day at onset, selected interactions and regression on summit milk. Least squares means and SE are presented. Duration averaged 7.3 \pm 0.2 h for Holstein cows (n = 977), 8.9 \pm 0.3 h for Jersey cows (n = 423), 10.6 \pm 0.3 h for Holstein heifers (n = 406), 12.6 \pm 0.5 h for Jersey heifers (n = 185). Jerseys had extended estrus periods and heifers exhibited estrus approximately 40% longer than cows (P \leq 0.01). For both heifers and cows, time of day that the onset of estrus occurred influenced the duration of estrus (P \leq 0.05). STD for Jersey heifers averaged 27.4 \pm 0.9 vs. 17.0 \pm 0.6 for Holstein heifers (P \leq 0.01). For heifers, spring and fall were similar with 24 STD; whereas, winter and summer were similar with 18 STD (P \leq 0.01). Time of day of onset of estrus influenced the number of STD for heifers and ranged from 17.8 when first STD occurred between 15:00 and 18:00 to 27.2 when onset occurred between 03:00 and 06:00 (P \leq 0.01). Summit milk yield was inversely related to STD (P \leq 0.01). Season and occurrence of the onset of activity did not affect STD for cows. STD per estrus ranged from 32.7 \pm 1.2 for Jersey heifers during the fall season to 5.7 \pm 0.8 for Holstein cows during the summer. Seasonal effect on STD were revealed

for heifers but not for cows and was probably due to our ability to keep cows cool and experiencing less heat stress during the summer.

Key Words: Dairy cattle, Estrous behavior, Radiotelemetry

1066 Synchronization of estrus in dairy heifers using GnRH, PGF_{2α} and ECP. H. Rivera* and P.M. Fricke, *University of Wisconsin-Madison.*

In a preliminary trial, cycling Holstein heifers (n=12) received GnRH (100 µg) at a random stage of the estrous cycle followed by PGF_{2α} (PGF; 25 mg) 6 d later. Proportion of heifers in estrus by 24, 48, 72, and 96 h after PGF was 2/12, 2/12, 6/12, and 1/12, respectively, with one heifer not displaying estrus. To assess the effect of ECP on timing of estrus and ovulation, cycling Holstein heifers (n=24) were randomly assigned to receive either GnRH (100 µg) at a random stage of the estrous cycle followed by PGF (25 mg) 6 d later (GP) or GnRH and PGF as per GP heifers with the addition of estradiol cypionate (ECP; 0.5 mg) 24 h after PGF (GPE). Timing of estrus was assessed using Kamar devices, and timing of ovulation was assessed by ultrasound examinations conducted every 6 h after Kamar activation. Overall, 50.0% (12/24) of heifers ovulated within 48 h after GnRH. Follicle diameter at GnRH was greater (p<0.01) for ovulatory vs. nonovulatory follicles (11.9 ± 0.5 vs. 7.6 ± 0.8 mm), and 4 nonovulatory heifers displayed estrus after GnRH but before PGF. Based on serum progesterone, 83.3% (20/24) of heifers had a functional CL at PGF; 90.0% (18/20) of functional CL regressed and 16.7% (2/12) of GnRH-induced CL failed to regress. Overall, 66.7% (16/24) of heifers displayed estrus within 3 d after PGF, and interval from PGF to estrus (47.3 ± 2.6 vs. 51.0 ± 2.8 h) and ovulation (76.5 ± 2.7 vs. 84.0 ± 4.4 h) did not differ between GP and GPE heifers, respectively. Although diameter of ovulatory follicles at PGF did not differ between treatments (10.7 ± 0.6 vs. 9.9 ± 0.9 mm for GP vs. GPE, respectively), diameter of ovulatory follicles 6 h before ovulation tended to be greater (p=0.06) for GP (13.7 ± 0.5 mm) than for GPE (12.1 ± 0.7 mm) heifers. Diameter of ovulatory follicles at PGF was negatively correlated (p<0.01) with time from PGF to ovulation (r = -0.72). Characterization of follicular and luteal responses and timing of estrus and ovulation after GnRH and PGF will support development of a fixed-time AI protocol for dairy heifers. *Supported by Hatch project WIS04431.*

Key Words: Dairy Heifers, Synchronization of estrus

1067 Pregnancy rates to a timed insemination protocol using estradiol cypionate or GnRH in Holstein heifers and cows. J.D. Ambrose*, J.P. Kastelic², and R. Rajamahendran³, ¹*Alberta Agriculture Food and Rural Development, Edmonton*, ²*Agriculture Agri-Food Canada, Lethbridge*, ³*University of British Columbia, Vancouver, Canada.*

Three experiments were conducted using estradiol cypionate (ECP) and GnRH for synchronizing ovulation. In Experiment I, 19 pubertal heifers received (Day 0 of the experiment) an intravaginal CIDR-device and im injections of: 1) 0.5 mg ECP (n=6); 2) 100µg GnRH (Fertiline, n=6); or 3) 2 mL saline (n=7). All heifers received 25 mg PGF_{2α} (Lutalyse) im on Day 7 and the CIDR was removed on Day 8. Heifers given ECP on Day 0 received a second injection (0.5 mg) at CIDR-removal; those given GnRH or saline received their respective second injections on Day 9. Interval to establishment of a dominant follicle (6.3, 5.2, 5.7 d), its maximum diameter (13.9, 13.9, 15.3 mm), synchronized ovulation rate (100, 100, 86%), and mean interval from CIDR removal to ovulation (66, 56, 70 h; range 48-84, 48-60, 60-72) were not significantly different among ECP, GnRH and saline groups, respectively. Mean interval to the LH peak (after the second injection of ECP, GnRH or saline) was 38.1, 1.6 and 20.0 h (p<0.01) and peak LH concentrations were 9.3, 11.3 and 10.3 ng/mL (p>0.05). In Experiment II, pubertal heifers were given a CIDR and randomly assigned to receive ECP (n=53) or GnRH (n=59) treatments as in Experiment I. Timed-AI was done 44 or 16 h after the second injection of ECP or GnRH, and pregnancy rates (32 d) were 66.0 and 61.0%, respectively. In Experiment III, lactating cows (n=112) were given 100µg GnRH (Day 0), 500 µg cloprostenol (Estrumate, Day 7) and were alternately allocated to receive either 1 mg ECP on Day 8 (and AI 44 h later) or 100µg GnRH on Day 9 (and AI 16 h later). Pregnancy rates (40 d) were 23.5 and 33.3%, respectively (p>0.25). In conclusion, in CIDR-based protocols in heifers, ECP and GnRH effectively synchronized wave emergence and ovulation and resulted in acceptable fertility. However, substitution of ECP for the second GnRH in

an Ovsynch/timed-AI program in cows resulted in numerically lower pregnancy rates.

Key Words: ECP, CIDR, Timed Insemination

1068 Induction of a new follicular wave in holstein heifers synchronized with norgestomet. F.E.O. Garacia*^{1,2}, M.J.L. Cordero¹, E.A. Hizarza¹, O.J.G. Peralta¹, C.M.E. Ortega¹, M. Cardenas⁴, C. G. Gutierrez³, and T.E.M.T. Sanchez¹, ¹*Colegio de Postgraduados*, ²*Universidad de Guadalajara*, ³*Universidad Nacional Autonoma de Mexico*, ⁴*Instituto Nacional de la Nutricion, Salvador Zubiran.*

In order to synchronize estrous cycle in bovine, progestin has been used at common doses, however in the absence of a corpus luteum this practice cause persistence of the dominant follicle and a decrease in fertility of the synchronized estrus. Our objectives were to induce a new follicular wave in heifers synchronized with norgestomet. Thirty Holstein heifers, presynchronized with two doses of PGF_{2α} 11 days apart, six days after estrus (day 0=estrus) received a norgestomet implant (SMB, 6 mg) and 25 mg of PGF_{2α} im. On day 12, heifers were randomly assigned to 5 treatments (n=6): T1 received a second norgestomet implant; T2, heifers received 100 mcg of GnRH im; T3, 200 mg of progesterone im; T4, saline and in T5 heifers received 100 mcg of GnRH on day 9, and implant removal on day 16 plus 25 mg of PGF_{2α} im. Ultrasound examination and blood samples were collected every 48 h from day 3 to 11 and every 24 h from day 11 to 21. Induction of a new follicular wave succeeded in 6/6, 0/6, 6/6, 6/6 and 6/6 in T1, T2, T3, T4 and T5, respectively. Ovulation occurred at 54.0 and 110.5 h, day of ovulation was 3.05 and 5.42 d after implant removal and the size of the ovulated follicle was 20.03 ± 2.03 and 16.13 ± 1.78 mm for heifers that developed a persistent follicle or a follicle from a new wave, independent from treatment (P<0.05). Progesterone concentration was <1 ng/ml during the treatment period in T1, T2, T3 and T4 and in T5 was >1 ng/ml on days 15 and 16. In T5 a new follicular wave, with signs of estrus and ovulation was induced in all heifers (6/6).

Key Words: Estrous Synchronization, Persistent Follicle, Progestin

1069 Effect of sodium azide and glucose on post-compaction development of in vitro produced bovine embryos. J. F. De La Torre-Sanchez* and G. E. Seidel Jr., *Colorado State University, Fort Collins, Colorado.*

When oxidative phosphorylation is partially down-regulated with sodium azide (NaN₃), an inhibitor of cytochrome oxidase a₃, there is a beneficial effect on in vitro development of bovine embryos. Our aim was to evaluate effects of various levels of NaN₃ at different glucose concentrations on post-compaction development of in vitro cultured bovine embryos. Abattoir oocytes were matured in TCM-199 and fertilized in a chemically defined medium with nonessential amino acids, 0.5% FAF BSA and heparin (CDM) in 0.5 ml wells at 39°C in 5% CO₂ in air. After fertilization, presumptive embryos were placed in culture in CDM for 2 d and then in CDM plus essential amino acids (CDM-2) for 2 more d, all in 5% CO₂/5% O₂/90% N₂. Compact morulae then were selected (n=1440) and randomly allocated (10 per subclass) to 16 treatments (0, 3, 9 and 27 µM NaN₃ x 0, 0.5, 2 and 8 µM glucose) for an additional 72 h in CDM-2; the experiment was replicated 3 times with semen from each of 3 bulls. Evaluations were performed at 36 and 72 h for % blastocysts, stage of development, morphological quality (scale of 1 to 4), degree of lightness as a measure of lipids (subjective scale of 1 to 5) and quality of the inner cell mass (scale of 1 to 4). Embryos then were fixed and stained to count cells. Wells were coded to make evaluations blind. Data were analyzed by factorial ANOVA, with factors NaN₃ (4), Glucose (4) and bulls (3). Embryos exposed to the highest dose of NaN₃ were brighter at 72 h (P<0.01) than embryos exposed to lower or no NaN₃. An interaction between NaN₃ and glucose for stage of development and quality at 36 h (P<0.05) was also observed; except for embryos in 3 µM NaN₃, all NaN₃ levels produced more advanced and better quality embryos when cultured in 2 µM, but not other levels of glucose. NaN₃ improved post-compaction development of in vitro produced embryos, especially with 2 µM glucose.

Key Words: Embryo, Glucose, Sodium azide

1070 Dynamic changes in body composition quality traits as influenced by sampling interval and handling in beef heifers. H. L. Evans^{*1}, S. T. Willard², R. King³, and R. C. Vann¹, ¹Brown Loam Branch Experiment Station, ²Mississippi State University, ³Designer Genes Technologies, Inc.

Age and weight are common criteria used to estimate onset of puberty in beef heifers, secondary metabolic characteristics, such as repartitioning of fat, may also influence reproduction in relation to stress and handling. The objective of this study was to determine whether fluctuations in percent intramuscular fat (%IMF) might be influenced by stress of handling and hormonal changes that occur during the estrous cycle in beef heifers. Crossbred beef heifers (n=26) were randomly assigned to two treatment groups; Intensive sampling (3X weekly; n=14) and Weekly sampling (1X; n=12). On D 0, cattle were weighed, assessed a reproductive tract and a body condition score, hip height measured, blood samples collected and all animals administered PGF2a (25mg i.m.; Pharmacia Upjohn). Sampling measurements consisted of real-time ultrasound for %IMF of the Longissimus muscle at the 11, 12 and 13th ribs, longissimus area, back fat thickness, rump fat thickness and glutueus medius depth using a 3.5 MHz 172mm transducer and Aloka 500V Ultrasound System. Carcass quality trait analysis and blood sampling were conducted from d 0 through d 28 post-PGF2a. Serum concentrations of progesterone (P₄) were determined by radioimmunoassay. Serum P₄ (P<0.05) profiles resembled those of normal estrous cycles and were consistent with heat detection data for both groups. Sampling treatment intervals did not contribute to fluctuations in %IMF or P₄ concentrations. Correlation of %IMF and stress score, a determination of IMF consistency, described a negative relationship (-0.63 to -0.38; P<0.06); thus as the stress score increased the consistency and percentage of IMF decreased. These data suggest no direct relationship between serum concentrations of P₄ (i.e., stage of estrous cycle) and %IMF. Stress of handling and sampling treatment intervals resulted in minimal impact on hormonal and %IMF fluctuations.

Key Words: IMF, Beef Heifers, progesterone

1071 Use of melengestrol acetate for estrus synchronization in an artificial insemination program in ewe. F.W. Castonguay^{*1,2}, G. Leduc², and F. Goulet^{1,2}, ¹Agriculture and Agri-Food Canada, Lennoxville, Quebec, Canada, ²Depart. Sciences animales, Université Laval, Quebec, Québec, Canada.

The objective of this study was to evaluate the potential of melengestrol acetate (MGA), an orally active progestagen, for estrus synchronization in an artificial insemination (AI) program. Two experiments were conducted in anoestrous season (May) to 1) determine the time of the LH peak in ewes synchronized with MGA and 2) evaluate the fertility rate of the ewes inseminated following estrus synchronization with MGA. In the first experiment, a total of 24 Canadian Arcott ewes received a daily oral dose of 0.25 mg/hd or 0.40 mg/hd of MGA for 12 d. Blood samples were collected every 4 h from 36 h to 96 h after the last feeding of MGA. Serum samples were analyzed for LH by radioimmunoassay. Three ewes did not show a LH peak during the sampling period. The mean interval between the last dose of MGA and LH peak was not different for the ewes treated with 0.25 (60.0±13.6 h) or 0.40 mg/hd/d (64.0±12.6 h) of MGA. The time of onset of the LH peaks varied from 44 h to 84 h. This information was used to determine the insemination time for experiment 2. In the second experiment, 81 Dorset ewes were assigned to one of three synchronization treatments: T1) vaginal progestagen sponge for 14 d + 500 I.U. PMSG at sponge withdrawal (control group, n=21); T2) 0.25 mg/hd/d MGA for 12 d + 500 I.U. PMSG 12 h after the last feeding of MGA (n=20); T3) 0.25 mg/hd/d MGA for 12 d + 500 I.U. PMSG 12 h after cessation of MGA feeding followed by 50 ug GnRH 60 h after the last dose of MGA (n=40). Ewes were inseminated with fresh semen 55 h after removal of the vaginal sponge (T1) or 76 h after the last feeding of MGA for T2 and T3. Lambing rate to timed AI were not different between the three treatment groups (42.9, 45.0 and 45.0% for T1, T2 and T3, respectively). In conclusion, MGA could replace the traditional vaginal sponge treatment for estrus synchronization in AI program in sheep.

Key Words: Ewe, Insemination, MGA

1072 Synchronization of estrus with SucroMate-D bovine and prostaglandin F2α in beef heifers. P. Ryan^{*1}, S. Willard¹, B. Gandy¹, S. Bowers¹, P. Burns², and B. Simon², ¹Mississippi State University, Mississippi State, MS, ²Thorn BioScience Inc., Lexington, KY.

SucroMate-D Bovine (SMD) is a parenteral formulation of deslorelin acetate designed to synchronize estrus in beef cattle when administered 7 d prior to administration of PGF2α (PG). The objective of this study was to determine the interval to estrus among beef heifers given 1 mL of SMD (50 µg/mL deslorelin acetate im) at 7 d before administration of Lutalyse (25 mg Dinoprost im) for comparison with controls given SMD vehicle and PG. Beginning at random stages of the estrous cycle, 76 heifers (Hereford, Angus and Charolais; weight >340 kg; age 14-16 mo.; and uterine score 3+ on a scale of 1-5) were assigned at random to be given SMD + PG 7 d later (n = 38) or SMD vehicle + PG 7 d later (n = 38). Daily observations for estrus beginning 30 days prior to treatment were supplemented using HeatWatch[®]. Fifty-two heifers had shown estrus before treatments commenced, while six showed no signs of estrus throughout the trial. Heifers were artificially inseminated (AI) after estrous detection using the am/pm rule. Heifers returning to estrus were inseminated again. Pregnancy diagnoses were made on d 35 and confirmed on d 55 after the first AI using transrectal ultrasonography. Twenty-nine heifers (76%) given SMD and 17 (45%) controls showed estrus within 72-h after PG (P < 0.05). These heifers had a first service conception rate of 76% and 69%, respectively (P > 0.10), and a pregnancy rate of 58% and 29%, respectively (P < 0.01). For the 30-day interval post-PG, the estrous detection rate, first service conception and pregnancy rates were 84%, 81% and 71% for SMD treated heifers and 87% (P > 0.10), 68% (P < 0.05) and 61% (P > 0.10) for controls, respectively. Efficiency of estrous detection by visual observation and HeatWatch[®] did not differ (P > 0.10). We conclude that, by comparison with PG controls, SMD + PG enhanced the synchrony of estrus and increased the pregnancy rate of beef heifers inseminated during a 72-h period after PG.

Key Words: Estrus synchronization, Beef heifers, Deslorelin acetate

1073 Induced twinning in postpartum suckled beef cows using artificial insemination and embryo transfer. G. C. Lamb¹, D. R. Brown¹, C. R. Dahlen^{*1}, and A. R. Spell², ¹University of Minnesota, Grand Rapids, MN, ²Cyagra LLC., Manhattan, KS.

The objectives of this experiment were to determine whether transferring an embryo into a cow after timed insemination would increase fertility and twinning rates. One hundred and forty four suckled beef cows were fed MGA (0.5 mg/head/d) for 7 d with a 25 mg injection of PGF on the last day of MGA (d -11). Cows received an injection of GnRH 4 d after PGF (d -7) and a second injection of PGF 11 d after the last day of MGA (d 0). Forty-eight hours later (d +2) all cows received a second injection of GnRH and were assigned randomly to three treatments: 1) on d +2 cows received one fixed time AI (AI; n = 48); 2) on d +9 cows received a direct transfer embryo placed in the uterine horn ipsilateral to the ovary containing a CL (TWIN; n = 48); and, 3) cows received a fixed-time insemination on d +2 and an embryo on d +9 (ET; n = 48). Ultrasonography was used to monitor follicle diameter on d +2, CL diameter on d +9 and to determine the presence of an embryo at 30 to 35 d after insemination. Pregnancy rates were greater (P < 0.05) for TWIN (54%) and AI (48%) than for ET (27%) treated cows. Of the 26 pregnant cows in the TWIN treatment 4 were twin pregnancies, whereas there were no twin pregnancies in either the AI or ET treatment. As a result, TWIN cows (64%) had more (P < 0.05) fetuses as a percentage of all treated cows than AI (48%) or ET (27%) treated cows. Pregnancy rates were greater (P < 0.05) in primiparous (56%) than multiparous cows (38%), but days postpartum on d 0 also were greater (P < 0.01) for primiparous (83 d) than multiparous (67 d) cows. Days postpartum was not correlated to CL or follicle size but was correlated (P < 0.01) to overall pregnancy rates (0.22). Corpus luteum diameter determined by ultrasound was correlated (P < 0.01) to CL score (-0.24); however, CL score was not correlated to embryo transfer pregnancy rates. We conclude that transferring an embryo into a cow after timed-AI increased twinning rates and overall pregnancy rates.

Key Words: Twinning, Artificial Insemination, Embryo Transfer

1074 Effects of calf removal on the diameter of the dominant follicles and on ovulation rates at GnRH and Estradiol Benzoate injections in anestrous Nelore cows. J.L.M. Vasconcelos*, E.R. Vilela, A.H. Souza, M. Meneghetti, and N. Ferreira Jr., *FMVZ-UNESP, Botucatu, SP, Brazil.*

This study was designed to evaluate whether CR (48h) prior to GnRH (100mcg) and/or after PGF $_{2\alpha}$ (25mg) injections in a protocol for synchronization of ovulation (GnRH-7 days-PGF $_{2\alpha}$ -24h-EB-24h-AI) results in larger dominant follicles (DF) and improves ovulation rates at GnRH and EB (1mg) injections. Cows were considered anestrous (n=99) if progesterone (P $_4$) was under 1.5ng/ml at 10d before and at the time of GnRH and suffered or not CR before GnRH and between PGF $_{2\alpha}$ and AI, in a 2 x 2 factorial. Ovarian morphology was evaluated by ultrasound to determine diameter of the DF and ovulation rates to GnRH and EB. Data were analyzed by logistic regression and ANOVA in SAS. Size of DF at day of GnRH injection was influenced (P<0.05) by CR and BCS (scale 1 to 5) and was 10.5 \pm 0.2mm (n=48) and 9.9 \pm 0.2mm (n=51) in cows with and without CR, and 9.8 \pm 0.3mm (n=37) and 10.5 \pm 0.2mm (n=62) in cows with BCS \leq 3 or >3. More cows with CR before GnRH ovulated (P<0.01; 83%) when compared with cows without CR (48%). Size of DF in cows that ovulated at GnRH was larger (P<0.05) than cows that did not ovulate (n=66; 10.6 \pm 0.2mm vs. 9.6 \pm 0.3mm, n=33). Size of DF at time of AI was influenced (P<0.01) by ovulation to GnRH and was 10.8 \pm 0.2mm (n=66) or 9.8 \pm 0.3mm (n=33) in cows with and without ovulation to GnRH, and by BCS (P<0.05, 9.9 \pm 0.3mm, n=37 and 10.8 \pm 0.2mm, n=62) in cows with BCS \leq 3 or >3. Ovulation to EB was influenced by CR (P<0.05, 77 with vs. 55% without CR), and size of DF at time of AI (P<0.01, 11.1 \pm 0.1mm, n=68 and 9.5 \pm 0.4mm, n=31) in ovulating and non ovulating cows. Interestingly, BCS did not influence ovulation to GnRH (P>0.10, 59 vs. 73%), but influenced ovulation to EB (P<0.05, 55 vs. 77%) in cows with BCS \leq 3 or >3, respectively. These data show that CR is an important tool that may be applied to increase ovulation rates in TAI protocol in anestrous Nelore cows through increases in size and persistence of the DF. In lower BCS (\leq 3) cows, GnRH had higher efficiency than EB.

Key Words: Calf Removal, Nelore cows, Anestrous

1075 Effect of PGF $_{2\alpha}$ timing on the reproductive performance of beef cows treated with CIDR-B and estradiol benzoate. A.T. Estrada*, J. Walton, K. Bateman, and W.H. Johnson, *University of Guelph, Guelph, Ontario, Canada.*

An effective ovulation synchronization program will result in acceptable conception rates following fixed-time artificial insemination (FTAI). The objective of this study was to compare the effect of PGF $_{2\alpha}$ timing in a FTAI synchronization protocol. Crossbreed beef cows (n= 154) and heifers (n= 71) were randomly assigned to one of two synchronization protocols and managed in spring and fall breeding groups. On Day 0, all animals received a CIDR-B device (Vetrepharm Canada Inc, London, ON) and 1 mg of estradiol benzoate (EB) plus 100 mg progesterone (P $_4$) (Veterinary Pharmacy, Guelph, ON). Treatment 1 animals received 25 mg of dinoprost (PGF $_{2\alpha}$, Lutalyse, Pharmacia & Upjohn, Orangeville, ON) on Day 6 and Treatment 2 on Day 7. CIDR-B devices were removed from all animals on Day 7. On Day 8, all animals received 1 mg of EB, and FTAI was performed 52 hrs after CIDR-B removal. Pregnancy diagnosis was determined by ultrasonography at

day 35 after FTAI. Conception rates were analyzed by chi-square test. Conception rates for Treatment 1 in the spring breeding group were; cows 74%(31/42), heifers 48%(10/21) and in the fall breeding group; cows 73%(27/37), heifers 81%(13/16). Conception rates for Treatment 2 spring breeding group were; cows 74%(28/38), heifers 55%(11/20) and in the fall breeding group; cows 68%(25/37) and heifers 57%(8/14). The conception rate for heifers in the spring breeding group was different when compared within Treatment 1 (p<0.05). There were no significant differences among treatments and within Treatment 2. Results indicate that administering PGF $_{2\alpha}$ on Day 6 or Day 7 of the program yielded similar conception rates and are equally effective in synchronizing ovulation for fixed-time artificial insemination. Treatment 2 reduces from 5 to 4 the number of times animals need to be handled.

Key Words: CIDR-B, Fixed-time, Synchronization

1076 Induction of ovulation in dairy cattle with a deslorelin implant. JA Bartolome*¹, JEP Santos², SM Pancarci¹, P Melendez¹, ACM Artech¹, O Hernandez¹, LF Archbald¹, TE Trigg³, and WW Thatcher¹, ¹University of Florida, Gainesville, Florida, ²University of California, Davis, California, ³Peptech Animal Health, North Ryde, Australia.

Progesterone (P $_4$) and estradiol influence embryo survival. Objective was to evaluate ovarian function after inducing ovulation with 450, 750 and 1000 μ g of Deslorelin in nonlactating cows and heifers. Animals received GnRH (100 μ g, im) on d -9, and 2 doses of PGF $_{2\alpha}$ (25 mg, im, 8 h apart) on d -2. Exp. 1: On d 0, cows (n=20) received either 100 μ g (im) GnRH (Control, n=6) or Deslorelin implants (sq) of 750 (DES 750, n=7) or 1000 (DES 1000, n=7) μ g. Exp. 2: On d 0, cows (n=23) received 100 μ g of GnRH (Control, n=8), or a 450 μ g Deslorelin implant (DES 450, n=6). In experiments 1 and 2, cows received PGF $_{2\alpha}$ on d 16. Ultrasonography and blood sampling for P $_4$ were used to monitor ovarian activity. Exp. 3: On d 0, heifers (n=44) received either 100 μ g of GnRH (Control, n=22) or 750 μ g of Deslorelin implant (DES 750, n=22). On d 16, all heifers received PGF $_{2\alpha}$. Blood samples were collected on d 7, 13, and 16. Exp. 1: P $_4$ (ng/ml) from d 0 to d 16 was not different between Control (5.9 \pm 0.6), DES 750 (6.4 \pm 0.6), and DES 1000 (6.3 \pm 0.6). P $_4$ was higher on d 11 for DES 1000 (11.1 \pm 1.0) compared to Control (8.2 \pm 1.1; P<0.05) and on d 12 for DES 750 (12.4 \pm 1.0) compared to Control (9.0 \pm 1.1; P<0.05). The first-wave dominant follicle (mm) was larger (P<0.02) for Control (9.48 \pm 1.1) compared to DES 1000 (4.92 \pm 1.0) and not different from DES 750 (7.82 \pm 1.0). The largest follicle from d 16 to d 20 was greater (P<0.001) in Control (16.1 \pm 0.9) compared to DES 750 (6.3 \pm 0.8) and DES 1000 (4.7 \pm 0.8). Exp. 2: Average P $_4$ did not differ between Control (5.9 \pm 0.80) and DES 450 (7.4 \pm 1.0). P $_4$ tended to be higher (P<0.10) on d 9 in DES 450 (11.4 \pm 1.5 > 8.0 \pm 1.2) and was higher (P<0.05) on d 10 (13.0 \pm 1.5 > 8.2 \pm 1.2). The first-wave dominant follicle was larger (P<0.01) for Control (11.4 \pm 1.0 > 6.0 \pm 1.1 mm) as was the largest follicle from d 16 to d 28 (16.5 \pm 1.85 > 9.7 \pm 1.85 mm; P<0.001). Deslorelin cows of experiments 1 and 2 failed to ovulate by d 28. Exp. 3: Overall P $_4$ tended (P<0.07) to be higher for DES 750 (12.9 \pm 0.7) compared to Control (11.1 \pm 0.7). In conclusion, Deslorelin implants induced ovulation, stimulated development of a normal CL, and delayed follicular growth during diestrus.

Key Words: Ovulation, GnRH agonist, Ovarian function

Ruminant Nutrition Feedlot, Transition Cow, and Silage

1077 Effect of sugar cane level on intake, digestibility, and ruminal fermentation in crossbreed steers fed stargrass. E. Aranda¹, G.D. Mendoza*¹, C. Garcia-Bojalil¹, J.A. Ramos¹, F. Castrejon², and R. Rojo³, ¹Colegio de Postgraduados, Montecillo, Texcoco, Mexico, ²UNAM-FMVZ, Cd. Universitaria Mexico, D.F., Mexico, ³Universidad Autonoma de Guerrero, FMVZ-URCCH, Cuajinicuilapa, Gro. Mexico.

An experiment was conducted to study effects of sugar cane on ruminal fermentation and fiber digestion in crossbreed steers fed stargrass. Sugar cane (SC) and stargrass (SG) were fed together to four crossed (*Bos taurus* x *Bos indicus*) steers (455 kg BW) with ruminal cannulae. A Latin square design experiment was used, and treatments were levels

(0, 1, 2, and 3% of BW) of chopped sugar cane (with 1% urea), whereas stargrass was fed ad libitum. Steers received SC at 0800, SG at 1200 and 2 kg of a high-protein supplement (23.4% CP) at 1300. Intake of SG was reduced linearly (P < 0.05) as SC level increased. Ruminal digestibility of DM, CP, NDF and ADF did not change (P > 0.05), although they tended to increase with higher proportions of SC, which was reflected in a linear increase (P < 0.12) in total DM digestibility (54.0, 53.3, 57.6, 60.9%). In situ digestibilities of SG and SC, VFA, and molar proportions of VFA were not affected (P > 0.05) by treatments. Results indicated that sugar cane can be used as a complementary forage with stargrass,

showing a substitutive effect without altering ruminal fermentation or digestibility of the diet.

Key Words: Sugar cane, Stargrass, Ruminal fermentation

1078 Influence of level and method of supplementation on the utilization of supplemental tallow fatty by feedlot steers . R.A. Zinn¹ and A. Plascencia*², ¹University of California, Davis, ²Instituto de Investigaciones en Ciencias Veterinarias-UABC.

Crossbreed steer calves (n=228; 267 kg) were used in a growth-performance trial to determine the influence of level and method of supplementation on the utilization of supplemental tallow fatty acids (TFA) in high-energy diets for feedlot cattle. Three methods of fat supplementation (fat added directly to the grain, fat added directly to the hay, and fat added as the last step in the batch mixing) were compared at each of three levels of supplementation (3, 6, and 9% TFA). Adding fat directly to the grain, or as the last step in batch mixing had similar (P > 0.10) effects on growth performance. The addition of fat directly to the hay depressed DMI and ADG at the 3 and 9% levels of fat supplementation (fat level x method of supplementation interaction, P < 0.05). Method of fat supplementation did not affect (P > 0.10) dietary NE. Increasing the level of fat supplementation decreased (linear effect, P < 0.01) ADG, DMI, feed efficiency, and dietary NE. Observed/expected dietary NEm was 1.03 with 3% supplemental fat and declined to 0.90 with 9% supplemental fat. We conclude that the feeding value of TFA is proportional to total fatty acid intake. When total dietary fatty acid intake is less than 6%, the NE value of TFA is consistent with tabular values for tallow. At greater dietary fatty acid concentrations, energy intake, ADG, and the NE value of TFA will decrease. The addition of high levels of supplemental fat directly to the forage portion of the diet may depress DMI and hence, ADG.

Key Words: Cattle, Dietary fat, Performance

1079 Effect of exogenous addition of liquid enzyme on performance of feedlot cattle. O.G. Lozano*¹, J. Angulo², V.M. Basurto-Kuba³, P. Frumholtz³, and E. Vazquez¹, ¹Universidad Autonoma de Sinaloa, ²Ganadería Flexi, Culiacán Sinaloa, ³AgribRANDS Purina Cargill, México.

The objective was to determine the effect of dietary liquid enzyme on ADG and feed efficiency in commercial feedlot. A total of 786 male calves (crossed *Bos taurus* and *Bos indicus*) were used in a 148 d average growing/finishing trial. Cattle were allocated by initial weight; light (173 kg) and medium (208 kg). The treated group (247 head) and the control group (539 head) were placed in a replicated feedlot corrals. The treatment was the application of the enzyme Promote N.E.T. on to the final diet evenly with the liquid sprayed enzyme 2 g d⁻¹ per head (pure salt = 1 g d⁻¹ per head) diluted in water. The diet, 70% steam-flaked corn, was balanced equally and similarly for all animals throughout the experiment. The last 30 d of trial, the application of liquid enzyme was interrupted to all treated groups due to the use of Zilmax (clohydrate of Zilpaterol) in order to diminish the cost of diet. Data were analyzed using SAS as a complete randomized design blocked by weight. The results showed that using the liquid enzyme in commercial feedlot, there are a significant effect (P< 0.01) in ADG and feed efficiency (P< 0.01). The return on investment increased 3.5% for the treated group. Thus, using exogenous spraying of the liquid enzyme Promote N.E.T. on feedlot diets improved ADG and feed efficiency.

Item	Control	Enzyme	P<	SEM
Initial weight, kg	190.5	189.2		
Final weight, kg	390.8	408.8		
ADG, kg	1.318	1.515	0.01	0.02
DMI, kg	6.89	7.47	0.05	0.16
Feed efficiency ^a	5.23	4.92	0.01	0.05

^a Intake/Gain

Key Words: Feedlot performance, enzyme, Promote

1080 Effect of feeding diets containing corn grain with Roundup (event GA21 or NK603), control, or conventional varieties on steer feedlot performance and carcass characteristics. L.L. Berger*¹, N.D. Robbins¹, and E.P. Stainisiewski², ¹University of Illinois-Urbana, ²Monsanto Company, St. Louis, MO.

Two finishing trials were conducted to determine the effect of feeding genetically modified corn containing the Roundup Ready# trait (Trial 1: event GA21; Trial 2: event NK603) on performance and carcass characteristics of feedlot steers. In trial 1, 175 Angus-continental steers were used to compare corn diets, containing grain from DK626 Roundup Ready, DK626 (non-transgenic control), RX826, and RX730. Steers were allotted by weight into one of 25 pens, housing 7 animals/pen in a randomized complete block design. Steers were adjusted to a common finishing diet over a three-week period prior to feeding test corn diets. Final live weight was determined by dividing carcass weight by an average dressing percentage. Steers did not differ (P>0.05) in daily gain, feed intake, or feed efficiency (G:F), due to corn diet. There were no significant differences (P>0.05) in carcass characteristics. A cross section of the longissimus thoracis muscle was analyzed for moisture, protein, ash, and ether extract. Percent moisture was greater (P<0.05) for steers fed DK626 compared with other diets. In Trial 2, 196 Continental-cross steers were utilized to evaluate feedlot performance and carcass characteristics of steers fed a Roundup Ready corn hybrid with event NK603, non-transgenic control or two conventional hybrids, DK647 and RX740. Steers were allotted by weight to one of 28 pens, with 7 animals/pen. Trial 2 was conducted the same as Trial 1. Steers did not differ (P<0.05) in daily gain or feed efficiency due to corn diet. Steers fed RX740 had the highest DMI at 10.49 kg/d which was greater (P<0.05) than steers fed DK647, 9.92 kg/d. Steers fed control, 10.02 kg/d and NK603 corn, 10.18 kg/day, were intermediate. Carcass characteristics were not significantly different (P>0.05). We concluded that both Roundup Ready corn events (GA21 and NK603) had similar feeding value to non-transgenic corn for feedlot steers.

Key Words: Corn, Roundup Ready, Feedlot Performance

1081 Evaluation of a controlled-release capsule of n-alkanes for studies with ruminants. D.E. Oliveira*¹, M.Q. Manella¹, C. Boin¹, D.P.D Lanna¹, J.J.A.A. Demarchi², and G.F. Alleoni², ¹Esalq-USP, ²Instituto de Zootecnia.

The objective of this study was to evaluate the rate of release of n-dotriacontane C₃₂ and n-hexatriacontane C₃₆ n-alkanes from controlled-release capsules used as markers to estimate feed intake. Six ruminally-cannulated Nelore steers weighting 380 kg at 18 months were housed in metabolic cages and received diets with three different proportions of concentrate (20, 40 and 60%) ad libitum. Corn silage was the sole roughage source. Experiment lasted four weeks, with two steers per concentrate level. After one week of adaptation, one capsule containing 8g of each n-alkane (Alkane CRC for 300-650 kg Cattle - Captec, NZ) was administered intra-ruminally. The capsules were attached by a nylon string to the rumen cannula and removed 5 times for measurements on days, 3, 7, 10, 13 and 17 after start of incubation. Rate of plunger travel (mm/day) was determined with calipers and used as an estimate of n-alkanes release into rumen. One capsule from the same batch was opened and tablet thickness measurements taken. Mean tablet thickness was 10.3mm. Plunger travel were 2.55 (± 0.16), 2.52 (± 0.08), 2.59 (± 0.18), 2.56 (±0.17) and 2.91 (± 0.08) on days 3, 7, 10, 13 and 17, respectively. The data were analyzed by simple linear regression using the least-square method, with the model Y= b₀ + b₁X, where Y= plunger travel (PT, mm/day) and X= day after capsule incubation (DAI). There were no effects of diet (P>0.05) and the model and regression coefficient were linear (P≤0.0001). Coefficient of variation and residual standard deviation were 4.2% and ±0.85, respectively. The equation obtained was PT= 0.19 + 2.49DAI (r²= 0.99 and SEE= 0.049). For the suggested sampling period, the average plunger travel was 2.55mm (± 0.03), equivalent to an alkane release of 396mg/day. The Captec capsule label informs that the daily release of C₃₂ and C₃₆ n-alkanes is 400 mg/day. Based on the disappearance rate of the tablets our results are consistent to that figure.

Key Words: N-alkanes, Release rate, Feed intake

1082 Sites of digestion in steers fed fresh oats and supplement with flint or dent corn grain offered whole or ground. J.M. Grigera^{*1-2}, F.J. Santini¹⁻², and J.C. Elizalde¹⁻³, ¹Fac. Cs. Agrarias-UNMDP., ²INTA-Balcarce., ³CONICET, Argentina.

The objective of the experiment was to study the effect of supplementation with flint (F) or dent (D), offered whole (W) or ground (G) corn on site and extent of digestion of OM, starch, NDF, ADF and total nitrogen (TN) in steers fed fresh forage of winter oats (WO) (CP 20.4%, NDF 41.1 %). Five Holstein steers (300±30 kg) cannulated in rumen, duodenum, and ileum in a 5 × 5 Latin square design were used. The treatments were: WO = 100 % fresh forage, S = supplemented (1 % of BW) with corn: GD = ground dent, WD = whole dent, GF = ground flint, WF = whole flint. The animals were fed indoors every 8 h. Chromic oxide (Cr₂O₃) was used as external marker for digesta flow estimation. Contrasts were WO vs S, W vs G, F vs D, and GF vs WD. Ruminal digestibility of DM, starch, NDF, ADF, and NT was similar among treatments ($P>0.10$). Total tract OM digestibility was higher ($P<0.10$) for WO than S, for G than W ($P<0.10$), and for D than F ($P<0.10$), and ruminal digestion was higher for WO than S ($P<0.10$). Post-ruminal starch digestion was not affected by treatments ($P>0.10$). Total tract starch digestibility was higher ($P<0.10$) for G than W (89.3 vs 84.8 %), for D than F (89 vs. 85 %), and similar ($P>0.10$) between GF and WD (mean = 86.75). Ruminal pH was higher for WO than S ($P<0.10$), for F than D ($P<0.01$), for W than G ($P=0.08$), and for WD than GF ($P<0.01$). The efficiency of bacterial protein synthesis (g of bacterial N/Kg of OM truly fermented in rumen) was higher ($P<0.10$) for S than WO (23.1 vs 19.4; $P<0.10$) but duodenal flows of NAN nitrogen was similar (145 g/d vs 139.6 g/d; $P<0.10$) because of the lower ($P<0.10$) duodenal flows of dietary nitrogen (26.5 g/d vs 58 g/d) with the S treatments. Ruminal VFA were similar between treatments. Ruminal ammonia-N was lower for S than WO ($P=0.01$) and similar between S. Supplementing with ground corn to steers feed fresh oats slightly increased total starch digestion, and a similar trend was found between dent and flint corn. Consequently, it is possible to improve corn starch utilization by grain processing or by selecting the type of corn better adapted to animal nutrition.

Key Words: Fresh forage, Corn grain, Digestion

1083 Effect of linoleic or oleic acid-rich oils on ruminal fermentation, nutrient digestibility and performance of finishing cattle. A. N. Hristov*, L. R. Kennington, M. A. McGuire, C. W. Hunt, and J. K. Ropp, *Department of Animal and Veterinary Science, University of Idaho, Moscow, ID 83844-2330.*

Two trials were conducted to determine the effect of linoleic (LIN) or oleic (OLE) acid-rich oils on ruminal fermentation, nutrient digestion, and performance of beef cattle. In trial 1, six ruminally and duodenally cannulated Angus steers (573±70.7 kg BW) were fed a 78% steam rolled barley grain:15% wheat silage and alfalfa hay diet (DM basis, same diet was fed in trial 2). LIN (76.5% linoleic acid safflower oil) and OLE (76.5% oleic acid safflower oil) were mixed with the daily ration at 5% (DM basis) and fed in a cross-over design with covariate periods (no oil supplementation). Ruminal fluid samples were analyzed for fermentation variables and protozoal counts. Digestibility was determined using acid insoluble ash as a marker. In trial 2, 16 Angus cattle (423±7.4 kg initial BW) were blocked by BW and sex to two treatments: LIN or OLE (5% of dietary DM). Cattle were gradually adapted to the diet and fed individually for 116 days. Oils were fed during the last 86 days of the trial. Ruminal pH, total and individual VFA, and acetate to propionate ratio were not affected ($P > 0.05$) by oil supplementation or type of oil. Addition of LIN to the diet reduced ($P < 0.05$) protozoal counts and ammonia concentration in the rumen compared to the covariate period (10.6 vs 1.2×10⁵/ml and 9.40 vs 4.68 mM, respectively). Type of oil had no effect ($P > 0.05$) on protozoal counts or ammonia concentration. Compared to LIN, OLE tended ($P < 0.1$) to decrease total tract DM, OM, and ADF digestibility. Compared to the covariate period, OLE reduced ($P < 0.05$) DM, OM, CP, NDF, and starch digestibility (by 15, 14, 18, 31, and 4%, respectively). Similarly, DM, OM, and starch digestibility tended ($P < 0.1$) to be lower when LIN was fed compared to the covariate period (4, 4, and 2%, respectively). DM intake, average daily gain, feed efficiency or back fat thickness and rib eye area did not differ ($P > 0.05$) between LIN and OLE (trial 2). In conclusion, 5% linoleic acid-rich safflower oil added to a finishing, barley-based diet had

beneficial effects on ruminal fermentation but no corresponding effects on nutrient digestibility or cattle performance were observed.

Key Words: Dietary oil, Protozoa, Cattle

1084 Effect of dietary starch level on carcass characteristics and the hematin contents of beef. Kyouko Hodate^{*1}, Yumi Higashiyama¹, Hiroyuki Abe¹, Akihiro Iguchi², Masakazu Kobayashi², Tomoo Mori², Katsumi Kasai³, Yoshihiro Kanbe⁴, Hideto Mashiya⁴, and Tsutomu Asada⁵, ¹National Institute of Livestock and Grassland Science, ²Chiba Livestock Experimental Station, ³Ibaraki Livestock Experimental Station, ⁴Tochigi Livestock Experimental Station, ⁵Gunma Livestock Experimental Station.

Thirty-eight Japanese Black steers were used to determine the effect of dietary starch level on hematin contents of muscle. The steers (initial BW=548kg) were divided into two groups and housed in individual outdoor pens. One group was fed a diet of 47% starch and 18% NDF (HS), and the other group was fed a diet of 40% starch and 23% NDF (LS) from 19 to 27 mo of age. Blood and rumen fluid samples were taken for analysis of iron and volatile fatty acids at 23 mo of age. Upon completion of the trial, all steers were slaughtered for evaluation of carcass data and chemical components of the longissimus thoracis (LT) muscle. HS steers ate greater amounts of starch than LS steers (3.8 vs 3.3 kg/d, $P<0.01$). HS steers showed larger weight gain (0.77 vs 0.67, $P<0.01$) and lower feed conversion (8.68 vs 9.60, $P<0.01$), compared to LS steers. Carcass weights and rib eye areas were larger for HS steers (52 vs 48 cm², $P<0.01$), compared to those for LS steers. The hematin contents of LT muscle in the HS group were higher than in the LS group (21.7 vs 19.0 mg/100g, $P<0.02$). The other characteristics for a carcass grading and chemical component of LT muscle were similar. The concentrations of propionic acid in rumen fluid in the HS group were higher than in the LS group (2.64 vs 2.17 mmol/dL, $P<0.05$). Propionic acid concentrations were positively associated with the hematin contents of LT muscle ($P<0.01$) and the iron concentrations of blood plasma ($P<0.05$). Plasma iron concentrations were also positively associated with the hematin contents of LT muscle ($P<0.05$). These results suggest that in grain-finished steers the high starch diet causes high concentrations of propionic acid in rumen fluid, and high concentrations of iron in plasma. Therefore, the high starch diet produces a darker color of beef.

Key Words: Meat color, Starch, Hematin

1085 Fall and winter supplementation of post-weaning steers of two different mature body weight grazing high quality pastures supplemented with two types of energy source. F. J. Santini, E. Pavan, E. L. Villarreal, and J. M. Grigera, *National Institute of Agricultural Technology (INTA).*

The objective was to evaluate the effect of type of energy fall-winter supplementation on the performance of low and high mature body weight (MBW) of Aberdeen Angus steers: corresponding to 420 (L) and 500 (H) kg MBW breeding female. Equal energy level of high moisture corn grain (G) or corn silage (S) was used as supplement treatment. Forty calves were randomly assigned to four supplement-MBW groups. Supplements were offered daily for 176 days. Pastures (IVDMD= 78.7; DM= 21.2; NDF= 40.2; CP= 17.7%) were grazed under a daily rotational system. Live weight (LW) and subcutaneous backfat (SBF) were measured every 21 days. LW gain (LWG) and SBF deposition rate (SBFDR) were estimated individually by linear regression. Trial was planned to end when each treatment achieved 6 mm of SBF or lasted 13 month in the trial. Data were analyzed as a complete randomized design with a factorial arrangement. L and H steers received 1.9 and 1.7 of G and 2.4 and 2.0 kg DM/an/d of S, which represent 38, 35, 47 and 48% of total DMI. Supplement effect on LWG and SBFDR depended on MBW. However, at the beginning of the summer (L-G ending point), interaction effects disappeared for both variables ($p>.10$). LWG was only affected by MBW (769 and 675 g/d for H and L, $p<.01$), but DFDR was also affected by type of supplement (0.20 and 0.46 for H and L and 0.39 and 0.27 mm/30d for G and S, $p<.01$). It was concluded that G fall-winter supplementation improve LWG and SBFDR relative to S, only when steers reach their end point close to the end of the supplementation period. Otherwise, the supplement effect is lost. With the supplementation offered, H did not reach the 6 mm of DBF within a year.

	H ¹		L		SEM
	G ²	S ³	G	S	
Fattening period, d	405	405	258	365	-
Final					
Body weight, kg ^M	430	433	325	355	9.3
SBF ⁴ , mm ^M	4.6	4.8	7.1	6.6	0.5
Live weight gain, g/d ^{M,S,I}	677	700	692	593	20
SBF deposition rate, mm/30d ^{M,S,I}	0.20	0.19	0.54	0.32	0.30

¹H, high and L, low mature body weight. ²High moisture corn grain. ³Corn silage. ⁴Subcutaneous backfat. ^MMature body weight effect (p<.05). ^SSupplement effect (p<.05). ^IInteraction effect (p<.05).

Key Words: Grazing, Supplement, Mature body weight

1086 Influence of abomasal starch hydrolysate and/or casein on pancreatic exocrine secretion and plasma hormone concentrations in beef steers. J. A. Benson*, K. C. Swanson, J. C. Matthews, and D. L. Harmon, *University of Kentucky, Lexington.*

Eight Angus steers (290 ± 8 kg), surgically prepared with pancreatic pouch-duodenal re-entrant cannulas and abomasal infusion catheters were used in a replicated 4 x 4 Latin square experiment to investigate the effects of abomasal infusion of starch hydrolysate (SH) and/or casein on pancreatic exocrine secretion and plasma concentrations of hormones. Steers were fed a basal diet of alfalfa (1.2 x NE_m) in 12 equal portions/d. Abomasal infusion treatments (6 L total volume infused/d) were water (control), SH [2.7 g/(kg BWd)], casein [0.6 g/(kg BWd)] and SH + casein. Periods were 3 d adaptation and 8 d full infusion. Pancreatic juice and jugular blood samples were collected over 30 min intervals for 6 h on day 11. Weight and pH of pancreatic samples were measured and a 10% subsample composited and frozen until analysis of total protein and pancreatic enzyme activities. The remaining sample was returned to the duodenum. Plasma was harvested and frozen until analyzed. Pancreatic juice (67 mL/h) and protein (1.8 g/h) secretion rates were not affected by nutrient infusion (P > .2). There were SH x casein interactions for all pancreatic enzyme secretions and plasma insulin. SH + casein did not increase secretion of pancreatic enzymes compared to casein alone. Glucose and cholecystokinin octapeptide (CCK-8) were increased by SH, but glucagon was decreased. Casein decreased plasma CCK-8. The data indicate that positive effects of postruminal casein on enzyme secretion were inhibited by SH, however the role of the hormones measured in regulating enzyme secretion is not clear.

Item	Infusion					P <		
	Control	SH	Casein	SH + Casein	SE	SH	Ca-sein	SH Ca-sein
<i>Enzyme (units/h)</i>								
α-Amylase	20,406	20,553	43,486	20,462	4,892	.03	.03	.03
Trypsin	110	173	148	115	26.4	.58	.70	.08
Chymo-trypsin	27	36	55	30	7.2	.28	.14	.03
<i>Hormones (pM)</i>								
Insulin	69	103	96	108	6.5	.01	.03	.10
Glucagon	27	25	30	27	1.6	.09	.21	.90
PP ¹	75	79	77	62	6.5	.38	.22	.16
CCK-8	9.6	12.7	8.6	10.3	.09	.02	.07	.47
Glucose mM	4.06	4.30	4.25	4.26	.064	.07	.27	.11

¹ PP, pancreatic polypeptide

Key Words: Postruminal nutrients, Pancreatic secretion, Hormones

1087 The influence of treating wet distiller's grains and solubles with three levels of preservative (KI-151) on feedstuff stability, intake and performance of finishing steers. K. E. Tjardes*¹, C. L. Wright¹, C. Myers², and M. Martinez², ¹South Dakota State University, Brookings, ²Kemin Americas, Inc., Des Moines, IA.

One hundred fifty-two (152) steers with initial weight of 565 ± 33 kg were weighed and randomly allotted to 8 pens with 7 steers/pen and 8 pens with 12 steers/pen at the Southeast Research Farm, Beresford, SD. Steers were adapted to a finishing diet containing 20% wet distiller's grains and solubles (WDGS), 10% hay, and 68% cracked corn on a DM basis for 15 d before trial initiation. One d before trial initiation, WDGS without or with three levels of a proprietary experimental organic acid based preservative formulation (KI-151) were received and stored in adjacent silage bags. Levels of KI-151 were 2.4, 2.9, and 4.0 kg/t of as-is WDGS. Samples of WDGS for later determination of DM, CP and microbial load (mold and yeast) from each treatment were collected before being placed into silage bags. After adaptation, WDGS without or with KI-151 was fed at 20% of diet DM and offered once daily for 20 d for steers to have ad libitum access. Samples of feedstuffs and diets were taken weekly and analyzed for microbial load, and percentages of DM and CP. Steer weights were taken before feeding on d #15, 0, and 20. On day 21, steers were processed at a commercial processing plant and hot carcass weights were recorded. When WDGS was treated with KI-151 at 4.0 kg/t, mold counts were not detected at any of the 3 subsequent sampling dates and yeast counts were significantly lower at each of the 3 dates when compared to control (average of 3.4x10⁷ vs 460 cfu/g for KI-151 at 0 and 4.0 kg/t, respectively). Feeding WDGS treated with KI-151 at 2.4, 2.9, and 4.0 kg/t did not have an effect (P > 0.10) on steer DMI over the 20 d treatment period (11.6, 11.7, 11.2, and 11.5 kg/d for KI-151 at 0, 2.4, 2.9, and 4.0 kg/t, respectively). Feeding WDGS without or with KI-151 had no effect (P > 0.10) on steer ADG, efficiency of gain, hot carcass weight, or dressing. In conclusion, treating WDGS with levels approaching 4.0 kg/t of as-is WDGS reduced detection of mold and yeast without having any adverse effects on steer intake and performance.

Key Words: distiller's grains, mold inhibition, yeast inhibition

1088 Effect of low calcium diet (Ca) and vitamin D₃ (D₃) on Ca metabolism of finishing steers. G. Aranda-Osorio* and J.J. McKinnon, *University of Saskatchewan, Saskatoon, SK, Canada.*

The objective of this study was to increase serum Ca levels in an effort to improve beef quality by feeding a low Ca diet prior to supplementation with D₃. Nineteen steers (522 ± 34 kg), penned individually, were randomly assigned to four groups. Groups 1, 2, and 3 were fed a 90% barley-based concentrate, 10% barley silage diet (DM basis) with a Ca level of 0.16% (low Ca), while group 4 was fed the same basal ration with a Ca level of 0.62% (normal Ca) for 10 d (d L1-L10). Following this, the cattle were fed the normal Ca diet with groups 1, 2, 3, and 4 supplemented with 0, 1.25, 2.5 and 5 million IU (MIU) D₃/hd/d for 7 d (d S1-S7), respectively. The cattle were then subjected to a 5-d withdrawal period (d W1-W5). Blood samples were obtained every second day by jugular venipuncture. The response variables were total (TCa) and ionized (ICa) serum Ca, plasma D₃, 25-hydroxyvitamin D₃ (25(OH)D₃), 1-25 dihydroxyvitamin D₃ (1,25(OH)₂D₃), parathyroid hormone (PTH) and calcitonin. The data were analyzed by repeated measures analysis and single degree of freedom contrasts. Feeding the low Ca diet decreased (P<.05) serum TCa and ICa and plasma D₃. Supplementation of D₃ increased (P<.05) serum TCa and ICa, and plasma D₃ and 25(OH)D₃ levels. The increase was related to the level of D₃ fed. Maximum TCa and ICa levels in serum for all treatments were achieved on d W3 and W5, respectively. Plasma D₃ increased quadratically reaching a maximum of 352.9 ng ml⁻¹ on d S6 for the 5 MIU D₃ treatment. In contrast, 25(OH)D₃ increased in a linear fashion. On d W1, PTH levels were decreased (P<.05) while 1,25(OH)₂D₃ was increased (P<.05), responses related (P<.05) to the level of D₃ fed. Calcitonin was not altered (P>.05). These results suggest that Ca absorption and resorption mechanisms were activated by the low Ca diet. However, there was no synergistic effect between the low Ca diet and D₃ supplementation on serum Ca levels.

Key Words: Calcium, Vitamin D₃, Beef Quality

1089 Methods for calculating diet energy values from feedlot performance of cattle. F. N. Owens*, M. A. Hinds, and D. W. Rice, *Pioneer Hi-bred Int'l, Johnston, IA.*

Because the California Net Energy (NE) system accurately predicts rate of gain, estimated energy values of diets (EME) should be reliably calculated from animal measurements and feed intake. However, EME varies with specific inherent assumptions. First, some relationship between diet NE_m and diet NE_g must be chosen. In NRC for Beef Cattle (1970), NE_m and NE_g were related logarithmically to ME; hence, EME was the solution to a quadratic equation. In later NE versions, NE_m and NE_g were tied to ME by equations that included quadratic and cubic factors; hence, EME must be solved iteratively. Later versions also adjust diet NE_m for ionophore use. Secondly, weighing conditions markedly alter EME. Weights must be as specified (shrunk or empty) for an equation. Final weight can be calculated from carcass weight using a standard dressing percentage (e.g., 63%) to avoid differences in gut fill and fatness ignoring any differences in internal fat removed during evisceration. In earlier NE versions, NE_m requirements were related to animal age, gender, or type; in later versions, breed and environment were employed. Finally, having carcass grades simplifies equivalent weight adjustment assuming that choice grades increase from 0% to 100% when mean shrunk weight increases 16 kg (478 vs 462 kg; NRC, 1996). Alternatively, carcass quality or yield grades can be regressed against shrunk final weights to derive an adjustment. To calculate EME for a single diet ingredient, ME contributed by other diet components must be subtracted from diet EME; EN_m and EN_g then are calculated from residual EME. Imprecision of EME can be ascribed to inaccurate estimates of body or equivalent weights, environmental factors, and the NE version employed. All assumptions inherent in EME calculations should be specified in published articles. EME also can differ from the sum of ME from diet components due differences in site or extent of digestion. Spreadsheet and SAS methods for calculating EME based on various NE systems have been developed and will be distributed.

Key Words: Net energy, Feedlot, Cattle

1090 Effects of dietary cation anion balance on blood parameters and performance characteristics of beef cattle during the pre-receiving and receiving phases of the feedlot. J. J. Williams*¹ and L. W. Greene¹, ¹ *Texas A&M University Agricultural Research and Extension Center, Amarillo TX.*

Twenty-seven crossbred heifers, 255 kg, were blocked by weight and randomly assigned to a growing diet containing one of three dietary cation anion difference (DCAD) treatments to determine the effect on urine and blood pH, and performance. The DCAD diets were -100, +75 and +250 mEq/kg of diet, calculated as $(\text{Na}^+ + \text{K}^+ + 0.38\text{Ca}^{2+} + 0.3\text{Mg}^{2+}) - (\text{Cl}^- + 0.6\text{S}^{2-} + .5\text{P}^{3-})$. Heifers were individually fed using Calan electronic gate feeders. During d 1 to 70, heifers were fed to gain 0.91 kg/d. During d 71 to 80 heifers were transitioned to full feed. On d 81, heifers were removed from the DCAD diets and started on a feedlot finishing diet over a 16 d period. This period consisted of an initial diet of 30% steam flaked corn (SFC), 60% cottonseed hulls (CSH) and 10% supplement with a 10 percentage unit increase in SFC and decrease in CSH at 3 d intervals. Urine pH was determined on d 14, 28, 42, 56, 70, 80, 96 and 110, and at 3-d intervals from d 81 to 95. One-third of the heifers were sampled on each day of the 3-d interval. Arterial blood pH, pCO₂ and HCO₃⁻ were determined on d 28, 56, 70, 80, 96 and 110. By d 14, urine pH was lower ($P < 0.05$) for the heifers fed -100 compared to the heifers fed +75 and +250 (6.79 vs 7.94 and 8.13) and remained lower until d 85. When heifers were fed ad libitum (d 70 to 80), urine pH decreased 15% for those fed -100 but not for those fed +75 and +250. It took 5 days for the urine pH of the heifers fed the -100 to equilibrate to those fed +75 and +250. There was no difference ($P > 0.05$) in blood pH due to DCAD treatment. Blood pCO₂ and HCO₃⁻ were lower ($P < 0.05$) on d 80 for heifers fed the -100 compared to those fed +75 and +250. Feed intake and ADG were lower ($P < 0.05$) for heifers fed -100 than for +75 and +250 for d 70-110. Results indicate that consumption of a diet containing -100 mEq/kg DCAD prior to entering the feedlot may decrease feed intake during the start-up period.

Key Words: Dietary Cation Anion Difference, heifer, pH

1091 Effect of high linoleic sunflower oil on growth performance and carcass characteristics of feedlot steers. J. Baah*¹, T.A. McAllister¹, A.N. Hristov², F.H. Van Herk¹, and M. Ivan¹, ¹ *Agriculture and Agri-Food Canada, Lethbridge, AB,* ² *University of Idaho, Moscow.*

To investigate the effects of high linoleic acid sunflower oil (HLSO) on growth performance and carcass characteristics of cattle, finishing diets including the oil at 0 (control), 3, 6 or 9% (DM basis) were offered for ad libitum consumption to 60 individually fed crossbred steers (450 ± 25 kg BW) in a 112-d study ($n = 15$). Other dietary components were barley silage (11%), mineral/vitamin mix (5%) and rolled barley grain (84, 81, 78 or 75%). Steer weights and DM intake were determined at 28-d intervals. Carcasses were evaluated according to Canadian Beef Grading Standards. Including HLSO in the diet at 9% of DM numerically depressed DMI (by 7.5%, $P > 0.05$) over the course of the study (by 12% in month 3, $P < 0.05$). Treatment did not affect ADG, as compared to controls, although a numerical improvement (13%, $P < 0.05$) in overall ADG was observed in steers fed 6% HLSO. A linear ($P < 0.05$) improvement in feed efficiency (FE) with inclusion of HLSO was observed at d 28, and overall FE was numerically improved when oil was fed (by 5.8, 7.2 and 7.2% with 3, 6 and 9% HLSO, respectively). Feeding HLSO did not affect ($P > 0.05$) warm carcass weight, fat cover, ribeye area or saleable meat yield, but it may have improved marbling, as all 45 carcasses from steers fed HLSO graded AA or AAA, whereas 2 of the 15 from the control group graded A. The added cost of including HLSO in feedlot diets would not be offset by these modest improvements in performance, although it is possible that HLSO could favorably alter fatty acid composition of the beef.

Key Words: Sunflower Oil, Steers, Growth Performance

1092 Substitution of sorghum for citrus pulp on finishing yearlings. I. Mejia-Haro*¹, G. Tirado-Estrada¹, F. Gonzalez-Castaneda², J. Fajardo-Pena¹, J. Mejia-Haro³, and B. Ortiz-de la Rosa⁴, ¹ *CIGA ITA de Aguascalientes, Mexico,* ² *INIFAP - Aguascalientes, Mexico,* ³ *Universidad de Guanajuato, Mexico,* ⁴ *CIGA ITA de Conkal, Yucatan, Mexico.*

In Mexico, feedlot diets are expensive because production of grains is low and most of them are imported from USA. One way to alleviate the problem is through the use of Agriculture byproducts. Citrus pulp is a byproduct available in Mexico that could be used in feedlot diets and reduce the costs of feed, since the citrus pulp price sometimes is 40% lower than that of sorghum. The objective of this study was to substitute partially sorghum for citrus pulp and observe effects on ADG, feed conversion and carcass weight in finishing yearlings. This study was carried out in Pabellon de Arteaga, Aguascalientes, Mexico in the facilities of INIFAP in 2000. Twenty-four Brahman yearling steers (327 kg BW) were assigned randomly to one of four treatments (inclusion of citrus pulp in diet): T1, 0%; T2, 8%; T3, 16%, and T4, 24%. Yearlings were fed for 98 d after being adapted to the diet for 15 d and weighed every two weeks. Feed intake, feed conversion, ADG and carcass weight were recorded. Data were statistically analyzed by analyses of variance using the statistical package of the University of Nuevo Leon, Mexico. No significant differences ($P > .10$) were found in ADG (T1, 1.094; T2, 1.078; T3, 1.108; T4, 0.986 kg) feed conversion (7.59, 8.17, 7.23, and 8.43 for T1, T2, T3, and T4, respectively). Similarly, no effects were observed ($P > .10$) in feed intake (8.146, 8.655, 7.850 and 8.205 kg/d and carcass weight (58.4, 59.7, 58.2, and 59.1%) for T1, T2, T3, and T4, respectively). Substituting up to 24% of the sorghum for citrus pulp had no effects on animal performance in feedlot.

Key Words: Feedlot, Citrus Pulp, ADG

1093 Effects of Monensin (Rumensin®) and Salinomycin (Salocin®) on Feedlot Performance of Beef Cattle in Northern Mexico. B.I. Giner-Chavez*¹, G.J. Vogel², and M.A. Hernandez¹, ¹ *Elanco Animal Health, Eli Lilly de Mexico,* ² *Elanco Animal Health, Eli Lilly and Company, U.S.A.*

A study was conducted to evaluate the effects of Rumensin® and Salinomycin on feed intake during the summer months in feedlot cattle. The study was a complete randomized block design with two treatments and four replications of 20 animals per treatment. The study consisted of two periods; period 1 was defined as day 1 of the trial to day 36, and period 2 from day 37 to day 81 or the termination of the feeding period. Animals selected were yearling steers weighing approximately 272

± 17.7 kg. Cattle were Charolais X Brangus crossbreeds of similar origin and sex. In the rations for the Rumensin[®] treatment, two levels of Rumensin[®] were included in a step up approach. Rumensin[®] at a level of 15 PPM was included in the rations of period 1, and at 25 PPM for the rations in period 2. The rations for the Salinomycin treatment contained 10 PPM of Salinomycin. Individual weights were taken on day 1, day 36, and at the conclusion of the trial. Overall weight gain and average daily gain were not significant. The Rumensin[®] fed cattle had an improved feed efficiency ($P < 0.05$) and a lower feed intake ($P < 0.01$) compared to the Salinomycin fed cattle. The improved feed efficiency for the Rumensin[®] treatment demonstrates that feed utilization is improved, as the same gain was realized as compared to the Salinomycin treatment. Carcass weight and yield were not different between experimental treatments. As a result of the improvement in feed efficiency a total benefit of \$8.46 dollars was obtained per animal. This is a return over an investment of 1:9 when using Rumensin[®] in the ration instead of Salinomycin.

Key Words: Cattle, Feedlot, Ionophres

1094 Influence of close-up dry period protein supplementation on full lactation productive and reproductive performance of primiparous Holstein cows. J.M. Moorby^{*1} and P.H. Robinson², ¹*Institute of Grassland and Environmental Research, Aberystwyth, Wales, UK*, ²*UCCE, Dept. Anim. Sci., UC Davis, Davis, CA*.

Recent studies report that increased crude protein (CP) levels of close-up rations of heifers, to about 14% of DM, improve their performance in the subsequent lactation. Pregnant Holstein heifers (n=331) were assigned to close-up groups that were offered a low CP (11.7% DM) ration based on corn silage, alfalfa cubes, oat hay, corn and barley grain, or a medium CP (14.4%) ration as the low CP ration plus 1 kg/d/cow of a supplement (60% canola meal or rumen protected (RP) canola meal and 40% others), or a high CP (16.6%) ration as the low CP ration plus 2 kg/d/cow of one of the two supplements. After calving, use of BSt, movement through the high and low production groups, and breeding events were determined by the herd manager. Full lactation production parameters were pooled to means. Time close-up varied (1-19 d) and cows were allotted to 4 time groups for ANOVA. As their time close-up increased, cows tended ($P=0.056$) to produce more milk, 41.5 kg/lactation per day close-up (intercept = 9311 kg/lactation) but source or level of CP had no influence. Full lactation yield of milk fat and protein was not influenced by source or level of CP, or time close-up. Full lactation body condition and locomotion scores were higher ($P=.03$ and $.04$) for cows supplemented with RP canola meal (3.28 vs. 3.22; 1.22 vs. 1.14). Cows were started on BSt 7 d earlier ($P=.01$) if supplemented with RP canola meal and tended ($P=.06$) to stay on BSt 9 d longer. Time in the high and low production groups, day of first breeding and services per conception, were not influenced by any treatment variable. However, as their time close-up increased, cows had a later ($P=.03$) day of conception, 1.87 d/d close-up (intercept = 88.7 d). Increasing close-up ration CP from 11.7% to 16.6%, or changing its rumen degradability, had no substantive impact on full lactation productive or reproductive performance. However, increasing the length of the close-up period enhanced full lactation milk yield, but at the apparent expense of a longer period to conception.

Key Words: Transition, Primiparous, Protein

1095 Influence of close-up dry period protein supplementation on full lactation productive and reproductive performance of multiparous Holstein cows. P.H. Robinson^{*1} and J.M. Moorby², ¹*UCCE, Dept. Anim. Sci., UC Davis, Davis, CA*, ²*Institute of Grassland & Environmental Science, Aberystwyth, Wales, UK*.

Recent studies are equivocal in the impact of increased crude protein (CP) levels of close-up rations of multiparous cows, above about 12% of DM, on their performance in the subsequent lactation. Pregnant Holstein cows (n=286), were assigned to close-up groups that were offered a low CP (11.7% DM) ration based on corn silage, alfalfa cubes, oat hay, corn and barley grain, or a medium CP (14.4%) ration as the low CP ration plus 1 kg/d/cow of a supplement (60% canola meal or rumen protected (RP) canola meal and 40% others), or a high CP (16.6%) ration as the low CP ration plus 2 kg/d/cow of one of the two supplements. After calving, use of BSt, movement through the high and low production groups, and breeding events were determined by the herd manager. Full

lactation production parameters were pooled to means. Time close-up varied (1-19 d) and so cows were allotted to 4 time groups for ANOVA. Full lactation production of milk (mean = 11247 kg/lactation), as well as milk fat and protein, were not influenced by source or level of CP, as well as time close-up. Full lactation body condition and locomotion scores were also not influenced by any treatment. Cows were started on BSt 9 d earlier ($P=.01$) if supplemented with RP canola meal but only tended ($P=.11$) to stay on BSt 7 d longer. Cows tended ($P=.07$) to stay on BSt longer as the level of protein increased (149, 155 and 160 d for the 11.7%, 14.4% and 16.6% CP diets). Time in the high and low production groups, day of first breeding and services per conception, were not influenced by any treatment. As ration CP increased, cows only tended ($P=.10$) to have a later day of conception (101, 114, 117 d). Increasing close-up ration CP from 11.7% to 16.6%, or changing its rumen degradability, had no substantive impact on full lactation productive or reproductive performance. Indeed, results do not support the need for a specific close-up period at all, as increasing its length had no substantive impact on full lactation productive or reproductive performance.

Key Words: Transition, Multiparous, Protein

1096 Influence of early dry-off of twin-carrying multiparity Holstein cows on their productive performance in the first 120 days of lactation. P.H. Robinson^{*1}, J.H. Kirk², and T. Riordan³, ¹*UCCE, Dept. Anim. Sci., UC Davis, Davis, CA*, ²*UCCE, Vet. Med. Teaching Research Centre, Tulare, CA*, ³*Nutri-Systems, Fresno, CA*.

The incidence of twin births on commercial dairies has been increasing in recent years. Twinning percentages of 5 to 8% of total births in multiparity cows are commonly reported, and cows bearing twins have been associated with higher levels of metabolic disease and reduced productivity. Multiparity Holstein cows on a large commercial dairy in California were manually palpated for the presence of twin fetuses at the first pregnancy check over a 12 mo period. Those judged to have twin fetuses were assigned to either a control (C: herd normal dry-off relative to days carried calf) or early dry-off (ED: target dried 14 d earlier than C). A third group, those cows judged to be carrying single fetuses but actually calving with twins, were assigned to a third group (undetected twins: U) at calving. After calving, use of BSt, movement through production groups, and breeding events were determined by the herd manager. A total of 71 cows were judged to be carrying twin fetuses based upon manual palpation, although 14 (20%) aborted prior to calving. Of those cows calving, 9 (16%) calved with single calves. Of the 121 cows calving with twins, only 48 (40%) had been judged to be carrying twins based upon manual palpation, and 18 (15%) were culled or died before 120 d of lactation. Cows that were dried early (ED) only tended to be dry 12 d longer than cows dried normally (C) (68 vs. 56 d; $P=.08$), even though they were actually dried off 15 d earlier (202 vs. 217 days carried calf; $P<.01$). There were no differences in production of milk (avg. = 47.8 kg/cow/d), or its components, among groups C, ED and U in the first 120 d of lactation and milk components were similarly unaffected (avg. fat = 3.74%). Manual palpation of pregnant cows resulted in a relatively low identification rate of cows carrying twins and a relatively high incidence of false positives. Early dry-off of cows carrying twin fetuses had no impact on their performance in the first 120 d of lactation.

Key Words: Twin, Dry-off, Early

1097 Dietary supplementation of polyunsaturated fatty acids affects the immune response in dairy cows during the transition period. N. Gagnon^{*}, H.V. Petit, and M. Lessard, *Dairy and Swine R and D Centre, Lennoxville, Qc, Canada*.

The effects of dietary polyunsaturated fatty acids (PUFA) on the immune response of 21 primiparous and 27 multiparous pregnant Holstein dairy cows were studied during the transition period. Six weeks before calving, cows were randomly allotted to one of three dietary fat treatments: Megalac (MEG), micronized soybeans (SOY) or whole flaxseed (FLA) which are, respectively, rich in saturated fatty acids, n-6 or n-3 PUFA. On week 6 and 3 before parturition, cows were injected subcutaneous with ovalbumine (OVA) to measure the antibody (IgG) response in the serum and colostrum. Colostrum samples were collected at the first milking after calving and blood samples were taken 6, 3, and 1 wk before the expected date of calving and 1, 3, and 6 wk after calving. Mononuclear cells (PBMC) isolated from blood were cultured to evaluate the blastogenesis response to concanavalin A (conA) and the *in vitro*

productions of interferon- γ (IFN- γ), tumor necrosis factor- α (TNF- α), nitric oxide (NO), and prostaglandin E2 (PGE2). Multiparous cows fed SOY had a higher IgG level to OVA in colostrum than those fed FLA ($P < 0.001$) or MEG ($P = 0.06$). The IgG level to OVA in serum was unaffected by dietary fatty acids. The blastogenesis response of lymphocytes to conA was lower in multiparous ($P = 0.03$) and in primiparous ($P = 0.09$) cows on SOY than for those on FLA. Multiparous cows fed MEG had a similar ($P > 0.10$) blastogenesis response than cows fed SOY or FLA. However, primiparous cows fed MEG had a higher ($P = 0.09$) blastogenesis response than those fed SOY. There was no interaction week by diet ($P > 0.10$) for any *in vitro* measurements. The productions of NO and IFN- γ in multiparous cows and the production of TNF- α and IFN- γ in primiparous cows were significantly affected ($P < 0.05$) by week of the experiment. These data suggest that the immune response of primiparous and multiparous dairy cows during the transition period can be affected by dietary fatty acids and parturition.

Key Words: Dairy cow, Fatty acids, Immune response

1098 Energy balance (EB) during the transition period in high producing Holstein cows. M.A. McGuire*, B. Shafii, G. Orthel, and J.G. Giesy, *University of Idaho, Moscow.*

The transition period is associated with many metabolic changes that reflect mobilization of body energy reserves upon initiation of lactation. This period of negative energy balance, as it relates to energy intake and output in the form of maintenance and milk production, is associated with immunosuppression, periparturient disorders, and increased days to ovulation and first breeding. Previous estimates of time to energy balance range from 0 to 16 wk postpartum. Our objective was to determine the pattern of EB in cows during the transition period. Twenty multiparous cows were studied from freshening until 12 wk postpartum. Another 9 cows were followed from 4 wk prepartum to 12 wk postpartum. The cows were fed using Calan gates to measure feed consumption. Daily milk weights (2x) were obtained and milk composition was determined 2x/wk. Body weights and body condition scores were obtained weekly. Energy balance was calculated as the weekly mean of NE_L consumed (DM intake \times NE_L/kg DM) minus NE_L requirement (maintenance and milk). Milk production was 46.3 ± 7.7 kg/d over the 12 wk of lactation with peak yield of about 49 kg/d sustained from wk 4 to 10. DM intake averaged 26.2 ± 4.7 kg/d with maximum intake of 28 kg/d during wk 7 to 12. Energy balance was 11.3 Mcal/d prepartum and declined to -9.2 Mcal/d in the first wk after calving. Thereafter, EB increased after the first wk of lactation reaching positive EB in the fourth wk. Mean EB over the 12 wk of lactation was 2.8 ± 7.3 Mcal/d. Body condition scores declined after calving from 3.6 to 3.0 by wk 5 and did not change thereafter. Simple correlations demonstrated a strong relationship between DM intake and EB ($r = 0.75$, $P < 0.0001$) but no relationship between milk yield and EB whereas EB and body condition score were weakly related. In conclusion, EB can occur early in lactation in high producing cows but body condition score is not a great evaluator of EB. DM intake is the driving force behind the achievement of energy balance in early lactation.

Key Words: Energy balance, Lactation, Transition period

1099 Vitamin B12 metabolism and bioactivity during the transition period in the dairy cows. B. Graulet*, A. Desrochers², and C.L. Girard¹, ¹Dairy and Swine R&D Centre, Agriculture and AgriFood Canada, Lennoxville, ²Faculte de Medecine Veterinaire, St-Hyacinthe, Canada.

Methionine synthase (MS, E.C. 2.1.1.13) and methylmalonyl-coenzyme A mutase (MCM, E.C. 5.4.99.2) are vitamin B12-dependent hepatic enzymes acting in protein synthesis and neoglucogenesis, respectively, two metabolic pathways which are especially important during gestation and lactation of the cow. The aim of the present study was to explain the decrease in hepatic MCM activity observed previously during the transition period of the dairy cow. Liver biopsies and blood samples were taken repeatedly 3 wk before calving and at 2, 4 and 8 wk of lactation from 12 multiparous cows randomly assigned to a control or a vitamin B12 supplemented diet (500 mg/d). For both treatments, MCM activity assayed spectrophotometrically from purified mitochondrial matrix decreased just after calving (315.92 ± 42.98 to 169.76 ± 21.53 nmol/min/g of fresh liver, $P = 0.0172$) then returned to the level observed before calving. Its holoenzyme fraction increased between wk 2 and 4 of lactation from 40 to 60 %. MS activity quantified chromatographically from purified cytosol raised (19.743 ± 1.976 to 29.161 ± 1.048 nmol/min/g of

fresh liver, $P = 0.0073$) 2 wk after calving in the liver of the vitamin B12 supplemented cows then returned to values observed 3 wk before calving. Its holoenzyme activity was close to 100 % whatever the period or the treatment. During the experimental period, vitamin B12 decreased in plasma (249.5 ± 23.8 to 167.6 ± 12.1 pg/ml, $P = 0.0006$) and milk (2308 ± 587 to 1451 ± 261 pg/ml, $P = 0.0613$) and remained stable in the liver of the control cows (857.41 ± 21.89 nmol/kg), but it increased in plasma (321.4 ± 23.7 to 738.0 ± 80.5 pg/ml, $P = 0.0219$), liver (940.7 ± 59.6 to 1296.6 ± 115.3 nmol/kg, $P = 0.0276$) and was strongly increased but stable in milk (4919 ± 349 pg/ml) of the vitamin B12 supplemented cows. In conclusion, the decrease in MCM activity after calving cannot be explained either by a competition with MS for vitamin B12 utilization, or by a low availability in vitamin B12 in the whole liver but inside the hepatic mitochondria.

Key Words: Vitamin B12, Cow, Liver

1100 Metabolic responses of lactating dairy cows to 14-day subcutaneous infusions of several dosages of glucagon. G. Bobe*, B. N. Ametaj², Y. Lu¹, D. C. Beitz¹, and J. W. Young¹, ¹Iowa State University, Ames, IA, ²Purdue University, West Lafayette, IN.

Fatty liver is a major metabolic disease of dairy cows in early lactation. Elevated liver triacylglycerol (TAG) concentrations can be decreased by 14-day continuous intravenous infusions of glucagon beginning at d 21 postpartum. We tested whether 14-day subcutaneous infusions of several dosages of glucagon decrease liver TAG concentrations. Multiparous Holstein cows ($n = 13$) were assigned randomly to 2 groups and received 0 (Normal; $n = 3$) or an extra 5 kg/d of cracked corn during the last 30 d of the dry period (Susceptible; $n = 10$). "Susceptible" cows were assigned randomly to 3 groups and received beginning at d 8 postpartum 0 (Saline Susceptible; $n = 4$), 5 (5 mg/d Glucagon; $n = 3$), or 10 mg (10 mg/d Glucagon; $n = 3$) glucagon in saline by subcutaneous infusions at 10 ml/h for 14 d. "Normal" cows (Saline Normal) received the same treatment as "Saline Susceptible" cows. Blood, liver, and milk samples were taken at d -4 (only blood and liver), 4, 8, 11, 14, 21, 28, 35, and 42 postpartum and were analyzed for plasma β -hydroxybutyrate (BHBA), glucagon, glucose, insulin, NEFA, and urea nitrogen (PUN), liver glucose, glycogen, and TAG, and milk fat, lactose, protein, and urea nitrogen (MUN). Subcutaneous glucagon infusions or feeding extra corn in the dry period affected none of the measured parameters ($P > 0.1$) except for plasma glucagon concentrations. Subcutaneous glucagon infusions increased plasma glucagon concentrations ($P < 0.1$); however, the plasma glucagon responses to glucagon injections were much smaller than during intravenous infusions (10 % of intravenous glucagon response) and not linear to the dosage infused. Furthermore, the plasma glucagon response decreased during the subcutaneous glucagon infusion period because of an inflammatory response and infections near the infusion site. We conclude that feeding an extra 5 kg/d cracked corn 30 d prior to calving are insufficient to induce fatty liver. Furthermore, we conclude that continuous subcutaneous infusions of 5 and 10 mg glucagon in saline at 10 ml/h for 14 d beginning at d 8 postpartum are not an effective treatment of fatty liver because of the small and nonlinear glucagon response to continuous subcutaneous glucagon infusions.

Key Words: Fatty liver, Glucagon, Corn

1101 E. coli O157:H7 intervention strategies for feedlot cattle. T. J. Klopfenstein*, D. R. Smith¹, R. A. Moxley¹, G. E. Erickson¹, J. D. Folmer¹, S. Hinkley¹, and C. N. Macken¹, *University of Nebraska, Lincoln, NE.*

E. coli O157:H7 prevalence in feedlot cattle is a major food safety concern. A feedlot study was conducted (May to September, 2001) to evaluate 3 *E. coli* O157:H7 intervention strategies: competitive exclusion microbials (2 *L. acidophilus* organisms, NPC 747 and NPC 750), diet change (starch removal) and pen cleaning. A finishing diet (33% high moisture corn, 20% dry rolled corn and 40% wet corn gluten feed, 7% alfalfa with vitamins, minerals, Rumensin and Tylan) was fed to 432 steers (340 kg) in 54 pens, 8 steers/pen. The design was a 3x2x2 factorial. The competitive exclusion products were fed daily to 18 pens each. Half the pens were cleaned monthly, the other half only at the end. Two weeks prior to slaughter, the diet was changed for half the cattle (corn bran replacing corn). Individual fecal samples were obtained monthly and 0, 1 and 2 weeks prior to slaughter. The samples were analyzed for *E. coli* O157:H7 using primary enrichment, immunomagnetic separation, culturing and confirmation with PCR. Neither the competitive

exclusion products nor pen cleaning affected steer performance ($P > 0.39$). Diet change reduced DMI ($P < 0.001$; 12.8 kg/d vs 11.5 kg/d) during the last 2 weeks and reduced ADG and efficiency for the entire feeding period ($P < 0.001$). Carcass weight was reduced 8.4 kg by diet change. Pen was the experimental unit for detection of *E. coli* O157:H7 and a pen was positive if any of the 8 steers was positive. Overall detection of *E. coli* O157:H7 was low (145/3024 animal-weeks). Pen cleaning and diet change had no effect on *E. coli* O157:H7 prevalence. Feeding the competitive exclusion products numerically reduced *E. coli* O157:H7 positive pens the week of marketing (44% vs 17%; $P = 0.10$). We conclude that pen cleaning and starch removal from the diet did not affect *E. coli* O157:H7 prevalence while feeding competitive exclusion products shows potential to reduce shedding.

Key Words: *E. coli* O157:H7, Diet, Competitive exclusion

1102 Effects of anionic and cationic diets fed in prepartum on blood parameters on peripartum of Holstein cows with different dry periods, associated or not with estradiol injection. L. Teixeira^{*1}, M. Gulay², D. Furtado¹, J. Perez¹, J. Souza¹, M. Liboni², and H. Herbert², ¹Universidade Federal de Lavras, ²University of Florida.

Effects of anionic and cationic diets fed in prepartum on blood parameters on peripartum of Holstein cows with different dry periods, associated or not with estradiol injection. Lucia de F. A. C. Teixeira¹, Mehmet S. Gulay², Daniel Furtado¹, Juan R. O. Perez¹, Jose C. de Souza¹, Marcio Liboni², H. H. Head², Universidade Federal de Lavras¹, University of Florida².

The effects of anionic diets, associated or not with estradiol injection were evaluated in 30 days and 60 days dry period on hematocrit (HEMA), plasma protein (PP), glucose (GLU), insulin (INS), non esterified fatty acids (NEFA) changing concentrations were evaluated in plasma of 40 Holstein cows in peripartum. Cows were bled for 27 days in both, before and after calving. Forty cows were assigned randomly to one of six treatments, associated or not with estradiol injection, in a 2x2+2 factorial arrangement for 21 days in prepartum. Anionic or cationic diets were fed to cows in prepartum. After calving a standard dairy diet was fed to all cows postcalving more 21 days. The cows were under two different ranges of temperatures: lower temperatures and calved in autumn and over extreme temperatures and calved in summer. Anionic diets (-136 meq/kg of DCAD) associated or not with estradiol did not affect any blood parameters in any day dry period. The average means of parameter evaluated were under recommended concentrations. Neither higher nor lower temperatures affected the plasma composition evaluated, except to PP, which decreases around the calving, associated with decrease feed intake. However, after calving, a remarkable increasing of PP concentrations, suggesting that the diets supported the protein requirements in onset of lactation, when cows recovered feed intake. Both plasma INS and GLU were reduced around calving, suggesting an intensive utilization of GLU to produce lactose in onset of lactation, and exceeding glucose synthesis and absorption. Although NEFA concentrations were in expected range, they stayed high after first week [487,20; 537,10 ng/ml], even higher feed intakes were observed, but NEFA concentrations can not be considered as ketotic condition, supporting the positive effects of anionic diets on postpartum intake and consequently higher nutrient supplying to the cow.

1103 Effects of feedings soybeans and rumen protected choline during late gestation and early lactation on performance of dairy cows. W. A. Scheer^{*}, M. C. Lucy, M. Kerley, and J. N. Spain, *University of Missouri - Columbia*.

This study was designed to investigate the effects of soybeans and rumen protected choline (RPC; ReashureTM Choline, Balchem, Slate Hill, NY) fed during late gestation and early lactation on intake and production of dairy cows. Sixty-six Holsteins were blocked by parity and expected calving date and randomly assigned within block to one of six diets. Dietary treatments were fed from 25 days prepartum to 100 days in milk. Treatments were arranged as a 3 x 2 factorial design. Cows received no soybeans, soybeans beginning at calving, or soybeans for the duration of the study. Soybeans were fed raw, cracked beans at feeding rates of 1.9 and 2.8 kg DM per cow per day during pre- and postpartum periods, respectively. RPC was top-dressed once daily at a rate of 0 or 15 g dietary choline per cow per day. Cows were individually fed diets as total mixed rations using electronic feeding gates that allowed daily measurement of feed intake. Body weights and body condition scores were measured weekly throughout the study. Cows were milked twice

daily and milk yields were measured electronically. DMI measured during the pre- and postpartum periods were not different. Feed intake of all diets decreased during the last 3 days of gestation, but recovered quickly after calving. Soybeans did not alter milk yield during the first 50 days of lactation. Supplemental choline tended to increase daily milk yield (30.9 vs. 32.9 kg/d; $P < 0.14$). Changes in body weight and body condition score reflected normal changes for lactating dairy cows during these phases of production. Milk fat percentage was not different due to diet. Analysis of milk protein percentage included a significant interaction between the feeding of soybeans and RPC. Cows fed no soybeans prepartum had higher milk protein percentage when fed choline. Cows fed soybeans for the entire duration of the study had lower milk protein percentage when choline was added to the diet. These results indicate that soybeans can be fed during the prepartum period without adverse effects on animal performance. Supplemental choline tended to increase milk yield and improved milk protein percentage when soybeans were not fed prepartum.

Key Words: Transition cows, Soybeans, Rumen protected choline

1104 Body condition replenishment during the dry period and its effects on metabolic status and lactation of dairy cows. D. B. Carlson^{*}, M. S. Laubach, D. E. Schimek, W. L. Keller, J. W. Schroeder, and C. S. Park, *North Dakota State University, Fargo, ND, USA*.

The objective of this study was to examine the effects of replenishing body reserves during the dry period compared to increasing condition during late lactation (LL) on periparturient metabolic status and the subsequent lactation. Seven Holstein cows were stratified by parity, milk production, and body condition score (BCS) and assigned to one of two dietary treatments: 1) Control (C), and 2) Restriction (R). Control ($n = 3$) cows were fed according to NRC (2001) recommendations for ad libitum intake during LL (60 d), the far-off dry period (28 d), and the transition period (28 d prior to expected calving date, ECD). Restriction cows ($n = 4$) were fed an energy-restricted diet during LL to maintain BCS, and were fed a transition diet ad libitum during the entire dry period (56 d prior to ECD) to increase BCS. NE_L intake (Mcal/d) of the R group was 71% of that of C cows (23.9 ± 1.4 vs. 33.6 ± 4.5 , respectively) in the LL period. All cows were fed a common diet for 12 wk after calving. Body weight (BW) was determined twice weekly, while BCS was determined monthly before calving, and bi-weekly after calving. Blood samples were collected monthly prior to ECD, and d -7 to d 7, 28, 42, 56, 70, and 84 with respect to calving date. Dry matter intake (DMI) was determined daily until 28 d after calving. Control cows tended ($P < 0.10$) to gain more BCS in LL compared to R cows, while BCS increased ($P \leq 0.05$) during the dry period for R cows compared to C animals (2.94 to 3.5 vs 3.33 to 3.5). Treatment did not affect BW change ($P > 0.05$). DMI was greater ($P < 0.01$) during LL for C cows, however DMI was similar ($P > 0.05$) during the other periods. Milk and milk component yield was not affected ($P > 0.05$) by treatment. Serum non-esterified fatty acids and glucose were not altered ($P > 0.05$) by dietary treatment. Increasing body condition during the dry period does not affect metabolic status or the subsequent lactation of Holstein cows.

Key Words: Transition, Periparturient, Body condition

1105 The effect of monensin controlled release capsule at dry-off on calving-related disorders and milk yield in Holstein cows. P. Melendez^{*}, C. Risco, and A. Donovan, *University of Florida, Gainesville, FL, USA*.

The objective was to evaluate the effect of a monensin slow-release capsule given at dry-off on the incidence of calving-related disorders and milk yield on Holstein dairy cows. The study was conducted in a 3000-cow commercial Holstein dairy farm (milk RHA of 10,500 kg). Cows were housed in a dry-lot system, fed a total mixed ration and milked 3 times a day. Between July and August 2001, 580 cows dried-off 50 to 70 d before expected parturition were randomly assigned either a treatment or a control group. Treated group ($n=290$) received orally a capsule of monensin (releasing 300 mg of monensin daily for 95 days). Control cows (no capsule, $n=290$) were randomly matched by parity. The outcome variables were incidence of dystocia, retained fetal membranes, metritis, digestive disorders, displacement of abomasum, clinical ketosis and daily milk yield up to 20 d pp. Milk yield was analyzed by repeated measure ANOVA developing a mixed model. Each calving-related disorder was analyzed by logistic regression. Cows treated with monensin

were 2.1 times more likely to develop dystocia than control cows ($p \leq 0.01$). Treated cows correcting by dystocia were 0.2 times less likely to develop metritis ($p \leq 0.01$). There was no treatment effect for retained fetal membranes, displacement of abomasum, digestive disorders and clinical ketosis. For milk yield, within parity 1, treated cows without dystocia produced more milk than control cows without dystocia at d 5, 6, 10, 13, 14 and 19 ($p \leq 0.05$). However treated cows with dystocia produced less milk than control cows with dystocia at d 13 and 15 pp ($p \leq 0.05$). Within parity 2, treated cows produced more milk than control cows at d 3, 12 and 15 ($p \leq 0.05$). Within parity 3 or greater there was no interaction treatment by day effect ($p > 0.05$). It is concluded that although monensin increased milk production in certain days within parity 1 and 2, monensin also increased the incidence of dystocia and indirectly negatively might have affected milk yield within the first 20 d pp.

Key Words: Monensin, Milk yield, Calving-related disorders

1106 Replacing alfalfa silage with chopped alfalfa hay in a coarse barley silage based total mixed ration for dairy cows. M.S. Einarson*¹ and J.C. Plaizier¹, ¹Department of Animal Science, University of Manitoba.

Excess coarseness of barley silage based diets might constrain feed intake and production. The effect of replacing alfalfa silage with chopped alfalfa hay in a coarse barley silage based diet was investigated. Three total mixed rations (A,B,C) contained (DM basis) 34.6% coarse barley silage, 3.5% sunflower seeds, 33.6% commercial energy supplement and 14.7% commercial bypass protein supplement. Diets A, B, C varied in their inclusion rates (DM basis) of alfalfa silage (13.7%, 6.9%, 0%) and chopped alfalfa hay (0%, 6.9%, 13.7%). Diets were fed to 12 lactating dairy cows in 4 3 by 3 Latin squares with 3-week periods. Milk yield, milk composition, dry matter intake (DMI), rumen pH, and particle size (Penn State Particle Size Separator) were determined during the last week of each period. Replacing alfalfa silage with chopped alfalfa hay increased DM and CP contents, slightly increased NEL content and reduced soluble protein (SP) and NDF contents and particle size of the diet. The largest effect was on dietary physically effective NDF (peNDF) content. Replacing silage with hay increased DMI, reduced milk protein content, but did not affect rumen pH and milk yield. Diet B resulted in the highest milk fat content. The effect of replacing silage with fine chopped hay on feed intake can be explained by an array of factors, including dietary peNDF, moisture and fermentation product contents and digestibility. It is believed that the major constraint on DMI was the excess peNDF content of coarse barley silage. Reducing the peNDF content of coarse diets, e.g. by including finely chopped hay, can increase feed intake and, depending on the quality of this hay, also increase production.

	Diet				
	A	B	C	SE	P
DMI (kg/d)	19.1 ^b	20.4 ^{ab}	21.2 ^a	0.43	< 0.0005
Rumen pH	6.52	6.54	6.60	0.04	n.s.
Milk yield (kg/d)	33.3	32.1	32.3	0.68	n.s.
Milk fat (%)	3.02 ^b	3.31 ^a	3.08 ^b	0.07	<0.005
Milk protein (%)	3.04 ^a	2.91 ^{ab}	2.89 ^b	0.05	0.07
PSPSS					
Upper tray (%DM)	20.1	16.8	11.6		
Middle tray (%DM)	32.6	26.7	27.7		
Bottom tray (%DM)	47.4	56.5	60.7		
Upper tray (%As fed)	22.9	15.2	12.9		
Middle tray (%As fed)	30.9	26.2	27.3		
Bottom tray (%As fed)	46.2	58.7	59.8		
DM (%)	45.2	51.1	54.9		
CP (%)	14.1	16.3	15.7		
SP (% CP)	35.9	30.1	27.8		
NDF (%)	49.4	46.0	46.4		
NEI (Mcal/kg DM)	1.56	1.57	1.57		

^{a,b}: significant ($P < 0.05$)

Key Words: fiber, barley silage, dairy cows

1107 Effects of microbial inoculation of alfalfa haylage on milk production of dairy cows . V. J. Magalhaes¹, S. Manginelli¹, P. M. Meyer², and P. H. M. Rodrigues*¹, ¹Faculdade de Medicina Veterinária e Zootecnia, University of Sao Paulo, Brazil, ²Escola Superior de Agricultura Luiz de Queiroz, University of Sao Paulo, Brazil.

The results of using lactic acid bacteria in ensiling alfalfa for cattle has been conflicting. This study was conducted to evaluate the effects of microbially inoculated alfalfa haylage on milk production and composition. Twelve multiparous lactating dairy cows (Holstein, 135 DIM) were assigned to a cross-over design with two periods (12 animals/treatment). Treatments were alfalfa haylage (50% DM and 16.5% CP, on average) control or under inoculation with Silobac[®] product (*Lactobacillus plantarum* and *Pediococcus pentosaceus*). Silobac inoculant was chosen among 3 different inoculants and alfalfa among 5 different crops (corn, sorghum, sunflower, elephant-grass and alfalfa) which underwent a prior fermentation test and a in vivo digestibility assay with wethers and showed the best responses to microbial inoculation. Diet contained 50% roughage and 50% concentrate constituted of corn grain, extruded soybean and minerals. Diet was offered twice daily as total mixed ration. The experimental period extended for twenty-one days; the last five for dry matter intake evaluation and the last three for milk sampling. The inoculation did not influence DMI (inoculated = 17.8 kg/d vs. control = 17.8 kg/d), milk yield (23.0 vs. 22.4 kg/d), 4%-FCM (21.0 vs. 20.4 kg/d), milk fat (3.46 vs. 3.47% or 0.781 vs. 0.769 kg/d), milk protein (2.96 vs. 2.93% or 0.674 vs. 0.649 kg/d), lactose (4.64 vs. 4.67% or 1.073 vs. 1.049 kg/d), total solids (11.88 vs. 11.94% or 2.74 vs. 2.65 kg/d), SCC (5.43 vs. 5.16 log 10x3 cells/mL), MUN (11.65 vs. 12.07 mg/dL) or milk density (1030.08 vs. 1030.04 g/ml). These results do not permit recommendation of microbial inoculation of alfalfa haylage. Financial support: FAPESP (Sao Paulo, Brazil).

Key Words: Milk yield, Lactic acid bacteria, Lucerne

1108 The effect of microbial inoculation of alfalfa haylage on ruminal and total digestibility in dry cows . S. Manginelli¹, V. J. Magalhaes¹, P. M. Meyer², and P. H. M. Rodrigues*¹, ¹Faculdade de Medicina Veterinária e Zootecnia, University of Sao Paulo, Brazil, ²Escola Superior de Agricultura Luiz de Queiroz, University of Sao Paulo, Brazil.

The objective was to evaluate the effects of microbially inoculated alfalfa haylage on ruminal and total digestibility in ruminants. Twelve dry cows (Holstein, 670 kg BW) were blocked by body weight and assigned to two treatments: alfalfa haylage (60% DM and 19.5% CP, on average) control or microbially inoculated with Silobac[®] product (*Lactobacillus plantarum* and *Pediococcus pentosaceus*). Silobac inoculant was chosen among 3 different inoculants and alfalfa among 5 different crops (corn, sorghum, sunflower, elephant-grass and alfalfa) which underwent a prior fermentation test and a in vivo digestibility assay with wethers and showed the best responses to microbial inoculation. Diet contained 50% roughage and 50% concentrate constituted of corn grain, extruded soybean and minerals. Diet was offered twice daily as a total mixed ration. In vivo total digestibility was evaluated using chromic oxide and rumen degradability by the nylon bag technique. The experimental period extended for 21 days, the last 10 for adaptation to chromic oxide and the last 5 for feces collection and incubation of bags. The inoculation did not influence total digestibility of DM (inoculated = 70.0% vs. control = 71.2%), CP (72.3% vs. 73.0%), EE (77.0% vs. 76.8%), NFE (74.4% vs. 77.7%), CF (65.4% vs. 60.4%), NDF (61.2% vs. 55.9%), ADF (66.8% vs. 61.8%), gross energy (72.5% vs. 73.7%), TDN (70.6% vs. 71.8%), and DMI (2.6% vs. 2.4% of BW), but it decreased ruminal effective degradability of DM (54.1% vs. 58.6%), CP (79.9% vs. 82.5%) and NDF (29.8% vs. 34.5%), assuming a passage rate of 0.05 (5%/h). These results do not permit recommendation of microbial inoculation of alfalfa haylage.

Key Words: Digestion, Lactic acid bacteria, Lucerne

1109 Effect of feeding carrot pulp silage on digestibility, performance and immune response of sheep. F.T. Sleiman*, R.K. Sarkis, E.K. Barbour, M.G. Uwayjan, and M.N. Nimah, American University of Beirut.

Evaluation of the nutritive value of carrot pulp silage (CPS) and its effect on immune response was made using 12 Awassi ram lambs (60

kg BW) in a 3-wk digestibility study with 1-wk collection period. The experimental treatments were: I)100% barley silage (BS) as control, II)100% CPS, III) 70% CPS +30% ground yellow corn (GYC) and IV) 60% CPS + 40% GYC. All lambs had ad libitum access to the different silage treatments in addition to 1 kg/h/d of a concentrate mixture (14% CP on DM basis). Furthermore, at the beginning of the study, all lambs were subcutaneously injected with 2cc of 50% concentrated chicken RBC as a source of antigen. Blood samples were collected from all animals on days 1,14 and 21 of the experiment. Silage DMI of treatment III was not significantly different ($p>0.05$) from the control (749 Vs 601g/d) but was significantly ($p<0.05$) higher than that of treatments II and IV (389 and 314g/d,respectively). Apparent DM digestibilities of the CPS treatments were significantly ($p<0.05$) higher than that of the BS (78.7, 81.3 and 76.6 Vs 69.2% for treatments II,III,IV and I, respectively). Treatment II had the highest CF digestibility which was only significantly different ($p<0.05$) from treatment IV (65.7 Vs 44.4%). The ADF and NDF digestibilities were not different ($p>0.05$) among treatments. EE digestibility of treatment III was significantly ($p<0.05$) higher than those of treatments I and II (86.6 Vs 72.6 and 73.4%,respectively). The hemagglutination results indicated that the immune response of treatment I at d 21 was significantly ($p<0.05$) higher than that observed at day 1 and 14 (136 Vs 10 and 18,respectively). The high blood titer of the BS treatment detected at d 21 was not different ($p>0.05$) from that of treatments III and IV (136 Vs 40 and 48, respectively). All experimental lambs gained weight by the end of the study. However, BW change was highest for treatments III and I (257 and 240g/d, respectively) which were significantly ($p<0.05$) higher than treatment IV (71g/d). Results indicate that CPS is acceptable to sheep and is efficiently digested with a favorable immune response when properly ensiled and adequately supplemented.

Key Words: Carrot pulp silage, Digestibility, Immune response

1110 Effects of replacing dietary alfalfa silage with formate-treated alfalfa silage or red clover silage on milk production and nutrient utilization in dairy cows. G. A. Broderick* and W. J. Radloff, *U.S. Dairy Forage Research Center, Madison, WI.*

Fifteen Holstein cows averaging 256 DIM were blocked by parity and DIM and randomly assigned to 5 squares in a 3x3 Latin square trial and fed TMR containing (DM basis): 40% control alfalfa silage (CAS), 20% corn silage, 33% high moisture corn, 6% soybean meal (18% CP); 40% ammonium tetraformate-treated alfalfa silage (TAS), 20% corn silage, 33% high moisture corn, 6% soybean meal (18% CP); or 54% red clover silage (RCS), 6% dried molasses, 33% high moisture corn, and 6% soybean meal (16% CP). All diets contained 33% NDF and 38 to 40% NFC. Hay-crop silages differed ($P < 0.01$) in NPN and ADIN (% of total N): 49 and 4% (CAS); 45 and 4% (TAS); and 28 and 17% (RCS). Periods were 4-wk long; data were collected during the last 2-wk of each period and analyzed using proc mixed in SAS. Means separated using a protected LSD ($\alpha = 0.05$) are reported below. Replacing CAS with TAS (with lower NPN) increased DMI, yield of milk, FCM, protein, and SNF, and DM- and N-efficiency. Replacing CAS with RCS (with lower NPN but higher ADIN) also increased DMI and N-efficiency but did not increase yield. Replacing CAS or TAS with RCS lowered MUN and milk NPN, increased apparent digestibility, and diverted N excretion from urine to feces.

Item	CAS	TAS	RCS	SE	P ¹
DMI, kg/d	24.0 ^b	25.0 ^a	24.9 ^a	0.8	< 0.01
BW gain, kg/d	0.31	0.44	0.64	0.16	0.37
Milk, kg/d	27.8 ^b	30.2 ^a	28.4 ^b	1.0	0.01
Milk/DMI	1.16 ^{ab}	1.20 ^a	1.15 ^b	0.03	0.05
Milk N/NI, %	21.1 ^b	22.4 ^a	22.3 ^a	0.4	0.01
3.5% FCM, kg/d	30.3 ^b	32.4 ^a	30.0 ^b	1.2	0.04
Fat, %	4.20 ^a	3.96 ^b	3.95 ^b	0.15	< 0.01
Fat, kg/d	1.14	1.19	1.10	0.06	0.08
Protein, %	3.40 ^a	3.43 ^a	3.29 ^b	0.08	< 0.01
Protein, kg/d	0.93 ^b	1.03 ^a	0.92 ^b	0.04	< 0.01
SNF, %	9.05 ^{ab}	9.12 ^a	8.99 ^b	0.12	0.02
SNF, kg/d	2.48 ^b	2.75 ^a	2.52 ^b	0.10	< 0.01
MUN, mg/dl	17.8 ^a	18.0 ^a	13.8 ^b	0.4	< 0.01
Milk NPN, mg/dl	30.5 ^a	30.9 ^a	23.7 ^b	0.4	< 0.01
Dry matter digestibility, %	57.0 ^b	56.6 ^b	63.3 ^a	1.2	< 0.01
NDF digestibility, %	35.5 ^b	35.6 ^b	53.2 ^a	1.1	< 0.01
Fecal N, kg/d	0.298 ^b	0.318 ^b	0.351 ^a	0.015	< 0.01
Urinary N, kg/d	0.232 ^b	0.231 ^b	0.156 ^a	0.011	< 0.01

¹Probability of significant effect of diet. ^{a,b}Means in rows without common superscripts are different ($P < 0.05$).

Key Words: silage, alfalfa, red clover, ammonium tetraformate

1111 Milk from forage as affected by degradability of carbohydrates in the rumen with alfalfa silage-based rations. E. Charbonneau*¹, P.Y. Chouinard¹, G. Allard¹, H. Lapierre², and D. Pellerin¹, ¹FSAA, *Universite Laval, Qc, Canada*, ²AAC, *Lennoxville, Qc, Canada*.

To optimize the production of milk from forage (MF), previous studies pointed to a better adequacy between the concentrates and the forage served. With alfalfa silage, increasing the rumen degradability of carbohydrates (CD) should lead to a better use of RDP in forages. To evaluate this concept, eight multiparous Holstein cows in early lactation were used in a replicated 4x4 Latin square design with 3-wk periods. Diets were fed as TMR and formulated to provide similar concentrations of NEL and CP while differing in CD. Treatments were: 1) cracked corn (control, low CD), 2) ground corn (medium CD), 3) ground corn plus starch (high CD), 4) ground corn plus dry whey permeate (high CD). Compared to control (22.7 kg/d), DMI increased (24.4 kg/d; $P<0.01$) with ground corn or corn and starch, but dry whey permeate resulted in the highest DMI (25.7 kg/d; $P<0.01$). Milk production with dry whey permeate (35.8 kg/d) was lower than with ground corn or corn and starch (37.5 kg/d; $P<0.01$) but higher than the control (34.0 kg/d; $P<0.01$). Milk fat content was higher with dry whey permeate (3.88%) and lower with corn and starch (3.49%; $P=0.08$); ground corn (3.55%) and control (3.82%) had intermediary values. No changes were observed in protein concentration (3.31%). Treatments had no effects on MF calculated on an energy basis, but ground corn and the corn and starch treatments increased MF calculated on a protein basis (13.2 vs 9.6 kg; $P<0.01$). Overall MF production was higher than control for these last two treatments (7.8 vs 4.7 kg; $P=0.09$). Rumen pH was not affected by treatments. Milk urea was higher with the control diet (13.4 mg/dl; $P<0.01$) compared to the other three treatments (10.1 mg/dl). Increasing CD allowed a better use of N without disturbing ruminal function. Results emphasize the advantages of increasing CD in the rumen to improve the production of milk from forage when feeding silage with high RDP.

Key Words: Milk from Forage, Carbohydrate Degradability, Alfalfa Silage

1112 Effect of different roughages conserved in silage form on the nutrient intake, digestibility and milk production of lactating cows. E.S. Pereira^{*1}, A.M.V. Arruda¹, L.F. Miranda³, L.F. Silva², I.Y. Mizubuti², A. Kraap¹, J.C. Barreto¹, M.A. Syperreck¹, and A.M. Fernandes⁴, ¹UNIOESTE Universidade Estadual do Oeste do Parana, ²Universidade Estadual de Londrina, ³Universidade Federal de Minas Gerais, ⁴Universidade Federal de Viçosa.

The objective of this study were evaluate the effect of different roughages on the nutrient intake and total apparent digestibility of the dry matter (DM), crude protein (CP), organic matter (OM) ether extract (EE), neutral detergent fiber (NDF), total carbohydrates (TC) and non structural carbohydrates (NEC), milk composition and milk production. There were used 12 holstein lactating cows with mean of 30 kg milk production, feeding with three experimental diets, (first) composed by 50 percent of corn silage and 25 percent of ryegrass silage and 25 percent of barley silage; (second) composed by 50 percent of ryegrass silage and 25 percent of corn silage and 25 percent of barley silage; (third) 50 percent of barley silage and 25 percent of corn silage and 25 percent of ryegrass silage. The experiment followed a change over arrangement in the latin square 3 for 3 with extra period. The DM, OM, EE and NDF intakes were not influenced by the roughages sources. The CP intake and total apparent digestibility of the DM, OM, CP, NDF and TC were higher (0.01 probability percentage) for the diets with 50 percent of ryegrass silage. The corrected milk production, or not, for 3.5 percent of fat, the fat and protein milk level, and the feeding efficiency (milk production kg/DM intake kg) were not influenced by the experimental diets.

Key Words: digestibility, intake, milk production

1113 Ingestive behaviour of lactating cows feeding with different roughages conserved in the silage form. Elzania S. Pereira^{*1}, Alex M.V. Arruda¹, Lidia F. Miranda³, Leandro F. Silva², Ivone Y. Mizubuti², Andre Kraap¹, Julio C. Barreto¹, Mirna A. Syperreck¹, and Alberto M. Fernandes⁴, ¹UNIOESTE Universidade Estadual do Oeste do Parana, ²Universidade Estadual de Londrina, ³Universidade Federal de Minas Gerais, ⁴Universidade Federal de Viçosa.

The objective of this study was to evaluate the effect of different roughages on the ingestive behavior of lactating Holstein cows. The cows met between second and third lactation and were in individual stalls, like a tie stall. The experiment followed a change over arrangement in latin square 3 for 3 with an extra period. Twelve lactating Holstein cows with mean of 30 kg milk production, were fed three experimental diets, (first) composed by 50 percent of corn silage and 25 percent of ryegrass silage and 25 percent of barley silage; (second) composed by 50 percent of ryegrass silage and 25 percent of corn silage and 25 percent of barley silage; (third) composed by 50 percent of barley silage and 25 percent of corn silage and 25 percent of ryegrass silage, and all treatments were supplemented with concentrate ration. The animals were submitted to the visual observation every 14 days to evaluate the ingestive behavior, during two consecutive days on the four experimental periods. In the first day of observation the animals were evaluated during three periods of two hours (8 at the 10 hours; 14 at the 16 hours; and 18 at the 20 hours), and the average number of chews ruminating per bolus and the average time spent for this physiological process, being used digital chronometer. In the second day, the ingestive behavior of each cow was determined visually, to intervals of five minutes, for 24 hours, for determination of the time spent feeding and ruminating. There was no significant difference (0.05 probability percentage) for time spent on the feeding and rumination (minutes/day), feeding efficiency and rumination (gDM/h and gNDF/h) of the cows in relationship to the experimental rations. There were no significant differences (0.05 probability percentage) for the number of meals/day, as well as for number of rumination periods. The mean number of 8.31 meals/day was observed, with duration of 36.20 minutes on average and mean of 12.67 rumination periods/day. The ingestive behavior of the lactating cows was not influenced by the dietetic roughages sources.

Key Words: ingestive behavior, ruminations chews, silages

1114 Corn silage chop length and long hay effects on intake, chewing activity, and digestion in early lactating dairy cows. J. Couderc^{*1}, D. Rearte², G. Pieroni², F. Santini², O. Di Marco², and G. Eyherabide², ¹CONICET / PGPA INTA Balcarce-UNMDP, Argentina, ²INTA Balcarce-UNMDP, Argentina.

Five cannulated Holstein cows (24 DIM, initial BW = 575 Kg) in a 5x5 latin square were used to test the effects of two corn silage (CS) chop lengths: 6 mm (FCS) and 23 mm (MCS), and addition of long hay (H) on DMI, chewing, ruminal fermentation, and in situ degradation of CS DM and NDF. Treatments were five TMRs: FCS with H at 0% (F0), 5% (F5), and 10% (F10), and MCS with H at 0% (M0), and 5% (M5). Treatment NDF contents were 32.3%, 32.6%, 38.3%, 33.4%, and 34.7% for F0, F5, F10, M0, and M5, respectively. The DMI tended to be higher in F0 than in M0 ($P < 0.1$), decreased with the H level in FCS diets, and increased with the H level in MCS. Ruminating time tended to be lower ($P < 0.1$) with the addition of 5% H on MCS. Acetic:propionic ratio tended to be higher ($P = 0.11$) in M0. MCS diets had higher ruminal pH ($P < 0.05$) lower NDF degradation Lag time ($P = 0.13$) and higher NDF degradation rate constant ($P < 0.1$). These results suggest that shorter chop length could improve DMI, that the addition of H to FCS has no benefits in ruminal environment and digestion, while depressing the DMI, and that addition of H to MCS could improve ruminal digestion of NDF allowing a high intake, perhaps because of a faster disappearance of NDF from the rumen, which could reduce the filling effect of the diet and the need for rumination.

	Treatments							P value			
	F0	F5	F10	M0	M5	SEM	C ¹	HLF ²	HQF ³	HM ⁴	
DMI,											
Kg×d ⁻¹	25.0	23.1	21.7	22.7	27.1	0.8	0.06	0.01	NS	0.001	
Ruminating,											
min×d ⁻¹	411	430	380	416	432	28.4	NS	NS	NS	0.09	
pH, mean	5.7	5.6	5.7	5.8	5.9	0.6	0.02	NS	NS	NS	
A:P ⁵ Ratio	2.6	2.9	2.5	3.9	2.8	0.5	0.11	NS	NS	NS	
NDF dis-											
appearance											
PD ⁶ , %	51.5	50.2	53.0	53.1	43.5	4.8	NS	NS	NS	NS	
K ⁷ ,											
%×h ⁻¹	2.2	2.0	2.9	2.0	4.4	0.8	NS	NS	NS	0.05	
Lag, h	8.9	7.8	9.5	3.8	3.2	2.3	0.13	NS	NS	NS	

¹C: Effect of CS chop length in diets without H, ²HLF: linear effect of H addition on FCS diets, ³HQF: quadratic effect of H addition on FCS diets, ⁴HM: effect of H addition on MCS diets, ⁵A:P: acetic:propionic. ⁶PD: Potentially digestible NDF. ⁷K: NDF digestion rate constant. NS: $P > 0.15$.

Key Words: corn silage chop length, hay addition, NDF digestion

1115 Corn silage of different chop length as base of mid lactation dairy cows rations 1. Effect on dry matter intake, milk production, live weight gain and body condition score. P. Gregorini^{*}, F. J. Santini, H. H. Fernandez, and D. H. Rearte, Universidad Nacional de Mar del Plata. INTA, Balcarce, Buenos Aires/ Argentina.

The objectives were to evaluate the effects of two different chop lengths of unprocessed WPCS as a base of mid-lactation dairy cows rations. The experiment was carried out to assess, DMI, milk production and composition, live weight gain (LWG) and body condition score (BCS). Sixteen multiparous mid-lactation dairy cows were assigned to two treatments in a completely randomized design for a period of 76 days. The treatments were: Fine (FCH) and Coarse Chop Length (CCH), with 6 and 24 mm of theoretical length of cut (TLC) respectively. The TMRs had (DM basis) 60% of WPCS, 19% of sunflower meal, 19% corn grain, 1% of urea and 1% of minerals salts. Their average chemical composition was similar: DM 42.3%, crude protein 16.8%, *in vitro* DM digestibility (IVDMD) 65%, NDF 34.9%, ADF 22.1% and starch 24.4%. Reducing WPCS chop length increased DMI and LWG. However there were not change in BCS and milk production and. These results suggest that in this situation there are not productive advantages, in the short term, about the reduction of UWPCS chop length.

Item	FCH	CCH	SEM	p value
Milk (kg/d)	25.1	24.5	3.35	0.71
Fat (%)	3.6	3.7	0.03	0.63
Protein (%)	3.5	3.5	0.05	0.85
Lactose (%)	4.8	4.9	0.09	0.7
DMI (kg DM/cow/d)	27.3	26.4	0.01	0.001
LWG (kg)	31	13.4	0.2	0.01
BCS (pts)	0.26	0.28	0.2	0.4

Key Words: Corn Silage, Chop Length, Milk Production

1116 Corn silage of different chop lengths as a base of mid-lactation dairy cow rations. 2. Effect on the ruminal environment and chewing activities. P. Gregorini*, F. J. Santini, H. H. Fernandez, and D. H. Rearte, *Universidad Nacional de Mar del Plata, INTA, Balcarce, Buenos Aires/ Argentina.*

The objectives were to evaluate the effects of two different chop lengths of unprocessed whole plant corn silage (WPCS) as a base of mid-lactation dairy cows rations on total chewing time (TCHT), eating time (ET), rumination time (RT), pH, N-NH3, and volatile fatty acid (VFA) concentration in rumen liquor. Four multiparous mid-lactation dairy cows were used in a 2 x 2 crossover design with two 15-d periods and two treatments. The treatments were: Fine (FCH) and coarse chop length (CCH), with 6 and 24 mm theoretical length of cut (TLC), respectively. The TMR had (DM basis) 60% of WPCS, 19% of sunflower meal, 19% corn grain, 1% of urea and 1% of minerals salts. The average chemical composition was similar: DM 42.3%, crude protein 16.8%, *in vitro* DM digestibility (IVDMD) 65%, NDF 34.9%, ADF 22.1% and starch 24.4%. Reducing WPCS chop length decreased pH and acetic acid concentration, possibly as a consequence of a trend for less RT. These results show the lower physical effectiveness of fine chop WPCS NDF. Nevertheless it could be enough to maintain rumen health and milk fat percentage.

Item	FCH	CCH	SEM	p value
pH	6	6.2	0.09	0.04
NNH3 (mg/dl)	31.9	35.9	1.4	0.12
Total VFA (moles/L)	72.9	67.8	3.2	0.62
Acetate (moles/100 moles)	60	62.7	0.08	0.05
Propionate (moles/100 moles)	22.4	19.9	1.34	0.12
Butirate (moles/100 moles)	12.4	12	0.45	0.2
Others (moles/100 moles)	5.2	5.6	0.47	0.43
TCHT (min/d)	793	813	39.5	0.54
ET (min/d)	360	353	12.3	0.64
RT (min/d)	433	465	24	0.15

Key Words: Corn Silage, Chop Length, Rumen Environment

1117 Replacing corn silage with sorghum silage to supplement growing steers grazing high quality pastures: effects on ruminal fermentation and nutrient digestion. L. O. Abdelhadi*¹²³ and F. J. Santini, ¹*Fac. Cs. Agrarias-UNMdP, ²INTA EEA Balcarce, ³CONICET - Argentina.*

Other studies showed that starch from grain sorghum hybrids was less digestible than starch from corn hybrids, when silage was made without rolling. In order to improve digestibility and to achieve corn silage (CS) responses in beef cattle, grain sorghum silage (SS) must be rolled. The aim of the experiment was to evaluate if replacing CS with SS would affect ruminal fermentation and nutrient digestion of grazing steers. Forty-two British steers (9 months age and 187±26 kg) were assigned to one of three treatments in a randomized design: TP, fresh pasture ad libitum; TCS or TSS, with pasture plus CS or SS, both fine chop and rolled at dough grain stage, representing 40% of the total diet (on a DM basis), respectively. Two paddocks (reps) per treatment and 7 animals per rep were used. All steers grazed in a one-day strips throughout 115 days mixed pastures (70% grass and 30% legumes), with 2975 kg DM/ha availability, 16.0% DM, 22.3% CP, 35.8% NDF and 74.6% IVDMD. Supplements contained 6.1 and 6.7% CP, 50.9 and 42.9% NDF, 13.7 and 22.9% starch, 64.7 and 51.5% IVDMD; and were fed once daily (8h), before steers returned to pasture, for CS and SS, respectively. Four hours after supplementation, fecal (F) and rumen (R) (stomach tube) samples, were taken from all (F) or two (R) steers per rep, twice along the experiment; to determine apparent digestibility and ruminal fermentation parameters, respectively. SS could replace CS without affecting ruminal fermetation, but it reduced starch digestibility. This shows the importance of processing SS if performance similar to CS is expected.

Item	TP	TCS	TSS
Digestibility, %			
DM	72.6 ^a	69.9 ^{ab}	68.0 ^b
CP	83.9 ^a	72.3 ^b	71.7 ^b
Starch	99.6 ^a	98.7 ^a	83.9 ^b
VFA, mmol/L			
Total	100.2	107.2	100.3
Acetate	63.2	68.0	63.7
Propionate	18.4	19.9	18.5
n-Butyrate	10.8	11.7	10.7
A:P ratio	3.51	3.41	3.43
pH	6.74	6.69	6.72
N-NH ₃	24.9 ^a	17.7 ^{ab}	15.9 ^b

^{abc}Means within a row with unlike superscripts differ (*P*<.05)

Key Words: Sorghum Silage, Ruminal Fermentation, Digestibility

1118 Effects of replacing corn silage with superior third of cassava foliage silage on the production of dairy cows. E.C. Modesto¹, G.T. Santos*¹, J.C. Damasceno¹, C.C. Jobim¹, E. Detmann³, and H.V. Petit², ¹*Universidade Estadual de Maringa, ²Agri Food Canada, ³Universidade Federal de Vicosa.*

The objective of the experiment was to study the effects of replacing corn silage with the superior third of cassava foliage silage (STCFS) on the production of dairy cows. Twelve lactating dairy cows were used in a randomized block design to evaluate feed intake, digestibility, milk production, and milk composition. Substitution levels of corn silage with STCFS were 0, 20, 40, and 60 (%) (DM basis) and all diets were isonitrogenous and isoenergetic. The experiment was conducted at the Experimental Farm of Iquatemi of the State University of Maring in Brazil. The parameters studied were: intakes of DM, OM (OMI), CP (CPI), NDF (NFDI), total carbohydrates (TCI), non fibrous carbohydrates (NFCI), all expressed in kg per day; intakes (%) of live weight) of DM (DMILW), OM (OMILW), CP (CPILW), NDF (NFDILW), indigestible neutral fiber detergent (INFDILW); apparent digestibilities of DM (ADDM), OM (ADOM), CP (ADCP), NDF (ADNFD), total carbohydrates (ADTC), non fibrous carbohydrates (ADNFC); 4 (%) FCM yield, pH, acidity, density, fat, protein, lactose, total solid and urea in milk. Substitution of corn silage with STCFS had generally no effect (*P*>0.05) on measurements. However, there was a linear decrease in ADCP (*P*<0,01), CPI (*P*<0,10) and milk density (*P*<0,02) as the level of substitution increased in the diet. The data suggest that superior third of cassava foliate silage is a good replacement for corn silage.

Key Words: Cassava, Milk, Production

1119 Influence of genotype and infestation with European corn borer for nutritive value and quality of fresh and ensiled material from Bt and non-Bt corn hybrids. G. P. Munkvold, M. A. Faust*, and J. A. Schnitzler, *Iowa State University, Ames, Iowa.*

Objectives were to determine mycotoxin levels and composition for fresh and ensiled Bt (MON810 event) and isoline non-Bt corn hybrids. Five replicates of each of four hybrids (Bt and non-Bt for 2 genetic backgrounds) were planted on May 9 and harvested on September 4 when kernels were approximately 1/3 milkline. At harvest, samples of kernels and chopped fresh whole-plant material were evaluated for mycotoxins. Fresh sub-samples of chopped material were frozen for subsequent compositional analyses. Also, 2-3 replicates per sample of chopped whole-plant corn were ensiled using PVC mini silos. After a minimum of 60 d, ensiled material was removed from mini silos and frozen in ziploc bags. Levels of fumonisin B₁ were higher in kernels than in whole plants or silage, and for kernels were lowest for Bt hybrids. Fumonisin B₁ levels did not differ in silage for Bt and non-Bt hybrids, but were higher for silage (6.1 µg/g) than for fresh chopped whole-plant corn (2.7 µg/g). Levels of other mycotoxins were negligible. For silage and fresh samples, presence of the Bt gene was unimportant for most compositional and fermentation measures (*P* > .05). Silage pH was 3.8 ± 0.02 and 3.9 ± 0.02 for samples that were naturally and manually infested with European corn borer larvae, respectively (*P* < .05). Levels for several measures of fermentation products including pH and acetic and iso-butyric acids

were influenced by genetic background of hybrids ($P < .05$). Differences between fresh and ensiled samples for composition generally were not influenced by hybrid genotype or presence of the Bt transgene ($P > .05$). Findings suggest that levels of fumonisin B₁ mycotoxin increased during the ensiling process and further that fermentation end products may be influenced by genetic background of corn hybrids and infestation with European corn borer larvae. Also, the presence of the Bt transgene in corn hybrids did not influence compositional measures and fermentation end products for corn silage.

Key Words: transgenic-plants, fumonisin, *Bacillus-thuringiensis*

1120 Fermentation of non-pasteurized whey with probiotic Lactobacilli for calf feeding. M. Montero^{*1}, F.I. Juárez¹, B.I. Escudero², and H.S. García², ¹CIRGOC-INIFAP, ²UNIDA-Instituto Tecnológico de Veracruz.

The Lactoperoxidase system (LPS) was used on natural whey to reduce microbial counts. Four different probiotic Lactobacilli species were inoculated and the whey fermented. Analyses of pH, titratable acidity,

fat and protein content and total soluble solids were performed, along with total plate count and coliform count. Whey was obtained from nine small rural cheese plants near the city of Veracruz which manufacture cheese from raw milk. The LPS was activated using ratios of sodium thiocyanate:hydrogen peroxide of 1:1, 1:2, 2:2 and 2:1, using as ratio 1:1 the equimolar concentrations of 0.25 mM of the two reagents. Results were analyzed by one-way ANOVA. Non-pasteurized whey was inoculated with *L. acidophilus*, *L. casei*, *L. reuteri* or *Bifidobacterium* sp., fermented at ambient temperature and populations were monitored for 72 h. Results showed a variation coefficient between 13 and 4% in composition of the different wheys, with elevated coliform count (ca. 3.3×10^6 cfu/ml). There was no difference between the thiocyanate:peroxide ratios used to activate the LPS, and only a reduction of 1 log cycle of the coliform count was achieved at best. The probiotic strains reached maximum populations (near 10^7 cfu/ml) between 18 and 36 h; however these populations started to decrease after 48 h and almost disappeared after 72 h. Coliform count decreased to 1×10^3 at 24h and disappeared after 36h. It is concluded that fermented raw whey could be used for calf feeding studies before 48 h post-inoculation.

Key Words: probiotics, lactoperoxidase, whey

Swine Species

1121 Comparing profiles of piglet mortality when administering medium-chain triglycerides, colostrum, oxygen and additional heat. H. Y. Zhang, B. Szkotnicki, M. Z. Fan, V. Osborne, and R. R. Hacker*, *University of Guelph, Guelph, ON, Canada.*

The objective of this study was to reduce piglet mortality during the first 7 d of life by administering medium chain triglycerides (MCT; Ultimate Nutrition, Inc. USA) and bovine colostrum (Col; Zenith Technology Ltd., NZ.) products with supplemental oxygen and/or additional heat. Sows were moved to farrowing crates by d 109 of gestation, and fed a 14% CP corn-soybean meal diet. The farrowing room was maintained at 21C or above and the creep heat zone was maintained above 35C with a 175W IR heat lamp. One hundred and eight sows and respective litters were assigned to an oxygen group (O₂; piglets administered 10-min of 40% oxygen), a heat group with 175W IR heat lamp positioned directly behind the sow (H; the farrowing zone maintained above 31C), or a control group (C). After farrowing, all piglets were randomly force-fed 6 ml of one of following treatment products: (1) water (W), (2) MCT, (3) Col, or (4) MCT plus Col (Mcol). The analysis of variance for 7 d weight gain (WG) was performed with the GLM procedure of SAS. LSD for percentage was used in analyzing the difference in total mortality over the 7 d of life between groups and treatments. The results confirm our earlier discovery that O₂ improved piglet survival whether within litter or between litters ($P < 0.01$). The H reduced piglet mortality by 20% when compared with C ($P > 0.05$). Piglet mortality to 7 d of age with BW under 800 g was different ($P < 0.01$) for the C (83.3%), vs. H (16.7%), and for O₂ (12.5%). MCT and Mcol did not assist in reducing piglet mortality, but Col itself reduced piglet mortality ($P < 0.05$). All piglet treatment products did not influence WG, but H achieved an increase ($P < 0.05$) over the C group. It can be concluded that O₂ is the most effective means for improving piglet survival; an additional heat lamp positioned at the rear of the sow during farrowing is an efficient and practical means for saving small piglets.

Key Words: Oxygen, Heat, Medium-chain triglycerides, Colostrum, Temperature, Piglets, Mortality

1122 Use of a natural carbon-mineral supplement in swine diets: effects on pig growth. S. W. Kim*, F. Ji, and J. J. McGlone, *Texas Tech University.*

A natural, carbon-mineral source (NCM) is a feed supplement that is mined and minimally processed (Promax#, HumaTech, Inc., Houston, TX). Carbon compounds include humic acid, fulvic acid, and other organic compounds and minerals include bioavailable iron and other trace minerals. One hundred twenty pigs, weaned at d 21 of age, were used to determine the effect of NCM on growth performance of pigs from the nursery to growing period. At weaning, pigs were allotted to one of three treatments. Treatments were control, 0.5% NCM supplementation, and 1.0% NCM supplementation. Each treatment had eight replications and each pen-replicate had five pigs. During the nursery period, pigs were

fed based on a three-phase feeding program. Phase 1 was 1-wk post-weaning, phase 2 was 2-wk after phase 1, and phase 3 was another 2-wk after phase 2. Body weight and feed intake were measured weekly. All pigs had free access to diets and water. After a 5 wk nursery period, pigs were moved to a grower facility and two pen-replicates were combined to 4 pen-replicates per treatment. Body weight and feed intake were measured twice during the growing period. Two-phase feeding program was applied to growing pigs. Phase 4 was 48 d after phase 3 and phase 5 was another 15 d after phase 4 until pigs reached 60 kg body weight. There was no difference in average daily gain and feed intake during the phase 1 and 2. However, pigs fed a diet containing 0.5% NCM had a greater ($P < 0.05$) ADG during phase 3 than pigs in other treatments. Average daily feed intake was the same among treatments during phase 3. Gain/feed was greater ($P < 0.05$) in pigs fed a diet containing 0.5% NCM than other treatments during phase 3. There was no difference in average daily gain of pigs among treatment during phase 4 and 5. However, pigs fed the control diet consumed a greater ($P < 0.05$) amount of feed during phase 5 than pigs in other treatments. Gain/feed was greater ($P < 0.05$) in pigs fed a diet containing 0.5% NCM during phase 5 than pigs fed the control diet. This study demonstrated that supplementing NCM at 0.5% level may improve ADG during the late nursery period and efficiency during the late growing period. Further evaluations are required over longer periods.

Key Words: Pigs, Natural carbon mineral, Growth performance

1123 Effects of bromocriptine on immune response of pregnant gilts and foetuses and on foetal development. M. Lessard*, M. Dupuis, and C. Farmer, *Dairy and Swine R and D Centre, Lennoxville, Quebec, Canada.*

To evaluate the effect of prolactin (PRL) on foetal development and on the immune response of pregnant gilts and their foetuses, an inhibitor of PRL synthesis, bromocriptine (BR), was given to 48 crossbred pregnant gilts. These were equally distributed into four groups: controls (CTRL), or 10 mg of BR given per os three times daily for 20 days from day 50 (BR50), 70 (BR70) or 90 (BR90) of gestation. Ovalbumin (OVA) was injected s.c. to all gilts on days 53 and 72 of gestation and serum samples were taken on days 50, 60, 70, 90 and 109. Interferon- γ (IFN- γ) production from blood mononuclear cells isolated from the CTRL and BR50 gilts and stimulated with concanavalinA (ConA) was measured on days 50, 70, 80 and 109 of gestation. Five gilts per treatment were slaughtered on day 110 of gestation and foetal weights were recorded. The spleen and thymus of six foetuses per litter were excised to characterize different lymphocyte populations by flow cytometry and spleens were weighed. The lymphocyte proliferative response to ConA was measured in the spleen of three foetuses per litter from the BR70, BR90 and CTRL groups. No difference was observed in the antibody titers to OVA between the four groups ($P > 0.1$). Production of IFN- γ was greater ($P < 0.04$) in the BR50 than in the CTRL group. Foetal body weights were lower ($P < 0.05$) in the BR50 and BR90 compared to

the CTRL group. Weights of spleens also tended to be lower ($P < 0.07$) in BR50 and were lower ($P < 0.005$) in BR90 fetuses than in CTRL fetuses. Lymphocyte populations in spleens and thymuses of fetuses were not affected by BR ($P > 0.1$). The proliferation of splenocytes in CTRL fetuses tended to be greater ($P < 0.16$) than that in BR90 fetuses. Inhibition of PRL synthesis in pregnant gilts therefore reduces both foetal body and spleen weights and tends to impair the capacity of foetal splenocytes to proliferate, especially when the inhibition is at the end of gestation.

Key Words: Pigs, Gestation, Immunology

1124 Puberty induction and the effect on gilt growth characteristics. H.J. Willis^{*1}, M.J. Zuidhof², A.I. Whelan¹, and G.R. Foxcroft³, ¹Swine Research and Technology Centre (AAFRD), 6909 - 116 Street, Edmonton, AB T6H 4P2, ²Poultry Research Centre (AAFRD), 7000 - 113 Street, Edmonton, AB T6H 5T6, ³Swine Research and Technology Centre, Rm 410 Ag/For Centre, Univ. of Alberta, Edmonton, AB T6G 2P5.

Over 80 percent of replacement gilts are purchased and arrive on-farm at 95-105 kg, 145 to 150 d of age and with 10 to 13 mm of backfat. Increased growth rate, decreased backfat and reduced appetite have been implicated in an increase in culling rate due to locomotor problems and reproductive failure, and consequent decrease in sow longevity in the herd. There is reason to believe that early onset of puberty may decrease postpubertal growth rate and ultimate body size, which may decrease maintenance feed costs and reduce culling rate due to locomotor problems. The purpose of the study was to determine whether inducing early puberty in gilts results in a reduced rate of growth and a smaller mature body size, without compromising reproductive function. At 70 d of age, 40 F1 Manor Hybrid, littermate gilts were balanced across treatments based on growth rate and weight and placed in pens of 5. Gilts were randomly assigned to either 1) receive twice daily boar exposure to induce puberty, beginning at 130 d of age (STIM), or 2) receive no boar exposure for the duration of the experiment (CON). Starting at d 80, individual daily feed intakes were recorded and weekly weight, backfat depth (P2) and loin muscle depth measurements were recorded until d 210. Pubertal and subsequent heats were recorded in both groups of animals. Data was analyzed by ANOVA using the GLM procedure of SAS and age at maximum growth and weight at maturity were estimated using the Gompertz model. There was a significant ($P < 0.05$) difference between age at puberty (149.84 vs 164.93 d), exposure to puberty interval (19.84 vs 34.93 d) and weight at puberty (100.01 vs 111.11 kg) between STIM versus CON gilts, respectively. There was no difference between P2 and loin depth at puberty, calculated age at maximum growth or calculated weight at maturity between treatments. Puberty can be induced using appropriate boar stimulus much earlier than current industry practices. The ultimate benefits of this trial to the industry could be 1) increased production efficiency, 2) improved animal welfare and 3) reduced culling rates of sows.

Key Words: Swine, Puberty, Growth

1125 Reducing odor in swine production: Effect of enzymes and probiotics on ammonia production. F. Ji^{*} and S. W. Kim, Texas Tech University.

Thirty pigs were used to determine the effects of an enzyme complex and a probiotics complex on ammonia reduction from swine manure. A 3 x 3 Latin square design was used for this experiment. Three treatments were control, enzyme treatment, and probiotics treatment. An enzyme complex (EasyBio System) mainly consists of alpha-1,6-galactosidase, beta-1,4-mannanase, and beta-1,4-mannosidase with other minor components. A probiotics complex (EasyBio System) mainly consists of *Bacillus* Sp., *Aspergillus Oryzae*, and *Lactobacillus Acidophilus* with other minor components. The enzyme complex was supplemented to the diet at 0.1% level and the probiotics complex was supplemented at 0.2% level. A metabolic chamber was used as a model to control the environment. A group of ten pigs was assigned to one of three animal groups. Each group was 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 3-d during which aerial ammonia was measured. The temperature inside of the chamber was maintained at 24C and the fan was working continuously during the experimental period. A gas monitor with the sensors for ammonia was used to measure the changes of ammonia during the 3-d collection period with 5 min intervals. Feed intake of pigs during the 3-d collection

period was measured. The initial and final body weights were measured before and after moving pigs to the chamber. Feed intake and initial body weight were used as covariates in analyzing the data. Data were collected for 66 h. Last 48-h was regarded as a data collection period and the first 18-h was regarded as an acclimation period. During the last 48-h pigs fed a diet with the probiotics had a lower ($P < 0.01$) ammonia production than pigs fed a control diet (79% of control). Pigs fed a diet with the enzyme had the same ammonia production when it is compared with the control (99% of control). During the last 24-h, however, enzyme treatment reduced ($P < 0.01$) ammonia production to 93% of control. During the whole experimental period, the regression equation for control group was different ($P < 0.05$) from the regression equation for probiotics group indicating that the ammonia production from probiotics pigs are lower ($P < 0.05$) than that from control pigs.

Key Words: Pig, Odor, Probiotics

1126 Productive performance and specific immunoglobulin G response in sows and their offspring fed a live strain of *Saccharomyces cerevisiae*. L. E. Zapata^{*1}, A. M. Martinez¹, M. A. Coba¹, V. G. Perez-Mendoza², M. L. Angeles², A. M. Anaya², F. Diaz¹, and J. A. Cuaron², ¹CNID-Microbiologia, INIFAP, ²CNI-Fisiologia y Mejoramiento Animal, INIFAP.

Productive performance and variation of serum and lacteal relative concentrations of immunoglobulin G (IgG) was studied in breeding sows immunostimulated by a killed virus pseudorabies (PRV) vaccine injected at d-70 of gestation to a PRV-free population. From d-30 of gestation and through weaning, 50 sows were randomized to 2 treatments: Control and the addition of 3 kg/ton of feed of live *Saccharomyces cerevisiae*, strain SC47 (S47). Sow blood serum samples were collected on d-70 (prior vaccination) and on d-109 of gestation. Lacteal secretion samples were hand collected from random udder sections of each sow at farrowing and on d-14 of lactation. At birth, 4 piglets per sow were randomly selected and blood samples were taken at 0, 6, 17 and 42 hours and on days 6, 15 and 47. Productive performance was measured. Immunoglobulin G concentrations were analyzed using a PRV antibody test. Results were analyzed by ANOVA and repeated measures. Sow feed intake, weight change during lactation, litter size and litter birth weight were not affected ($P > .05$) by treatment, but S47 improved ($P < .01$) litter weaning weight (53.6 vs. 46.5 kg). Colostrum and milk protein and fat were not affected ($P > .1$), but protein and energy yields were greater, because of a larger milk output after S47 addition to the diet. Live S47 addition to the sow's diet resulted in increased anti-PRV-IgG concentrations in serum (collected on d-109) and colostrum ($P < .05$). The greater IgG concentration in S47 treated sow's colostrum induced a higher ($\times 2$) IgG level ($P < .001$) in piglet's serum after birth, which decreased by d-6 of lactation. It is concluded that live S47 in gestation and lactation sow feed induces greater litter weaning weight and increased specific immunity, as depicted in this case by the anti-PRV-IgG.

Key Words: Sow, Specific immunity, Performance

1127 Analysis of the fecal microflora of lactating sows consuming *Saccharomyces cerevisiae*. A. M. Martinez^{*1}, C. Juste², J. Dabard², M. Sutren², C. Bridonneau², F. Beguet², C. Lay², J. Dore², and E. Auclair³, ¹CNID-Microbiologia, INIFAP, Mexico, ²Unite d'Ecologie et de Physiologie du Systeme Digestif, INRA, France, ³Lesaffre International, Marcq-en-Baroeul, France.

A total of 16 sows were used to study the effect of a live culture of *Saccharomyces cerevisiae*, strain SC47 (S47), on the diversity of predominant bacteria in feces by classical microbiological methods and 16S-rDNA based approaches. Starting at d-76 of gestation, and through weaning, sows were randomized to 2 treatments: Control (CTR) and the addition of 3 kg/ton of feed of lyophilized S47. Feces were collected at weaning and were analyzed for total anaerobic bacteria, *enterobacteriaceae*, *streptococci*, *lactobacilli*, and yeast. Identification of bacterial groups of 96 colonies isolated from dominant bacteria in anaerobic chambers was done by colonial and cellular morphologies and was expressed as % of morphotypes; PCR amplicons of the V6-V8 region of bacterial 16S-rDNA were analyzed by temperature gradient gel electrophoresis (TTGE). Performance and microflora data were analyzed by ANOVA, PCR-TTGE profiles were compared using Pearson correlation coefficients. No differences were observed in productive performance ($P > .32$), but lower counts of total bacteria were measured in feces of sows fed S47 (9.9 vs 8.9 UFC/g). The composition (% of morphotypes)

of dominant bacteria grown in anaerobic chambers were similar ($P>.12$) between treatments (CTR vs S47): for *bacteroidaceae*, 10 vs 6.1; *eubacteria*, 35.6 vs 37.1; *clostridia*, 1.1 vs 0.7; *peptostreptococci*, 7.4 vs 6.1; *lactobacilli*, 32.8 vs 38.6; *enterobacteriaceae*, 0.3 vs 0 and other non identified, 12.4 vs 11.5. The TTGE profiles of fecal 16S-rDNA showed differences, with some bands in common, indicating that each individual has a specific bacterial community but some dominant bacterial species are present in all individuals. A comparative analysis of banding patterns showed higher similarities (mean; range) within treatments for sows receiving S47 (94%; 89-98) or CTR (91%; 78-97) than between treatments (88%; 81-95). Inclusion of live S47 yeast in sow's feed did not affect performance, but did show an alteration of fecal microflora. However, a complete 16S-rDNA gene sequence is required to make a precise phylogenetic assignment of each organism that was changed by treatment.

Key Words: Microbiota, *Saccharomyces cerevisiae*, Sows

1128 A good quality meat and bone meal is an effective protein source for piglets if diets are formulated to true ileal digestibility of amino acids. C. Urbano¹, C. H. Dobler¹, and J. A. Cuaron^{*2}, ¹Agroporcina del Centro y PAIEPEME, A.C., Mexico., ²CNI-Fisiología y Mejoramiento Animal, INIFAP, Mexico.

High quality, low immunogenicity feed ingredients is preferred in diets for piglets at weaning, their use is frequently over-valued. This trial was designed to challenge the response of 20±1-d-old weaned piglets to Plasma Protein (PP), a hydrolyzed meat protein (HM) and a good quality meat and bone meal (MB) in Phase 1 and 2 diets. The use of HM and MB was to totally replace PP (at 7, Phase-1 and 3%, Phase-2 diets) in pelleted feed, industrially processed to current Mexican standards. Digestibility for all ingredients was calculated from appropriate prediction equations. The experiment was followed in a commercial operation affected by several diseases (including those of the respiratory syndrome and PRRS), to challenge overall immunological response. A total of 390 piglets (5.76±1 kg initial weight) in 10 experimental units per treatment were used. Performance was measured up to d-63 post-weaning in weekly intervals. Results showed no differences ($P>.3$) in average of daily feed intake or body weight gain (ADG) in any given period, including a compensatory response after a morbid episode. Least squares means after 63d were, for ADG: PP, 0.478; HM, 0.513 and MB, 0.533 kg/d or feed efficiency: PP, 0.448; HM, 0.495 and MB, 0.477 kg of gain/kg of feed consumed. Morbidity occurred after d-17 post-weaning and a difference ($P<.1$) in mortality rate was detected by d-28: PP, 6.07; HM, 2.40 and MB, 3.70%. The difference disappeared by d-63, being an average of 4.6%. The early mortality was noted during serum conversion (from passive to active immunity) to PRRS, suggesting that prevention of immune-challenges (claimed for PP by low antigenicity) could be lowering speed of development of the active immunity capacity. Meat and bone meal is a lower price ingredient with the advantage of an available phosphorus provision, therefore greater return could be expected for swine producers. Results clearly show that a good quality MB could be as effective or more than PP, as long as diets are formulated on a digestible amino acid basis. This supports confidence and prevalence of a good quality MB in diets for other stages of growth.

Key Words: Animal-by-products, Piglets, Feed-formulation

1129 Difference between estimated energy intake and requirements during gestation in sows from a commercial herd. H. Guimont^{*}, R. Bergeron, and J. F. Bernier, Université Laval, Ste-Foy, Québec, Canada.

Controlling energy gain during gestation in sows is critical to optimize reproductive performance and feed intake during lactation. The objective of this study was to determine in a commercial farm, if energy intake of individual sows matched closely their energy requirements estimated with INRAOs factorial model. One hundred and nine sows housed in individual stalls were followed for one gestation. Individual volumetric dispensers delivered feed in a common trough with individual dividers. DE intake was estimated from repeated calibration (7 on average) of dispensers and weekly feed analysis. Sow BW was measured at breeding, and at 110 d of gestation. Backfat thickness at P2 was determined by ultrasound at breeding and at 27, 61, 82, 102 and 112 d of gestation. Activity was measured by direct observation (scan sampling) for

2 h after feeding on two consecutive days at 30, 60 and 100 d of gestation. Litter weight was recorded to estimate DE requirement for gestation. Maintenance DE requirement was calculated from average BW. Energy requirement for sow tissue gain was estimated from BW and P2 thickness. Residual DE intake was calculated by subtracting DE requirements from DE intake. Breeding BW and P2 averaged 228.4±42.6 kg and 18.5±3.6 mm, while farrowing BW and P2 averaged 289.4±34.8 kg and 21.4±4.4 mm, respectively. Residual DE intake averaged 1.4 MJ/d but was highly variable. Residual DE intake was more closely linked to DE requirements ($r=-0.92$) than DE intake ($r=0.26$). Maintenance, gestation and tissue gain represented 76.6, 5.1 and 18.3% of DE requirements, but their correlation (r) with residual DE intake were -0.37, -0.01 and -0.61, respectively. Residual DE intake was not closely related to time standing ($r=0.13$) or lying ($r=-0.18$). These results show that, on this farm, estimated energy requirements of gestating sows corresponded, on average, to their intake. However, individual variation was strong and discrepancies between requirement and intake appear to be related to the estimation of tissue gain.

Key Words: sow feeding, gestation, energy requirements

1130 From farm to table: Effects of a microbial feed additive, *Pediococcus acidilactici* MA18/5M, along the production chain of cooked ham. J. Combes¹, H. Durand^{*2}, E. Chevaux², G. Deschodt³, and Y. Le Treut, ¹University of Tours, France, ²Lallemand Animal Nutrition, Toulouse, France, ³Fleury Michon, Pouzauges, France, ⁴Invivo, Saint-Gregoire, France.

Feed additives have been used primarily to improve animal performances and health. Since recent years, growing consumers' concerns about product quality, food safety and environmental issues have paved the way for a new generation of additives. A lactic acid bacterial strain, *Pediococcus acidilactici* MA 18/M, was developed as a microbial feed additive for swine. In the process of European Registration, the identity, safety and efficacy of the product have been thoroughly documented. However, as far as efficacy is concerned, the trials were focused in performance parameters only (i.e. Daily Weight Gain and Feed Conversion Rate). In order to address new market demands, a trial involving all the levels of production, from farm to slaughter up to cooked ham producer was designed. A herd of 430, 15 weeks-old pigs were split into two comparable groups: one (control) was fed a standard fattening diet without any growth promoter; the other (Pa) received the same feed supplemented with 10E9 CFU of *P. acidilactici* per Kg. The following parameters were measured: 1) On farm: weight gain, feed consumption. 2) At slaughterhouse: carcass weight, lean meat ratio, fresh ham weight, cutting yield, meat pH. 3) In the processing plant: meat composition, drip and cooking losses, fatty acids profile. In addition, a panel of experts assessed the sensorial quality of both fresh meat and cooked ham. On farm, the Pa group performed significantly better than the control, with a Daily Weight Gain of 849 vs 828 g/d. Lean meat ratio (59.1 vs 58.4%) and meat pH (5.91 vs 5.86) were also significantly improved, and the different technological yields were numerically increased. The losses during storage and cooking were numerically lower in the Pa group; the fatty acid profile displayed a trend to higher poly-unsaturated/saturated ratio. Finally, the panel of expert gave significantly higher ($p<0.05$) quotations for flavour, taste and visual aspects of fresh meat as well as processed ham. These data confirm the positive effects of a well equilibrated gut flora, not only on the zootechnical point of view but also all along the downstream chain.

Key Words: Microbial feed additive, Lactic acid bacteria, Meat quality

1131 Effect of micronization on indicators of nutritional quality of peas for pigs. Z. Zhang^{*1}, C.M. Nyachoti¹, S.D. Arntfield¹, W. Guenter¹, S. Cenkowski¹, and I. Seddon², ¹University of Manitoba, Winnipeg, MB, ²Manitoba Agriculture and Food, Winnipeg, MB.

Two in vitro studies were conducted to assess the impact of micronization of peas on lysine availability (LA), starch gelatinization (SG), and water extract viscosity (WEV) as indicators of nutritional quality. In Study 1, a pea variety (cv Croma) and four tempering moistures were used to determine the optimal moisture level for micronization of peas. In Study 2, four varieties of pea: AC Advantage (ACA), Radley (RAD), Carneval (CAR), and an unknown (UNK) variety were used to assess the effect of storage conditions on the nutritive value of micronized peas.

In both studies, 5 kg of each sample were tempered for 18 h to a designated moisture level (i.e. 21, 24, 27, or 30% in Study 1 and 25% in Study 2). The micronized peas were collected at temperature range of 110 to 115C. In Study 2, the samples were stored at either 4C or room temperature for 0, 2, 4, and 6 wk. A 50 g sample of raw, tempered (Study 1 only), or micronized pea was used for LA, SG, and WEV analysis. The results in Study 1 indicated that WEV of micronized peas was significantly reduced ($P < 0.05$) by 48 or 54% and SG temperature was significantly increased by 6.1 or 6.6% as the tempering moisture was increased from 21 to 30%. However, at a tempering moisture greater than 24%, LA tended to decline thus suggesting that 24% moisture is optimal for micronizing peas without compromising its nutritive value. The results in Study 2 indicated that micronization conditions used in this study had no effect ($P > 0.10$) on LA in all 4 pea varieties regardless of storage conditions, except for RAD. Compared to raw peas, WEV of micronized peas at wk 0 was significantly reduced by 16, 24, and 16% ($P < 0.05$) for ACA, RAD, and CAR. SG temperatures were significantly increased by 5.4, 6.2, 7.4, and 10.8% ($P < 0.05$) for ACA, RAD, CAR, UNK, respectively. Overall, the results in two studies suggested that the nutritive value of peas for pigs could be enhanced through proper micronization technology.

Key Words: peas, micronization, nutritive values

1132 Evidence for oocyte penetration rate as an effective indicator of proven boar fertility. Ana Ruiz-Sanchez*¹, Rose O'Donoghue¹, and George Foxcroft¹, ¹*Department of Agricultural, Food and Nutritional Science, University of Alberta.*

The principal objective was to compare *in vitro* fertilization (IVF) techniques with routine semen evaluation characteristics as effective indicators of *in vivo* fertility. Six experimental boars (B-1, R-1, G-1, R-2, G-2 and Y-2) were collected twice a week during a period of 8 months, beginning at 7 months of age. The first sperm rich fraction of all ejaculates was evaluated using standard laboratory procedures for motility, morphology and concentration, diluted to 1.5 billion morphologically normal sperm in 50mL BTS extender, and used to breed approximately 60 gilts. At least seven times during the breeding period, specific aliquots from the first sperm-rich fraction were evaluated using established IVF procedures. Oocyte penetration rate (percentage of matured oocytes penetrated by at least one spermatozoon) was different among boars ($P<0.0001$) and positively correlated with conception rate ($r^2=0.30$; $P<0.0005$) and farrowing rate ($r^2=0.21$; $P< 0.004$). Because of a boar x time interaction for sperm motility ($P<0.001$) and percentage normal sperm ($P<0.05$) on the day of collection, these characteristics were not useful indicators of persistent differences in proven fertility among boars. In particular, compared to other boars, oocyte penetration rate for Boar G-1 was lower (45.5 v 89.9, 76.4, 77.3, 87.9, and 97.31 %; $P<0.0001$) and was associated with lower conception rate (75.1 v 92.3,

83.3, 93.1, 98, and 92.8 %; $P<0.0001$) and farrowing rate (73.7 v 92.3, 81.5, 92, 98, and 91.1 %; $P<0.0001$). However, ranges of motility of raw semen (90 to 80 %) and percent normal sperm (97 to 82 %) for boar G-1 was acceptable and similar to other boars. In conclusion, oocyte penetration rate may be more useful for predicting sperm quality and boar fertility than routine semen evaluation methods. Implementation of this *in vitro* technology should allow swine producers to detect the high fertility boars for use in more efficient AI programs.

Key Words: semen quality, In vitro fertilization, boar fertility

1133 Effects of removing pigs from pens and floor space allocation on growth performance post-removal in finishing pigs. J. M. DeDecker*¹, M. Ellis¹, B. F. Wolter¹, B. P. Corrigan¹, S. E. Curtis¹, E. N. Parr², and D. M. Webel², ¹*University of Illinois, Urbana, IL/USA,* ²*United Feeds, Inc., Sheridan, IN/USA.*

Finishing pigs were removed from pens at different rates to determine the effects of pig removal and floor-space allowance on growth performance for the final 19 d of finishing. Thirty-two pens of crossbred pigs (n = 1664; 52 pigs/pen) were used in a randomized block design to evaluate four pig removal treatments: 1) 0% removed [Control], 2) 25% removed, 3) 50% removed, and 4) 50% removed and floor space/pig reduced to equal that of Control. Pens of pigs (mean BW = 114.9 ± 5.1 kg) were randomly allocated to treatment, and the heaviest animals were removed. Group size and floor space/pig for treatments 1, 2, 3, and 4 were: 52 and 0.65 m², 39 and 0.87 m², 26 and 1.30 m², and 26 and 0.65 m², respectively. Each pen contained a 6-place feeder (212 cm total trough space); however, only 3-places were accessible to pigs in Trt. 4. Pens of pigs with a 25 and 50% removal rate (Trt. 2 and 3) compared to Control had increased ADG ($P < 0.001$) and ADFI ($P < 0.001$), but similar ($P > 0.05$) gain:feed. Pens of pigs with a 50% removal rate and reduced floor space (Trt. 4) had higher ($P < 0.01$) ADG than Control, but similar ($P > 0.05$) ADG compared to the pens of pigs with a 50% removal rate (Trt. 3). No differences ($P > 0.05$) were observed among treatments for either morbidity or mortality. In summary, these results suggest that removing 25 or 50% of the heaviest pigs from within finishing pens increased the growth rate of remaining pigs and that the improvement in performance may only partly be due to increased floor space.

Treatment	1	2	3	4	SEM
ADG, g	668 ^c	836 ^a	813 ^{ab}	762 ^b	22.7
ADFI, g	2826 ^b	3145 ^a	3054 ^a	2891 ^b	44.5
G:F	0.22	0.27	0.24	0.26	0.013

^{a,b,c} Means with different superscripts differ $P < 0.05$

Key Words: Pigs, Pig removal, Floor space

Dairy Foods Chemistry

1134 Changes in fatty acid composition during yogurt processing and their effects on yogurt and probiotic bacteria in milk procured from cows fed with different diets. R. I. Dave*, N. Ramaswamy, and R. J. Baer, *Dairy Science College, South Dakota State University.*

Milk was collected from cow#s fed with four diets consisting control (C), C with 2% fish oil (FO), C with 1% each of fish oil and extruded soybeans (FOES), and C with 2% extruded soybeans (ES). Milks were processed and fermented with starter culture comprised of yogurt (*S. thermophilus* and *L. delbrueckii* ssp. *bulgaricus*) and probiotic (*L. acidophilus* and bifidobacteria) bacteria. Changes in fatty acid composition of yogurt mix and yogurt during manufacture and storage were monitored. Also, changes in viable numbers of starter bacteria were monitored in fresh yogurt and after 30 d storage. Milk fat of cows fed with C, FO, FOES, and ES diets was 3.31, 2.58, 2.94, and 3.47%, respectively. Milk, yogurt mix and yogurt from cows fed with FO or FOES diets showed 4-fold increase ($P < 0.05$) in the concentration of conjugated linoleic acid (CLA) and an increase ($P < 0.05$) in omega-3 fatty acids. Also, the same diet group products had increased concentration of transvaccenic acid (TVA). Unsaturated fatty acids were higher in the milk from cows fed with FO, FOES and ES diets compared to the C diet. The processing

of milk (incorporation of milk powder and heat treatment at 85C for 30 min) did not have any effect ($P > 0.05$) on fatty acids composition, especially CLA, TVA or omega-3 fatty acids. Further, changes in fatty acids composition (as a result of change in diet) did not show any significant effects on the viable numbers of starter bacteria. Also, yogurt bacteria were $> 10^7$ /g and probiotic bacteria were $> 10^5$ /g at the end of 30 d storage periods. Fermentation with yogurt and probiotic bacteria and storage did not alter ($P > 0.05$) the CLA, TVA or omega-3 fatty acids. Thus, probiotic yogurt made from milk with increased CLA and TVA be produced by changing the diets of cows, and it could offer health benefits to consumers.

Key Words: probiotics, CLA, yogurt

1135 Methods of milk storage and age of samples on milk components percentage, somatic cells count and urea nitrogen. P.M. Meyer^{*1}, P.F. Machado¹, A. Coldebella¹, C.H. Corassin¹, L.D. Cassoli¹, C.A. Oliveira¹, and P.H.M. Rodrigues², ¹*Clinica do Leite. Escola Superior de Agricultura Luiz de Queiroz/University of Sao Paulo, Brazil*, ²*Faculdade de Medicina Veterinaria e Zootecnia, University of Sao Paulo, Brazil*.

A trial was conducted to evaluate if different storage methods and age of samples would affect the results of milk analysis. Milk was collected from a bulk tank, poured into 210 vials and preserved with bronopol. Samples were used in a completely randomized design with a 4X5+1 factorial arrangement of treatments. One factor was storage method: 1) refrigerated (R), 2) frozen (F), 3) stored at controlled temperature (CT) or 4) stored at variable temperature (VT) (room temperature and warmed up to 40C for 4 h/day). The other factor was age of samples: 3, 6, 9, 12 and 15 days after collection plus day 0 as control. Samples were analyzed for fat, protein, lactose and total solids (TS) (%), somatic cells count (SCC) (1000cells/mL) and milk urea nitrogen (MUN) (mg/dL). Analysis of variance was done considering the model for this design and subsequently, orthogonal contrasts and regression analysis up to quadratic effect were done. The orthogonal contrasts studied were: control (day 0) against all; cold vs. not cold [(R + F) vs. (CT + VT)]; R vs. F; CT vs. VT within each age. Somatic cells count was analyzed as log transformation (LSCC). Results showed interaction between storage method and age of samples for fat, protein, lactose, TS and LSCC, but not for MUN. Fat showed significant decreases in function of age for CT and VT and the slopes were -0.008 and -0.058%/d, respectively. There were significant linear effects through age for TS and slopes were respectively -0.007, -0.016, -0.013, -0.058%/d for R, F, CT and VT. There were also linear decreases in function of age for LSCC and the slopes were -0.01, -0.006, -0.069 and -0.226 for R, F, CT and VT, respectively. Financial support: FAPESP and CNPq (Brazil)

Key Words: milk composition, preservation, storage

1136 Environmental influences on bovine kappa-casein: Reduction and conversion to fibrillar (amyloid) structures. H. M. Farrell, Jr.^{*}, P. H. Cooke, and E. D. Wickham, *USDA ERRC*.

The caseins of milk form a unique calcium-phosphate transport complex, which provides these necessary nutrients to the neonate. The colloidal stability of these particles is due primarily to kappa-casein. As purified from milk, this protein occurs as spherical particles with a weight average molecular weight of 400,000. The protein exhibits a unique disulfide bonding pattern, which (in the absence of reducing agents) ranges from monomer to octamers and above on SDS-PAGE. Heat treatment of the kappa-casein in the absence of SDS, prior to SDS electrophoresis, caused an apparent increase in the polymeric distribution (up to 60% high molecular weight polymers) presumably promoted by free sulfhydryl groups. To ascertain the role of the sulfhydryl groups, the protein was reduced and carboxymethylated (RCM-kappa). Surprisingly, the RCM- kappa-casein exhibited an increase in weight average molecular weight and tendency to self-association, when studied at 37C by analytical ultracentrifugation. Electron microscopy of the 37C RCM sample showed that in addition to the spherical particles found in the native protein, there was an equal concentration of fibrillar structures. The fibrillar structures were up to 400 nm in length. Circular dichroism (CD) and Fourier transformation infrared (FTIR) spectroscopies were used to investigate the temperature-induced changes in the secondary structure of the native and RCM-kappa-caseins. These studies suggest little change in the distribution of secondary structural elements during this transition with extended strand and beta turns predominating. Based on 3D molecular modeling considerations, there may exist a type of repeated sheet-turn sheet motif in kappa-casein, which may allow for the stacking of the molecules into the fibril structures. Previous studies on amyloid proteins have suggested that such motifs promote fibril formation. The results are discussed with respect to the role that such fibrils may play in the synthesis and secretion of casein micelles in lactating mammary gland.

II

Key Words: Milk Protein, Functionality, Structure

1137 Fatty acid profile of bovine, ovine, and caprine milks. J. Wojtowski, R. Dankow, and R. Skrzypek^{*}, *Agricultural University, Poznan, Poland*.

The objective of our study was to compare the fatty acid composition of bovine, ovine, and caprine milks. The milks were from 60 Holstein x Black-and-White cows, 26 East-Friesian dairy ewes, and 14 White goats. All animals were fed with similar roughages and concentrates, and ewes and goats were housed in the same experimental farm and fed according to the identical pattern. The fatty acid profile of milk-fats was assayed, using the gas chromatography method (HP-5890). The bovine milk-fat contained less fatty acids composed of 12 or less carbons ($P \leq 0.01$), whereas this fat contained significantly more C16:0, and C18:0 ($P \leq 0.01$). In result of this, the differences in total saturated fatty acids contents between bovine and other two milk-fats were insignificant (bovine 70.9%, ovine 71.3%, and caprine 73.8%). The bovine milk-fat had a higher content of monounsaturated fatty acids than ovine milk-fat (27.0% vs. 23.3%; $P \leq 0.01$), whereas the caprine milk fat was intermediate (25.3%; $P \leq 0.05$ relatively to ovine milk-fat). Contrary to this, the content of polyunsaturated fatty acids was lowest in the bovine milk-fat (2.1% bovine vs. 3.4% ovine, and 2.9% caprine; $P \leq 0.01$). Significant differences among species ($P \leq 0.01$) were also found in the ratio of linoleic (18:2n6) : alpha-linolenic (18:3n3) acids. This ratio ranked as follows: ovine 2.3, bovine 3.2, and caprine 3.7. The richest source of alpha-linolenic acid was the ovine milk-fat (1.0% vs. 0.5% bovine, and 0.6% caprine; the differences relatively to the ovine milk-fat were significant at $P \leq 0.01$). Concluding, the amount and profile of polyunsaturated fatty acids in the investigated milks indicates that the ovine milk-fat has a superior nutritive value.

Key Words: Ruminants, Milks, Fatty acid profile

1138 Treatment of microencapsulated β -galactosidase with ozone: Effect on enzyme and microorganism. H. S. Kwak^{*}, J. B. Lee, and J. Ahn, *Dept. Food Science and technology, Sejong University*.

The present study was designed to examine the effect of ozone treatment in microencapsulated β -galactosidase on inactivation of the enzyme and sterilization of microorganism. The efficiency was the highest as 78.4% when the ratio of polyglycerol monostearate (PGMS) was 15:1. Activities of lactase remaining outside the capsule were affected by ozone treatment. With the increase of ozone concentration and duration of ozone treatment, the activity reduced significantly. In sensory aspect, with 2% microcapsule addition, no significant difference in sweetness was found compared with a market milk during 12 d storage. Above result indicated that the additional washing process of lactase was not necessary to inactivate the residual enzyme. In a subsequent study, the vegetative cells of microorganisms were completely killed with 10 ppm for 10 min treatment by ozone. The present study provides evidence that ozone treatment can be used as an inactivation and a sterilization process. In addition, these results suggest that acceptable milk products containing lactase microcapsules made by PGMS can be prepared with ozone treatment.

Key Words: Ozone treatment, Lactase microencapsulation, Milk

1139 Cholesterol removal of Cheddar cheese by β -cyclodextrin. H. S. Kwak^{*}, C. S. Jung, S. Y. Shim, and J. Ahn, *Dept. Food Science and Technology, Sejong University*.

This study was carried out to find a cholesterol removal rate, and changes in flavor, fatty acid and bitter amino acid productions among 3 different treatments of cholesterol reduced cheese. The cheeses were made by 3 different treatments as followings: 1) Control (no homogenization, no β -CD), 2) Trt A (1000 psi milk homogenization, 1% β -CD) and 3) Trt B (cream separation following by 10% β -CD, mixed with skim milk at 1000 psi homogenization). The curds of Trts A and B were softer, more brittle and elastic than that of control during cutting and cheddaring. The cholesterol removals of the cheese were 79.30% (Trt A) and 91.22% (Trt B). The production of short-chain fatty acids (SCFA) increased with storage time in all treatments. The releasing quantity of SCFA was different among treatments at 3 and 7 mo ripening. Not much difference was found in volatile compounds production. In bitter-tasted amino acids, Trts A and B produced much higher than control. In sensory analysis, texture score of control Cheddar cheese significantly increased, however, those in Trts A and B decreased dramatically with

ripening time. Based on our results, we may suggest that homogenization and β -CD treatment resulted in the cholesterol removed Cheddar cheese and a rapid cheese ripening.

Key Words: Cholesterol removal, β -cyclodextrin, Cheddar cheese

1140 Microencapsulated iron for milk fortification. H. S. Kwak*, K. M. Yang, and J. Ahn, *Dept. Food Science and Technology, Sejong University.*

This study was designed to examine the microencapsulation efficiency of iron and to measure the stability and bioavailability of iron microcapsules in milk during storage. Coating material was PGMS and ferric ammonium sulfate was selected as a core material. The highest efficiency of microencapsulation was 75% with 5:1:30 ratio (w/w/v) as coating to core material to distilled water. Iron release was 15% when stored at 4°C for 30 d, and temperature below 20°C did not adversely affect iron release in milk during storage. *in vitro* study, only 3-5% of iron was released in simulated gastric fluid with low pH (3,4,5 and 6). Comparatively, iron release increased dramatically from 12.3% (pH 5) to 95.7% (pH 8) for 40 min incubation in simulated intestinal fluid. In sensory analysis, metallic flavor, color and overall scores were significantly different among commercial market milk, capsulated iron added milk, and uncapsulated iron added milk at 3 d storage. The present study provides evidence that emulsifiers can be used as an effective coating material for iron microencapsulation.

Key Words: Microencapsulation, Iron, Milk

1141 Protein profile and other characteristics of sheep milk. L. Basiricò¹, D. Giontella¹, F. Librandi¹, N. Lacetera¹, B. Ronchi¹, U. Bernabucci^{*1}, and A. Nardone¹, ¹*Department of Animal Production, University of Tuscia, Viterbo, Italy.*

Information about protein fractions of sheep's milk and their variations are limited. The objective of this study was to evaluate changes of protein fractions and other milk characteristics in Sardinian ewes. Thirty-five lactating ewes, which lambed in the period of 8 to 12 December, were selected and monitored from 70 to 200 DIM. Diet was based on pasture, ryegrass hay (on an ad libitum basis) and concentrate (0.6 kg/d). Milk yield was recorded and milk samples were taken at 2 wk intervals. Milk samples were analyzed to determine fat and protein percentages, pH, titratable acidity ($^{\circ}\text{SH}/50\text{ ml}$), freezing point and somatic cell counts (SCC). Skimmed milk was analyzed to determine protein profile and urea concentration. Proteins were separated by SDS-PAGE and quantification of the electrophoretically separated proteins was done by densitometry using bovine serum albumin as external standard. Protein fractions were expressed in g/L. Protein profile of milk showed significant changes during lactation and with the increase in SCC. Concentrations of $\alpha\text{s}1$ -, $\alpha\text{s}2$ -, β - and κ -casein decreased ($P \leq 0.01$), and γ -casein, proteose peptone, IgG and TCP increased ($P \leq 0.01$) with DIM. Time-related changes of protein fractions would indicate an impairment in cheesemaking properties of milk with advancing of lactation. Concentrations of $\alpha\text{s}1$ -, $\alpha\text{s}2$ - and β -casein decreased ($P \leq 0.01$), γ -casein increased ($P \leq 0.01$), and κ -casein did not change with increasing SCC in milk. These results confirm the high susceptibility of αs - and β -casein to proteolytic breakdown. Changes of protein fractions indicated an impairment of cheesemaking properties of sheep milk mainly due to stage of lactation and SCC.

Key Words: Sheep, Milk, Protein fractions

1142 Effect of seasons and breeds on composition and some physico-chemical properties of goat milk. Sophie Turcot^{*1}, Daniel St-Gelais¹, and Abdelghani Ould Baba Ali², ¹*Food Research and Development Centre, Agriculture and Agri-Food Canada, St-Hyacinthe, Quebec,* ²*Laiterie Tournevent Inc., Drummondville, Quebec, Canada.*

In this study, the composition and the physico-chemical properties of milk from five different goat breeds (Toggenburg, Saanen, Alpine, LaMancha and Nubian) were compared. To reduce environmental effects (diet, climate, etc.), the milk from the five breeds was obtained from one producer (farm) in Quebec. Throughout one year, the milk for a given breed was always obtained from the same individuals. For summer, autumn and spring season; milk for every goat breed was sampled

three times. Results indicated that seasons and breeds affected significantly ($P \leq 0.05$) the composition and the physico-chemicals properties of goat milk. For all goat breeds, components were higher in autumn. Moreover, the Nubian milk had the highest fat (3.6%), proteins (4.0%), caseins (2.8%) and ash contents (0.76%) than other goat milks (2.7, 3.3, 2.3 and 0.67%, respectively). Reverse-phase HPLC analysis indicated that goat milk was rich in β -casein (between 45 to 56% of total caseins) and poor in $\alpha\text{s}1$ -casein (8 to 16%). However, the Nubian milk had the lowest β -casein content (42%) and the highest $\alpha\text{s}1$ -casein (26%). For all goat breeds, buffering capacities, hydration of casein micelles and rennet coagulation properties of milk were higher in autumn whereas the casein micelle size was smaller. Results demonstrated that Nubian and Toggenburg milk had different physico-chemical properties probably associated with their specific composition. Variation in composition and physico-chemical properties of goat milk observed during seasons and between goat breeds should be taken into consideration to produce high quality goat dairy products.

Key Words: Goat milk, Composition, Physico-chemical properties

1143 Solution structures of casein peptides: contributions of terminal peptides to the associative behavior of alpha-s1 casein. Edyth L. Malin*, Harold M. Farrell, Jr., Eleanor M. Brown, and Edward D. Wickham, *Eastern Regional Research Center, ARS, U.S. Dept. of Agriculture.*

The N-terminal (f1-23) and C-terminal (f136-196) sections of bovine $\alpha\text{s}1$ -CN-B were characterized under conditions that favored or prevented self-association to determine the contributions of each fragment to the potential for $\alpha\text{s}1$ -CN interactions with itself or with other elements of the casein micelle. There was no evidence for conventional α -helix or β -sheet structures in NMR data for f1-23, and the peptide conformation was thermostable. However, f136-196 NMR studies indicated temperature sensitivity, as did near-UV and far-UV CD data, suggesting molten globule structure at higher temperatures for this fragment. CD results for f1-23 predicted 31% turns and 29% extended (β -sheet like), whereas CD for the larger peptide (f136-196) indicated 27% turns and up to 64% β -sheet. These results are compared with CD studies of intact $\alpha\text{s}1$ -CN. Molecular modeling studies confirmed these estimates in both fragments and in the whole molecule. Recently recognized conformational elements, such as loops and polyproline II helix, are interpreted in accord with evidence regarding the nature of unordered conformations that suggest the possible function of $\alpha\text{s}1$ -CN in facilitating casein-casein interactions.

Key Words: Casein micelle, Alpha-s1 casein, Casein peptides

1144 Validation of capillary electrophoresis for the ultra-rapid determination of inorganic phosphate and citrate in milk. Jesus M. Izco*, Monica Tormo, Phil S. Tong, and Rafael Jimenez-Flores, *Dairy Products Technology Center, Cal Poly University.*

The aim of this work is to optimize a Capillary Electrophoresis method for the ultra-rapid determination of citrate and inorganic phosphate in milk. The quantification of these compounds is very important because their distribution between soluble and colloidal phases of milk, and their interactions with milk proteins influence the stability and some functional properties of dairy products. Various parameters affecting analysis have been optimized, including capillary length, type, composition and pH of the electrolyte, and sample extraction. The separation was carried out on an uncoated capillary (50 cm, 75 μm I.D.) at -25kV for 2.5 min. According to pK_a values for citric and phosphoric acid, pH of the running buffer between 9.5 and 3.0 were tested in order to obtain all the possible ionized forms for both acids and to select the pH yielding the best separation. Ethanol, acetonitrile, sulfuric acid, water at 50°C and at room temperature were tested as sample buffers (SB). Water at room temperature gave the best overall results and was chosen for further validation. The extraction time was checked and could be shortened to less than 1 min. Also, sample preparation was simplified to pipette 12 μl of milk into 1 ml of water containing tartaric acid as an Internal Standard, not being necessary further treatment. The linearity of the method was excellent ($R^2 > 0.999$) with CV values of response factors $< 3\%$. The detection limits for phosphate and citrate were 5.1 and 2.4 nM respectively. The accuracy of the method was calculated for each compound (103.2 and 100.3%). In addition, several commercial samples were analyzed and the results showed a deviation less than 5%

from values obtained when analyzing the samples by official methods. Also, to study the versatility of the technique, other dairy products such as cream cheese, yogurt or Cheddar cheese were analyzed. Accuracy was similar to milk in all products tested. Because of the speed and accuracy of this method, it is promising as an analytical quantitative quality testing technique.

Key Words: Capillary Electrophoresis, Milk, Phosphate and Citrate

1145 Effect of physicochemical parameters on peptide-peptide interactions in a tryptic hydrolysate from β -lactoglobulin. P.E. Groleau*, P. Morin, S.F. Gauthier, and Y. Pouliot, *Centre STELA, Université Laval, Quebec, Canada.*

Previous work showed that decreasing to pH 4.0 a solution of tryptic hydrolysate from β -lactoglobulin (β -LG) reduced its solubility and resulted in peptide aggregation. The objective of this study was to characterize the changes in peptide solubility as affected by some physicochemical conditions. The turbidity of a 1% (w/v) solution of tryptic peptides from β -LG was measured at 500 nm under different physicochemical conditions: temperature of 5°C, 25°C, and 50°C; pH 3 to 10; in the presence of different salt concentration (0, 0.5 and 1M NaCl), denaturing and reducing agents (6M urea, 5% SDS or 5% β -mercaptoethanol). Results confirmed an increase of turbidity of the solution at pH 4, but also, a slight turbidity increase was observed at pH 8. The temperature and ionic strength dependency of the turbidity occurring at pH 4 indicates that hydrophobic interactions are involved in the aggregation process. Turbidity observed at pH 8 was decreased by 5% SDS and SDS- β -mercaptoethanol, suggesting that the aggregation may result from covalent interactions such as disulfide bonds. The peptides present in the precipitate at pH 4 were collected from RP-HPLC and analyzed by mass spectrometry and identified as β -LG 15-20, 41-60, 1-8, and β -LG 41-42 which is released by chymotryptic cleavage. These results suggest that a limited number of peptides species are involved in the aggregation process observed at pH 4.

Key Words: hydrolysate, peptide, turbidity

1146 Total radical trapping potential of whey based edible films containing spice oleoresins and antioxidants as determined by chemiluminescence. Z. Z. Haque*, P. Rantamäki², P. Marnila², and H. Korhonen², ¹Mississippi State University, MS State, MS 39762, ²Food Chemistry, MTT Agrifood Research Finland, FIN-31600 Jokioinen, Finland.

Edible films were cast using a commercial whey protein concentrate (WPC)(75% protein) and a pilot plant manufactured UF WPC (34% protein) from Ayrshire milk. A 1:1 ratio of dry sorbitol and commercially available spice oleoresins and water-soluble oleoresins (Kalsec, Kalamazoo, MI) were used with the WPC at a concentration of 0.3% (v/w) and films were cast using a standard method. Ascorbic acid was used at 0.1% w/w level, and BHT and BHA were also used at 50, 100 and 200 ppm levels. The residual total radical-trapping potential (TRAP) of the films was determined based on measurement of induction time and slope of luminescence peak during oxidation of samples of varying concentrations exposed to a free radical source with constant and known rate of free radical production under aerobic conditions. Luminol was used to induce chemiluminescence caused by radicals from pyrolysis of 2,2,2-azobis(2-amidinopropane)(ABAP). A luminometer was used to monitor the luminescence. Trolox, which binds 2 mol radicals per mol, was used as the reference antioxidant. Textural studies were with a Loyds Instrument. Though there were differences based on the type of WPC used, data showed significant differences in residual TRAP when the water-soluble oleoresins were used and this protective effect varied significantly amongst the oleoresins. Ginger showed the greatest scavenging ability at 6.7 mmol peroxy-radical /g compared to 0.23 for the control film that had no spice oleoresin. Capsicum gave a value of 1.3 mmol under the same conditions. The tensile strength of the films were unaffected by the additives tested.

Key Words: Whey, Edible, Film

1147 Anti-inflammatory factor in bovine colostrum. H Zhang, J. Guo, H. Guan, and L. Li, *Inner Mongolian Agriculture University, Huhhot, P.R. China.*

An anti-inflammatory factor (AIF) was isolated and purified from bovine colostrum using UF ion-exchange chromatography and gel filtration chromatography methods. The anti-inflammatory characteristics of AIF were evaluated. The results were: (1) AIF exerts remarkable anti-inflammatory effects on the rat footpad edema induced by carrageenin and formaldehyde, and can lower the PGE2 level in inflammatory footpad; (2) The optimal pathway for AIF action is IV injection, followed by subcutaneous injection (i.s.), intra-peritoneal (i.p.), and oral parenteral (o.p.) in the order of 67.95%, 61.81%, and 54.69% anti-inflammatory effect compared with IV injection (100%); (3) Through both oral administration and injection, AIF can considerably lower the permeability of mice capillary vessels. Based on the results of this study, it was proposed that the anti-bacteria and anti-inflammation system of colostrum is due to the intestinal local anti-infection effects of immunoglobulins/lactoferrin/lysozyme and lactoperoxidase combined with systemic anti-inflammatory effect of AIF. Therefore, colostrum offers external defense system against infection for neonates.

Key Words: Anti-inflammatory factor, bovine milk, anti-infection

1148 Molecular size and rheological characterization of whey proteins crosslinked by immobilized transglutaminase. V. D. Truong*, V. G. Janolino, G. L. Catignani, and H. E. Swaisgood, *Southeast Dairy Foods Research Center, North Carolina State University, Raleigh.*

Increasing utilization of whey proteins in various food systems has opened up a development opportunity in the dairy industry. To be competitive with other food ingredients, the functionality of milk proteins must be continually improved and designed for specific uses. Physical and chemical methods such as heat treatment and acid hydrolysis are commonly used. Enzymatic methods including transglutaminase are also utilized but the cost of continuous replacement of enzyme hinders its commercial application. A process by which microbial transglutaminase (mTG) immobilized on a glass bead matrix for limited crosslinking of whey protein isolate (WPI) has been developed in our laboratory. This study is a continued effort to characterize the properties of the crosslinked proteins. Large porous glass beads (CPG-3000) were used to immobilize mTG following the biotin-avidin procedure as previously reported. Immobilized mTG (4.9 units/ml beads) and 4% WPI in 50 mM sodium phosphate buffer, pH 6.0 containing 50 mM sodium sulphite and 5 mM calcium chloride (1 to 1000 v/v ratio of enzyme beads-WPI) were placed in a jacketed bioreactor. The reaction was carried out for 5 hrs at 40°C with continuous circulation. Aliquots were taken after 30, 60, 90 and 270 min for molecular weight analysis by laser light scattering technique and rheological characterization using a stress controlled rheometer. Molecular weights and gyration radii (R_g) of the treated WPI increased progressively with reaction time indicating a crosslinking reaction catalyzed by the immobilized mTG. Increased crosslinking of WPI was manifested with an increase in apparent viscosity and changes in gelation properties. The treated WPI exhibited lower gelling points and higher gel strength (increased storage modulus G'). Experiments are in progress to stabilize the enzyme activity for possible scale up of this technology of WPI modification.

Key Words: Whey protein functionality, Molecular size, Transglutaminase

1149 Assessment of hydrophobicity of adsorbed casein layers on latex particle and emulsion surfaces by fluorescence spectroscopy. Jiahong Su and David W. Everett*, *University of Otago, Dunedin, New Zealand.*

The hydrophobicity ($H\Phi$) of sub-micron particles coated with an adsorbed layer of each of the four major caseins (α_{s1} -CN, α_{s2} -CN, β -CN, or κ -CN) was investigated by fluorescence spectroscopy using 1-anilinonaphthalene-8-sulfonic acid (ANS) as a probe. The particles were either 1) low-charge density, sulfated polystyrene latex particles (LP), 2) the same latex coated with isolated native milk fat globule membrane (MFGM) material, or 3) soy oil emulsion droplets (SO) of size 250-350nm and coated with MFGM. The emulsion was produced using a MicrofluidizerTM at 75MPa with 5% oil and 1% MFGM in 20mM

buffer, imidazole at pH6.7 or sodium acetate at pH5.5. Caseins were isolated by ion exchange chromatography and purified by dialysis. MFGM was isolated by cream inversion, casein micelles were removed by washing three times with 0.01M Tris, 2mM MgCl₂ and 0.15M NaCl at pH7.4, and centrifugation at 100,000×g for 50 min at 15°C. Relative Fluorescence Intensity (RFI) was measured at pH5.5 and pH6.7 in the buffers specified previously, and was related to H Φ . These were chosen to represent the pH of fresh milk (6.7) and cheese (5.5). All measurements were made at least in duplicate.

RFI of MFGM decreased by 9.9% at pH5.5 and did not change at pH6.7 when adsorbed onto latex particles compared to free in solution. Caseins both in solution and also adsorbed onto surfaces had less RFI at pH6.7 compared to pH5.5, more so for α_{s1} -CN, α_{s2} -CN, and β -CN. At pH5.5 the decrease in RFI for α_{s1} -CN when adsorbed onto LP, LP+MFGM and SO was 34±13%, 38±21% and 39±49% respectively. The corresponding changes for adsorption onto these three surfaces for α_{s2} -CN was 5.5±13% increase and 19±5% and 2±10% decrease. For κ -CN the increases were 38±35%, 11±27% and 48±46%. The changes for β -CN were 10.9±14.3% decrease, 35±17.4% increase, and there were no conclusive results for adsorption onto the SO surface. Addition of either trypsin or chymosin decreased the RFI for all adsorbed caseins at both pHs. The order of increasing H Φ of casein when adsorbed onto a surface and at both pH values was β -CN < α_{s1} -CN < α_{s2} -CN < κ -CN, at variance with H Φ values when in solution. The ANS probe appears to bind differently to caseins when adsorbed. The results are consistent with κ -CN on the surface of caseins micelles interacting with fat globules coated with MFGM in cheese.

Key Words: Casein, Emulsion, Fluorescence

1150 Extraction of lipids from buttermilk using supercritical carbon dioxide. Johanna C. Astaire*¹, Harit K. Vyas¹, and Rafael Jiménez-Flores¹, ¹Dairy Products Technology Center; California Polytechnic State University, San Luis Obispo.

Buttermilk contains the milk fat globule membrane (MFGM), a material that possesses several lipids known to function as intracellular signaling molecules. For example, certain sphingolipids contained in the MFGM influence apoptotic pathways in cancer cells. These anticancer properties make them good candidates for use as potential therapeutic agents, or health enhancing supplements. In order to purify these potentially beneficial lipids without the use of conventional lipid extraction solvents not generally recognized as safe, we employed supercritical fluid extraction (SFE) using carbon dioxide as the only solvent. SFE is a method that employs achieving a solvent's supercritical state by using temperature and pressure conditions above a solvent's critical temperature and pressure points; carbon dioxide is frequently used as the solvent. In this state the solvent possesses a gas-like viscosity, allowing it to easily infiltrate a variety of samples. When introduced to the solvent specific compounds are solubilized, allowing them to be separated when the solvent is returned to ambient conditions. By optimizing conditions to remove nonpolar lipids with SFE we increased the purity of the MFGM lipids in our starting product; buttermilk powder, and microfiltered buttermilk powder processed to concentrate the MFGM were used. The conditions of extraction were 32 MPa, 333 Kelvin, and a constant flow rate of carbon dioxide at 25 g/min over two duplicate runs of 100 minutes. Thin Layer Chromatography (TLC) was used to obtain lipid profiles of the starting sample before and after extraction, and the product removed from the sample. The following solvent systems were used: petroleum ether:ethyl ether:acetic acid (85:15:1)(v:v) to analyze nonpolar lipids, and chloroform:methanol:water (65:25:4)(v:v) to analyze polar lipids (including the MFGM lipids). Standards were used to verify lipids present. The extraction process removed a fraction containing all nonpolar lipids, while the remaining sample retained all the MFGM polar lipids of interest.

Key Words: Buttermilk, Milk fat globule membrane (MFGM), Supercritical fluid extraction (SFE)

1151 Variability in atherogenic and thrombogenic potential of milk fat of standard and elevated *cis*-9, *trans*-11 CLA content. D. G. Peterson*¹, C. M. Luhman², J. A. Kelsey¹, and D. E. Bauman¹, ¹Cornell University, Ithaca, NY, ²Land O'Lakes Research Farm, Webster City, IA.

Many investigations have demonstrated the plasticity of milk fatty acid composition in response to dietary manipulation and a related area of

recent focus is the effect of diet on milk fat content of CLA. In humans, dietary lipids are a factor known to contribute to coronary heart disease and the possible role of saturated and unsaturated fatty acids as well as specific fatty acids has been an active area of research. Several methods have been devised to indicate the healthfulness of dietary fats ranging from the simple polyunsaturated to saturated fat ratio to the more complete atherogenic and thrombogenic indices of Ulbricht and Southgate (The Lancet, 1991, 338:985-992) that are based on the content of specific fatty acids. The variation in these indices among individual dairy cows has not previously been evaluated. We analyzed the variation in atherogenic and thrombogenic indices in milk fat among 30 Holstein cows fed a control diet, a CLA-elevating diet, or switched between the two diets at 3 wk intervals for a total of 12 wk. We found the average atherogenic and thrombogenic indices for milk fat to decrease in response to a CLA-elevating diet (1.65 vs. 1.15 and 3.52 vs. 2.58, respectively), indicating a more desirable fatty acid composition. Examination of individual variation demonstrated an approximate 2-fold range in atherogenic and thrombogenic indices among cows within a treatment group, although we also observed a high degree of consistency among individual animals over time. Comparisons of individuals in the group that switched between diets indicated that some animals responded dramatically to dietary treatment while others responded very little. This study demonstrates that there is substantial animal-to-animal variability not only in *cis*-9, *trans*-11 CLA content, but also in the plasticity of milk fat and its atherogenic and thrombogenic potential.

Key Words: CLA, Atherogenic Index, Variation

1152 Thermodynamical Equilibrium between *cis*#9,*trans*#11 and *trans*#8,*cis*#10 Conjugated Linoleic Acid (CLA) Isomers in Butter and Ruminant Fats. F. Destaillets*, C. Japiot, PY Chouinard, and P. Angers, Dairy Research Center (STELA), Laval University, Quebec, Canada.

Rumenic (*cis*-9,*trans*-11 C18:2) acid is the main CLA isomer in milk and ruminant fats. This fatty acid is partially isomerized into *trans*-8,*cis*-10 C18:2 acid when submitted to thermal treatment. Structure of the formed isomer was confirmed by mass-spectrometry of its 4,4-dimethylxazoline derivative. The rate of isomerization was assessed by heating pure methyl rumenate. Usual anhydrous butterfat, high CLA butter (produced by feeding cows with sunflower oil), unrefined beef and deer tallows were heated at 200°C for 2, 4 and 6 hours under aerobic condition. Isomerization of rumenic acid were followed by gas-liquid chromatography analysis using a 120 m capillary column coated with 70 % equivalent cyanoalkylpolysiloxane material. Analysis shown that after 6 h at 200°C, about 60 % of rumenic acid was converted into *trans*-8,*cis*-10 C18:2. This study has shown that following thermal treatment, *trans*#8,*cis*#10 C18:2 acid became the second major CLA isomer in milk and ruminant fats.

Key Words: Conjugated linoleic acid, modified milk fat, thermal reaction

1153 Effect of flax oil emulsion processing conditions on the oxidative stability of omega-3 enriched milk beverages. S. Lamothe*¹, L.P. Des Marchais¹, G. Trudeau², and M. Britten¹, ¹FRDC, Agriculture and Agri-Food Canada, St-Hyacinthe, Qc, Canada, ²Agropur, Granby, Qc, Canada.

Enrichment of milk with flax oil could provide adequate supply of omega-3 fatty acids without changing eating habits. However, flax oil is sensitive to oxidative degradation. Pre-homogenization of flax oil is proposed as a treatment to prevent oxidation. The purpose of this work was to determine the effect of processing conditions on the characteristics of flax oil emulsions and to measure creaming and oxidation stability of enriched milk. Flax oil emulsions were prepared in milk UF-permeate with sodium caseinate or whey protein isolate according to a complete factorial design. Processing variables were: protein concentration (1, 5%), oil volume fraction (10, 20%) and homogenization pressure (2000, 6000 psi). Emulsions were added to milk to reach 0.25% flax oil in the final product. Light reflectance profiles of milk samples were recorded after 2 weeks storage to determine the creaming index. High homogenization pressure and high protein content reduced droplet size of flax oil emulsions and improved creaming stability in milk. Milk samples were exposed to light and thiobarbituric acid reactive substances (TBARS) were monitored over a 40-hour period. The type of protein used to prepare flax oil emulsions had a strong influence on light-induced milk oxidation. After the exposition period, TBARS concentration in milks

enriched with casein and whey protein based emulsions averaged 7.2 and 4.0 $\mu\text{mol/L}$ respectively. Homogenization conditions leading to smaller droplet size increased final TBARS concentration in milk. This relationship suggests that increasing the emulsion surface area enhances susceptibility to oxidation. However, the improved stability observed with whey protein-based emulsions could not be attributed to oil droplet size. Droplet size was slightly lower in whey compared to casein-based emulsions. We conclude that the amino acid composition of the whey protein layer surrounding fat droplets is responsible for flax oil protection against oxidation.

Key Words: flax oil, fluid milk, oxidation

1154 Fe²⁺-induced cold gelation of whey protein: One strategy for increases iron bioavailability. G. Remondetto¹, E. Beyssac², and M. Subirade¹, ¹*Institut des nutraceutiques et des aliments fonctionnels, FSAA (Universite Laval)*, ²*ERT CIDAM, Faculté de Pharmacie, Université d'Auvergne, Clermont-Ferrand, France.*

Today, more than 2 billion people worldwide are iron deficient. An interesting solution to this problem consists in fortifying foods with iron. But incorporating iron into complex systems can lead to its oxidation or precipitation and affect its bioavailability (Hurrell, 1998). Proteins, such as biopolymers, may form ordered networks (i.e., gels) that trap water molecules (Clark & Ross-Murphy, 1987). Among the proteins, whey proteins (sub-products from cheese manufacture) are extensively used in foods, because of their high nutritional value and their ability to form gels. In the traditional gelling process, an aqueous solution containing native whey proteins had to be heated to above 65°C. More recently, the gelling of whey protein at low temperatures was successfully carried out by adding Ca²⁺ to a preheated protein suspension (Barbut & Foegeding, 1993; Bryant & McClements; 2000). In a previous study (Remondetto et al., 2001), we developed and examined the cold-gelling process in the presence of iron. Depending on the conditions used, we were able to identify two types of gel formation (i.e., filamentous and random aggregate), each with its distinctive physicochemical properties. By characterizing the gelling processes using FTIR and rheological methodologies, we were able to establish the gelation mechanism of the different gel types (Remondetto & Subirade, 2002). The objective of this work was to analyze the impact of gel microstructures (i.e., filamentous vs. random aggregate) on iron release under gastrointestinal conditions. An in vitro dissolution apparatus was carried out using a technical standard of the USP (United State Pharmacopeia). Our findings show that the random aggregate gels release higher levels of iron than filamentous gels under gastric conditions; the opposite is observed under intestinal conditions. In conclusion, the results obtained suggest that the transport and protection of iron inside a filamentous protein network allow for more iron to be released at the intestinal level, under conditions that favor the presence of amino acids, and, thus, increases iron bioavailability.

Key Words: Protein, Cold gelation, Iron bioavailability

1155 Effect of heat treatment on carnitine in milk and model systems. C. R. Smith*, M. Cattie, and M. R. Guo, *University of Vermont, Burlington VT USA.*

Carnitine is widely used in formulations of sports beverages, infant formulas, and nutritional supplements. The principal function of carnitine (beta-hydroxy-gamma-trimethylaminobutyrate) is transport of long-chain fatty acids into the mitochondria for beta-oxidation. Carnitine is added to sports drinks as a putative enhancer of fatty acid oxidation, which is essential to endurance and strenuous sports performance. In infant formula, carnitine is supplied in bovine milk or added as a nutrient during manufacturing, as infants cannot synthesize adequate carnitine. In this study, the levels of carnitine in the samples (milk, beverages, infant formulas, and the model system) were analyzed by a colorimetric method. The effect of heat treatment on carnitine-fortified skim milk (20 mg/l) and pure solutions (100 mg/l), and the distribution of carnitine in skim milk were also investigated. The samples were heated at 63°C for 30 min, at 70, 80, 90, and 100°C for 10 min, and 121°C for 12 min. Heat-treated skim milk samples were centrifuged at 45,000 X g for 2 hours at 4°C to obtain serum and pellet fractions. Analysis of sports drinks, milks, and infant formulas revealed carnitine levels that ranged between 3-49 mg carnitine/100ml. Carnitine in pure solution remained stable at all heat treatments. However,

in carnitine-fortified skim milk, there was a steady decline in carnitine level with increasing temperature, reaching a total loss of 16% by 121°C compared to unheated control. Approximately 98% of carnitine in skim milk and carnitine-fortified skim milk was recovered in the serum fraction. Further investigation is needed to determine the effect of heating conditions (i.e., pH/buffer) and interactions between carnitine and other components in foods.

Key Words: Heat treatment, carnitine, milk

1156 Effects of seasonal and regional variations in milk components on the buffering capacity of milk in California. A Harris*¹, P Tong¹, S Vink¹, J Izco¹, and R Jimenez-Flores¹, ¹*California Polytechnic State University.*

Milk samples from thirteen California dairy processing (cheese, fluid milk, butter and powder) facilities were examined over one year to understand seasonal and regional variations in buffering capacity. Total protein, casein, inorganic phosphate and citrate levels were analyzed to assess their impact on the buffering capacity. These components have been found to have the greatest impact on buffering capacity. Little seems to have been done to correlate those seasonal changes with seasonal differences in buffering capacity.

Samples from the 13 dairy facilities were taken two times per month. Individual samples, as well as combined monthly samples, were stored frozen and thawed prior to sampling for analysis. Composite monthly samples were analyzed for total protein and casein, while individual, bi-weekly samples were examined for phosphate and citrate. Citrate and phosphate concentrations were analyzed simultaneously using a rapid Capillary Electrophoresis method. Total nitrogen, non-casein nitrogen, and non-protein nitrogen were measured by Kjeldahl Nitrogen determination. Forward titration curves were obtained by acidification of milk to measure buffering capacity.

The lowest buffering capacity values were witnessed in samples during the September sampling (18.51 0.17 ml of titrant required to achieve pH 4.0). Maximum buffering values were reached in December (19.20 0.23 ml of titrant). These trends were also witnessed in casein, phosphate and citrate with citrate and phosphate values peaking earlier in the year than casein. It is likely that the variations in buffering capacity and the associated relationships to variability in milk composition can be traced back to known effects of feed, stage of lactation, breed and other dairy farm management practices.

Key Words: Buffering Capacity, Citrate, Phosphate

1157 Rheological characterization and comparison of derivatized whey protein ingredients. J.J Resch* and C.R. Daubert, *North Carolina State University, Department of Food Science, Raleigh, NC 27695-7624.*

The gelling ability of whey proteins provides important textural properties in many foods. However, because certain food products cannot be heated to the temperature needed for thermal gelation, cold-set gelation of whey proteins is advantageous for the food industry. A cold-gelling whey protein ingredient would also confer nutritional benefits not obtained from cold-gelling starches and hydrocolloids.

A derivatization procedure was developed for the production of a cold-gelling, whey protein isolate (WPI) ingredient, consisting of protein hydration, pH adjustment, thermal gelation, freeze drying, and milling. However, because freeze drying and WPI are expensive, commercial applications of this derivatized WPI ingredient may be cost prohibitive. Therefore, the derivatization procedure was modified by developing a spray drying operation to replace the freeze-drying step and was applied to whey protein concentrate (WPC) to create a more economical cold-set thickening ingredient. The objective of this study was to rheologically characterize the ingredients produced by the original and modified derivatization procedures and to make comparisons with other commercially available polysaccharide thickeners.

The resulting derivatized WPC powders, along with pre-gelatinized starch, guar gum, and xanthan gum, were reconstituted in water and evaluated through a range of rheological studies. The effects of temperature, concentration, pH, and shear on viscosity as well as the mechanical spectra were assessed to characterize the ability of the powders to function in food systems. The rheological characterization revealed the modified derivatization procedure yielded an ingredient capable of the same cold-set thickening and gelling ability over a wide array of environments as the original derivatized powder. The modified whey proteins

were also able to achieve, at higher usage levels, textural properties similar to several polysaccharide thickeners. Incorporation of spray drying created a more economical process for the production of a whey protein ingredient suitable for contributing viscosity and texture to a wide range of food systems.

Key Words: Whey protein, Cold-gelling, Spray drying

1158 Monthly and regional variation in nitrogen and protein distribution of milk in California manufacturing plants. Phillip Tong* and Sean Vink, *California Polytechnic State University.*

Good information concerning the protein content of milk is useful in discussions of milk pricing, manufacturing yields, and product composition control. The objective of this study was to generate information on the current composition of milk received at California dairy product manufacturing plants.

Thirteen plants from throughout California participated in the study which was undertaken from May, 2000 through April, 2001. Milk samples from all silos of milk received for a given day for a given plant were taken two times per month and blended in proportion to the amount of milk represented by each silo to make a pooled composite monthly sample. Each composite monthly sample was analyzed for total nitrogen,

non-casein nitrogen, and non-protein nitrogen by Kjeldahl methods. Total protein, casein and casein as a percent of total protein were then calculated.

Plant average crude protein (total nitrogen X 6.38) ranged from 3.19% to 3.40%. Plant average true protein ((total nitrogen - non-protein nitrogen) X 6.38), ranged from 3.00% to 3.20%. Casein as a percent of crude or true protein ranged from 76.8% to 77.9%, and 81.6% to 82.7%, respectively. Analysis of monthly variation in milk composition for all plants indicates that protein content was the lowest (approximately 3.2%) in the months of June through August) and the highest (approximately 3.4%) in the months of November through January. Although the number of plants in each region was small, the data indicate that Southern California region has lowest total crude protein and lowest casein as a percent of total protein compared to the other four regions (South San Joaquin Valley, North Central/Sacramento, North Bay Area). Casein as a percent of crude total protein averaged 76.8%, 77.1%, 77.1%, and 77.8% for South San Joaquin Valley, North Central/Sacramento, North Bay Area, respectively.

These results suggest protein content of milks received in California dairy manufacturing plants varied among regions and with time of year.

Key Words: California, milk, protein

Goat Species

1159 Use of 48-hour kid removal to decrease the post-partum rebreeding interval in meat does. C. M. Fletcher*, D. J. Jackson, and N. C. Whitley, *University of Maryland Eastern Shore.*

The objective was to examine the effectiveness of early kid removal in decreasing the post-partum rebreeding interval in goats. Boer and Boer crossbred meat-type does ($n = 25$) and bucks ($n = 4$) were used. Does had kidded in the Fall of the year and were allotted into two groups based on day of lactation and number of nursing kids. All does were housed together in a 67 m x 34 m dry lot pen, fed hay and a corn/soybean meal diet with water ad libitum. Does were injected intramuscularly with 7.5 mg PGF₂ α (Lutalyse, Pharmacia & Upjohn, Kalamazoo, MI; 1.5 cc) on approximately 28.1 \pm 0.8 days of lactation ($d = 0$). At the time of injection, kids from thirteen does (treatment group) were moved to a nearby barn while kids from twelve does (control group) were left with their dams. Kids from does in the treatment group were returned on d 2, while kids nursing does in the control group remained throughout the duration of the experiment. At kid removal, bucks wearing marking harnesses were introduced and remained for 10 days. Females were checked for estrus twice daily and number of animals bred was recorded to determine days to first mating and percentage bred (number bred/number exposed x 100%). In a subset of does (8 control, 11 treated), a milk sample was collected at 47.1 \pm 0.4 days after mating for pregnancy determination using a commercial bovine milk progesterone test (Target Rapid Progesterone Milk Test; BioMetallics, Princeton, NJ). Days to first mating was less ($P < 0.05$) for does whose kids were removed (1.5 \pm 0.4 days) compared to control does (2.8 \pm 0.4 days). In addition, by d 5, the percentage of does bred was greater ($P = 0.053$) for treated does (100 \pm 0.1%) compared to control does (74.6 \pm 0.1%). However, by day 10 of the experiment, all does had been mated. In the does tested, there was no difference in pregnancy rates, and the average was 73.7 \pm 0.1%. In conclusion, early kid removal decreased the post-partum interval, but was not necessary for inducing post-partum mating during the breeding season. However, further studies are needed to determine if pregnancy rates could be increased.

Key Words: postpartum, doe, breeding

1160 Reproductive seasonality in Spanish and Boer x Spanish does in south Texas. M. A. Lerma*¹ and R. L. Stanko^{1,2}, ¹Texas A&M University-Kingsville, Kingsville, TX, ²Texas Agricultural Research Station, Beeville, TX.

Seasonal breeding patterns of goat breeds is a major obstacle to increasing the intensity of meat goat production in temperate regions of the U.S. We conducted two experiments in TX (27° N latitude) to better define meat goat reproductive seasonality. In Exp. 1, Spanish (S,

$n=11$) and Boer x Spanish F₁ (%B, $n=5$) does were monitored for estrous cyclicity over 400 d. Blood samples for progesterone (P₄) determination were obtained weekly, beginning at the vernal equinox (March 21) of Yr 1 through May 3 of Yr 2. Does were kept together in a 2 hectare paddock and had ad libitum access to native forage and sudan hay. Does were group fed daily .45 kg \cdot hd⁻¹ of a commercial pellet (15% CP). Fence line exposure to a fertile buck began on April 26 of Yr 1. Does were anestrus prior to buck exposure. Days from buck exposure to elevated P₄ was similar ($P>0.1$) between S (44 \pm 1) and %B (59 \pm 20) does. A single estrous cycle was exhibited by 15/16 does followed by a summer anestrus period. Length of summer anestrus was similar ($P>0.1$) between S (77 \pm 1 d) and %B (83 \pm 6 d) does. A fertile buck was introduced on Oct. 1 for breeding. A subset ($n=6$) of S does were not exposed to the buck and continued regular estrous cycles until early-Feb. Mean Julian d to onset of anestrus was 40.5 \pm 5.2 and continued throughout the experiment. In Exp. 2, 31 mature, anestrus does of S ($n=21$) and %B ($n=10$) genetics were used to evaluate summer breeding. Weekly blood samples were obtained from June 1 to Oct. 1. Does were allocated to fertile S ($n=2$) or Boer ($n=2$) bucks on June 22. Days from buck exposure to elevated P₄ and level of P₄ were similar ($P>0.1$) between S and %B does. Pregnancy rate (95 % vs. 100%) and % kid crop (200 vs. 210) were similar ($P>0.1$) between S and %B does, respectively. Seasonal anestrus is evident in TX meat goats; however, a male-stimulated, summer breeding season may increase production potential.

Key Words: Goat, Reproduction, Seasonality

1161 A model to test the effect of manipulating photoperiod on the liveweight gain of goats in southern Queensland, Australia. M Flint*¹ and P.J. Murray², ¹School of Veterinary Science, The University of Queensland, St Lucia, Queensland 4072, Australia, ²School of Animal Studies, The University of Queensland, Gatton Campus, Queensland 4343, Australia.

In Australia irrespective of feed intake, goats undergo a period of growth stasis during winter. In feedlots, this results in loss of potential sales of goat meat to overseas markets. In a study using rats as a physiological model for goats, 56 sub adult rats (*Rattus norvegicus*) of the black and white hooded strain (starting weight 68.8 SD 16.8 g) were examined for liveweight gain (LWG) and feed intake over 42 days. The experiment compared combinations of two temperature and two light regimes; mimicking a constant summer temperature (26C) and a constant winter temperature (18C), and a diurnal 'summer' day length (12 hours of light per day) and a diurnal 'winter' day length (6 hours of light per day). With respect to LWG, we found that winter day length (winter day = 5.0 g/d vs summer day = 4.7 g/d LWG; $P = 0.001$) was more influential than winter ambient temperature (winter temperature = 4.9 g/d

vs summer temperature = 4.8 g/d LWG; $P = 0.12$). Greater LWG during the winter light regime may be due to rats being nocturnal feeders, unlike goats which are diurnal feeders. However, a greater efficiency of conversion of feed into LWG occurred under summer temperatures when compared with winter temperatures (3.4:1 and 3.8:1, respectively; $P < 0.05$) whereas day length appeared to have minimal effect (3.5:1 and 3.7:1, respectively; $P > 0.05$). The implications of these findings to goat meat production, particularly when lot feeding, are that artificially extending day light hours during winter may result in liveweight gains equivalent to that experienced during summer but at the cost of a reduced feed conversion efficiency. Extending day light may reduce the effects of growth stasis in goats during winter and allow lot feeding for 42 days prior to slaughter to continue on a year-round basis. These findings remain to be tested using goats in a feedlot.

Key Words: Goat Feedlot, Photoperiod, Rat Model

1162 Effect of sun radiation on plasma cortisol levels in goats under high ambient temperature. R. Rodríguez-Martínez^{*1}, F. Sánchez², R. Bañuelos-Valenzuela³, C. F. Arechiga³, and M. Arenas², ¹Universidad Autónoma Agraria Antonio Narro, U.L. Torreon, Coah., Mexico, ²Universidad Autónoma Metropolitana Xochimilco, D.F. Mexico, ³Universidad Autónoma de Zacatecas, Zacatecas, México.

Two trials were conducted to study the effect of sun radiation exposure under high ambient temperature (over 30°C) on plasma cortisol level in different goat breeds from a flock located in the north of Mexico (2606' NL, 10326' WL, 1092 masl). Samples of blood plasma were obtained at 13:00 and 17:00 h in days 1, 2, 8 and 9, from 15 Alpine and 15 Nubian yearling and non pregnant goats exposed to sun radiation (R) in a paddock without shade, and from the same number of goat and breeds in a paddock with shadow area (S). The trial was repeated the following year, but with two groups of 5 Alpine, 5 Saanen and 5 Granadinas each, and blood sampling in days 1, 2, 3 and 4. Plasma cortisol was determined by RIA. Daily mean cortisol levels per goat and sampling day were calculated and split-plot analysis of variance were conducted separately for each breed within trial. Lower cortisol means ($P < 0.05$) in R vs S goats were observed in Alpine and Saanen breeds. A similar, but non significant ($P > 0.05$) trend was observed in Nubians and Granadinas. These results suggest a different response in cortisol levels among breeds to cope the extra heat load in R groups and a probably greater sensitivity in Alpine origin breeds than in Granadinas and Nubians. Further research on the role of other variables such as corticotropin-releasing hormone (CRH) and CRH-binding protein, or the study of gene expression differences may explain how goats deal with high ambient temperature, and how it affects productive and reproductive performance.

Key Words: Heat stress, Goat breeds, Cortisol response

1163 Blood metabolites, visceral organ mass, meat quality, and calpain system in goats treated with low doses of bovine Somatotropin hormone. B. Kouakou^{*1}, S. Gelaye¹, G. Kannan¹, T. D. Pringle², T. H. Terrill¹, and E. A. Amoah¹, ¹Agricultural Research Station, Fort Valley State University, Fort Valley, GA 31030, ²The University of Georgia, Athens, GA 30602.

Growing female dairy goats ($n = 14$; BW = 24 ± 2.7 kg) were used in a 10-week experiment to assess the effect of daily injection of a low dose (40 µg/kg of BW) of recombinant bovine somatotropin (rbST) on concentration of blood metabolites, mass of visceral organs, calpain system, and goat meat (chevon) quality. Goats were randomly assigned to either a control (0.9 percent saline; $n = 7$) or a treatment group ($n = 7$) receiving a daily dose of 40 µg of rbST/kg BW. All animals were fed a 16 percent CP and 2.9 Mcal/kg DE alfalfa based-ration *ad libitum*. Blood samples were collected every 2 weeks for 10 weeks and analyzed for glucose, NEFA, and BUN. At the end of the 10-week experiment, animals were sacrificed and processed. A portion of the loin muscle was quickly removed, trimmed of fat, denuded and homogenized in extraction buffer for calpain/calpastatin determination. Components of the viscera were separated and individually weighed. The carcass was chilled for 24 h at 4 °C and fabricated into loin/rib chops. After instrumental color measurements were made, the chops were vacuum packed and aged for 1, 7 and 13 d at 4 °C. Before cooking, instrumental color measurements were done after 1 h bloom. Weight loss and shear values were determined on cooked chops. Bi-weekly data (metabolites

and BW) were analyzed as repeated measures. Carcass data were analyzed as a complete randomized design. Weight change, blood glucose and NEFA were not different but BUN was higher ($P \leq 0.05$) in rbST treated (20.9 mg/dL) than in control (14.9 mg/dL). Carcass weight, visceral organ mass, and loin eye area were not affected by rbST injection. Mean m-calpain (46 ± 1.9), μ -calpain (79 ± 2.4) and calpastatin (309 ± 11.1) activities (caseinolytic units per 50 g of tissue) were not affected by rbST injection. Pre-aging instrumental color (L^* , a^* , b^* , chroma and Hue) values were not affected by treatment. Cooking loss was not affected by treatment or treatment by aging interaction. Aging after 24 h chilling tended ($P = 0.09$) to decrease a^* (redness) value. Injection of rbST tended ($P = 0.09$) to decrease shear value. Aging decreased ($P \leq 0.01$) shear value but without significant improvement beyond 7 d. Daily injection of a low dose of rbST does not alter the calpain system in goat meat or modify weight of visceral organs.

Key Words: Goats, Somatotropin, Metabolites, Calpain, Calpastatin, Visceral organs

1164 Serum and milk leptin in does and growth of their offspring. N. C. Whitley^{*1}, S. A. Harley¹, D. J. Jackson¹, E. L. McFadin², and D. H. Keisler², ¹University of Maryland Eastern Shore, ²University of Missouri.

Secreted from both fat and mammary gland tissue, leptin has been found in the milk of a variety of species. It has been hypothesized that milk leptin ingested by offspring early in the postnatal period may influence growth and development of the offspring. However, it has not been determined if leptin is found in goat milk and if milk leptin levels are correlated with the growth of kids. Therefore, the objectives were to determine if goat milk serum contains leptin and to investigate possible correlations of milk and serum leptin in does and subsequent growth of their offspring. To conduct the study, 20 mixed-parity Boer and Boer crossbred meat type does were used. Approximately 5 days prior to kidding a body condition score was assigned and a blood sample was collected via jugular venipuncture. Blood and milk samples were collected within 2 hours of kidding (= d 0) from the does and also on days 0.5, 1, 3, 5, 7, 14, 21, 28, 35, 42, 49, and 56. Body weights of kids were taken at d 0, and body weights of both kids and does were measured weekly beginning on d 7 (kids) or d 21 (does). Blood and milk serum leptin concentrations were determined using radioimmunoassay. Pearson product moment correlation coefficients were obtained to evaluate the relationships between blood serum leptin, milk leptin, doe weight, kid weight, and doe body conditions score. Leptin was detected in milk and averaged 4.3 ± 0.9 ng/ml on d 0 and 1.0 ± 0.2 ng/ml on d 56. Days postpartum and milk serum leptin concentrations were negatively correlated ($r = -0.27$; $p < 0.0001$) while days postpartum and blood serum leptin concentrations were positively correlated ($r = 0.15$; $p < 0.02$). In addition, a negative correlation existed between milk serum leptin concentrations and kid body weight ($r = -0.25$; $P < 0.0009$). As expected, positive correlations ($p < 0.0001$) were found between leptin and doe body condition ($r = 0.42$) and leptin and doe body weight ($r = 0.44$), as well as for day and kid body weight ($r = 0.92$). In conclusion, leptin was present in milk and blood serum of does, but they act as independent depots.

Key Words: goat, milk, leptin

1165 Effect of clinical *Staphylococcus aureus* mastitis on early lactation dairy goats. G. M. Tomita^{*1}, S. P. Hart¹, and M. J. Paape², ¹E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK 73050, ²USDA, ARS, ANRI, IDRL, Beltsville, MD 20705.

A study was conducted to characterize the effect of induced *Staphylococcus aureus* mastitis on physical parameters and milk constituents of first lactation Alpine dairy goats in early lactation (22 d in milk). The right udder half of seven goats was challenged with approximately 120 colony-forming units of *S. aureus*. Seven additional goats were not challenged and served as control animals. All goats were free of mastitis at the start of the experiment. Milk samples from each udder half of all goats were collected immediately prior to challenge (0 h) and at 24, 48, and 72 h postchallenge for somatic cell count (SCC) and composition analysis (fat and protein). Rectal temperature and milk yield were also monitored at the time interval above. Acute clinical mastitis occurred within 24 h postchallenge, and clinical symptoms and the infection persisted through 72 h. The logarithm of milk SCC from challenged halves

was higher (6.75, $P < 0.05$, right half) than adjacent halves (6.01, left half) and the SCC of adjacent halves was higher than that of control animals (5.82, $P < 0.05$) at 24 h postchallenge. At 48 h and 72 h, SCC of milk from challenged halves remained elevated (6.86 and 6.96) above those of adjacent halves (5.89 and 5.88, $P < 0.05$) and control animals (5.79 and 5.88, $P < 0.05$). The percentage of milk fat from challenged halves was depressed only at 24 h postchallenge when compared with milk from adjacent halves and control group goats (3.55 versus 3.92 and 4.23, $P < 0.05$). However, the percentage of proteins in milk was higher ($P < 0.05$) in both infected and adjacent halves when compared with milk from control goats at 24 h (3.60 and 3.16 versus 2.76), 48 h (3.86 and 3.54 versus 2.72), and 72 h (3.57 and 3.66 versus 2.66). The rectal temperature of challenged goats peaked at 24 h (40.6 °C, $P < 0.05$) and returned to normal values by 48 h and 72 h (39.7 °C and 39.2 °C). Milk yields of infected goats were depressed at 24 and 48 h postchallenge when compared with control goats ($P < 0.05$) and recovered to prechallenge levels by 72 h. Results indicate that clinical mastitis in one udder half can influence physiological parameters in the adjacent half. Therefore, consideration must be given to both udder halves when evaluating the mammary gland health status of dairy goats.

Key Words: Dairy Goat, Clinical Mastitis, *Staphylococcus aureus*

1166 Prevalence of Coagulase Negative Staphylococci (CNS) and correlation with somatic cell counts in Italian dairy goat herds. P. Moroni¹, M. Antonini², F. Luzi³, D. Cattaneo⁴, G. Savoini⁴, and V. Bronzo¹, ¹Department of Animal Pathology, Hygiene and Veterinary Public Health, ²National Research Centre, ³Animal Husbandry, ⁴Department of Veterinary Sciences for Food Safety.

Intramammary infections (IMI) are among the most serious health and economic problems in dairy goat farming. While clinical cases of mastitis by *S. aureus* are less numerous, more important are the subclinical mastitis due to Coagulase-Negative-Staphylococci (CNS). Five commercial dairies with Alpine lactating goats were studied. Foremilk samples were collected monthly (March to November) for the whole lactation to determine the bacteriology and somatic cell counts (SCC). A total of 4242 milk samples were analysed from 240 lactating goats of various ages. The prevalence of negative samples (NRS) was 65.1% (least square means 825,350 50,653 scc/ml) while IMI caused by CNS was 28.7 % (least square means 1,841,543 79,800 scc/ml) with $P < 0.001$ and by other microorganisms was 6.2% (least square means 2,356,252 38,460 scc/ml). The IMI and SCC of goat milk increased as lactation progressed. In fact, we noticed during the whole lactation an increase of IMI (21.68%-36.84%) simultaneously with a rise in SCC (352,000 cell/ml- 3,137,000 cell/ml).

Key Words: Dairy goat, Coagulase Negative Staphylococci

1167 Morphology of infiltrated neutrophils obtained from goat mammary gland. S. Z. Tian, M. C. Hsu, W. J. Su, and C. J. Chang, *National Chung Hsing University, Taichung, Taiwan.*

Light microscopic morphology of infiltrated polymorphonuclear leukocytes (neutrophils) isolated from mammary secretion of healthy Toggenberg goats during stages of peak lactation, late lactation and the period following drying off were compared with their counterparts in circulation. After staining with Wright Giemsa stain, most neutrophils prepared from blood had an abundance of pink-stained cytoplasmic granules and bilobed nucleus. Infiltrated neutrophils, regardless of the stage of lactation, on the contrary, had multilobed nuclei and granules distributed only in the boundary. Among the three stages of lactation, infiltrated neutrophils from intermittently collected late secretion and dry secretion displayed pyknosis indicative of apoptosis. It is clear from morphology that transmigrated neutrophils are more advanced in stage of cell differentiation than prior to transmigration. Also, apoptosis occurs in aged infiltrated neutrophils with reduced milking frequency. Precaution should be taken in interpreting results if neutrophils from different sources of milk were to be used in study.

Key Words: Polymorphonuclear leukocytes, Mammary secretion, Morphology

1168 Effects of dietary fish oil on colostrum fatty acid profile in dairy goats. D. Cattaneo¹, V. Dell'Orto¹, A. Agazzi¹, V. Moretti¹, P. Moroni², and G. Savoini^{*1}, ¹Dipart. di Scienze e Tecnologie Veterinarie per la Sicurezza Alimentare, Università di Milano, Italy, ²Dipart. di Patologia Animale, Igiene e Sanità Pubblica Veterinaria, Università di Milano, Italy.

Fish oil is a nutraceutical rich in n-3 polyunsaturated fatty acids (n-3 PUFAs), including EPA (C20:5 n-3) and DHA (C22:6 n-3) which are crucial during perinatal growth and development in mammals. Aim of the study was to determine the composition and the fatty acid profile of colostrum as influenced by feeding fish oil to periparturient dairy goats. From ten days before expected day of kidding, 14 pregnant Saanen dairy goats were fed either a control diet (C) or a diet supplemented with 27 g/d cod liver oil (COD). The supplement contained 9.8% EPA and 13.6% DHA. Colostrum was sampled within the first 24 hours post partum. There were no significant effects of treatments on colostrum percentages of fat (5.63 and 5.08 %), protein (11.59 and 14.54 %), lactose (2.33 and 2.16 %) and on somatic cell count (3.38 and 2.98 %, respectively for C and COD). Dietary fish oil altered colostrum fatty acid profile, increasing the proportion of C16:1 (3.57 vs. 1.89%, $P < 0.01$) and lowering the concentrations of C18:0 (5.26 vs. 9.31%, $P < 0.01$), C18:2 (4.12 vs. 6.14%, $P < 0.01$) and C18:3 (0.78 vs. 1.12%, $P < 0.05$). Fish oil addition increased the concentration of long chain (\geq C20) n-3 PUFAs (1.56 vs. 0.64%; $P < 0.01$), including DHA (0.71 vs. 0.33%, $P < 0.01$) and EPA (0.84 vs. 0.43%, $P < 0.05$). Results indicate that feeding fish oil to periparturient dairy goats can increase concentration of long chain n-3 PUFAs in colostrum fat.

Key Words: Goat colostrum composition, Fish oil, n-3 PUFA

1169 Effects of the administration of fish oil on immune system in periparturient goats. G. Savoini^{*1}, A. Agazzi¹, D. Cattaneo¹, P. Moroni¹, L. Bonizzi², D. Pasotto², and V. Bronzo¹, ¹University of Milan, Italy, ²University of Padua, Italy.

Fish oil is a nutraceutical rich in n-3 fatty acids which beneficially influence the immune system. Aim of the study was to evaluate the effects of dietary fish oil during the peripartum on aspecific immune response and cell-mediated immunity of dairy goats. Ten days before kidding, 27 Saanen dairy goats were divided into 3 groups on the basis of parity: C=control, T1= unprotected fish oil (UFO), and T2= rumen protected fish oil (PFO). All goats received the same basal diet. Starting 10d before kidding and continuing until parturition T1 and T2 goats received 27g/d UFO and 55g/d PFO respectively. From kidding until 15d post-partum T1 and T2 groups received 45g/d UFO, and 90g/d PFO respectively. Goats were skin tested on day 4 before and 4, and 15 days after parturition. Aspecific immune response was evaluated by determining the increases in double skinfold thickness at 0, 8, 16 and 24h after the injection of 250 µg phytohaemagglutinin (PHA). Blood samples were collected at 10 and, 4d before and 4 and, 15d after kidding, and subsequently analyzed for leukocytes count and formula, and lysozyme. Data were analyzed by the GLM procedure of SAS. Skin test at 4d before and 15d after kidding was not statistically different among groups. Greater responses were observed in UFO vs C group at 8, 16 and 24h after injection at 4d after parturition (respectively 1.8 vs 0.97 mm, $P < 0.05$; 2.78 vs 1.31 mm, $P < 0.05$; 3.48 vs 1.02 mm, $P < 0.01$), and in PFO vs C at 24h after injection (2.37 vs 1.02 mm, $P < 0.05$). Treatments did not affect leukocytes count, basophils, eosinophils, and monocytes content while lymphocytes content was significantly higher on day 4 after calving for UFO vs C ($P < 0.05$). Lysozyme content was significantly lower in UFO vs C ($P < 0.001$) indicating a minor activity of monocyte cells. The administration of fish oil showed positive effects on aspecific immune response in dairy goats during the transition period.

Key Words: goats, fish oil, immune response.

1170 Physiological responses, immune function, and live weight shrinkage due to simulated preslaughter stress in goats fed a diet (Tasco) containing seaweed extract. G. Kannan^{*1}, T. H. Terrill¹, B. Kouakou¹, S. Galipalli¹, K. E. Saker², R. A. Kircher¹, S. Gelaye¹, and K. M. Gadiyaram¹, ¹Agricultural Research Station, Fort Valley State University, Fort Valley, GA, ²Virginia-Maryland Regional College of Veterinary Medicine, Blacksburg, VA.

Tasco feed is an *Ascophyllum nodosum* seaweed-containing product that has increased antioxidant activity in animals, but its effect on goats has not been tested. Mature female Spanish (S) and Boer x Spanish (BS) goats (average weight 39 kg, n = 20/Breed) were housed in pens (5 does/pen), and fed an alfalfa pellet diet plus a Tasco pellet supplement either with or without seaweed extract (Treatment) for three weeks. The Tasco feed supplement was given at 2% of daily intake. The animals were subjected to a 6-h transportation on two days (Replicate) to impose stress (20 does/Replicate) and then held overnight without feed in pens to simulate preslaughter conditions. The animals were weighed immediately before and after transport, as well as after holding to assess live weight losses. Blood samples were collected at 0, 2, and 6 h of transportation, and after holding (24 h) to assess stress responses and monocyte phagocytic activity (Time). Shrinkage was greater in BS than in S goats due to transportation ($P < 0.05$) and transportation plus holding ($P < 0.01$). Treatment did not influence plasma cortisol, urea nitrogen (PUN), non-esterified fatty acid (NEFA) concentrations and creatine kinase (CK) activity. Plasma glucose concentrations were influenced by Treatment x Breed x Time ($P < 0.01$) interaction effect. Plasma cortisol increased due to transportation, but decreased after holding ($P < 0.01$). Plasma CK activity also increased due to transportation and peaked at 6 h, but decreased after holding ($P < 0.01$). The PUN concentrations decreased with transportation time in both breeds, but increased significantly at 24 h only in S goats (Breed x Time, $P < 0.01$). There was a more rapid increase in NEFA concentrations due to Time in the S compared to BS goats (Breed x Time, $P < 0.01$). Neutrophil (N), lymphocyte (L), and monocyte counts and N/L ratio were not influenced by Treatment. However, seaweed extract supplementation decreased eosinophil counts ($P < 0.05$). Seaweed extract also decreased lipid peroxidation of cells, particularly after the onset of stress. The results suggest that live weight shrinkage and stress responses significantly differ in different breeds of goats. Tasco seaweed extract supplementation may be beneficial to goats because of its antioxidant activity.

Key Words: Goats, Preslaughter stress, Immune response, Shrinkage

1171 Adjustment factors for fat, protein, and somatic cell count for goat milk using different species-specific calibration standards. T.A. Gipson^{*1} and T. McKinney¹, ¹E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.

Currently, test-day samples of dairy goat milk are analyzed for fat, protein, and somatic cell count with laboratory equipment calibrated for cow milk, even though research has demonstrated that these measures are biased. The objective of this research was to examine breed, parity, and stage of lactation effects on this bias and to develop appropriate adjustment factors. Langston Dairy Herd Improvement (DHI) laboratory equipment was calibrated using both cow and goat milk standards. During 2001, 3,110 test-day samples from 875 does of six different breeds and 84 herds were analyzed for milk fat, protein, and somatic cell count with both calibrations. Of the 875 doe records, 373 were first parity, 181 second parity, 140 third parity, and 174 fourth or greater parity; and 196 were Alpine, 161 LaMancha, 284 Nubian, 45 Oberhasli, 124 Saanen, and 65 Toggenburg. Lactation was divided into 6 stages of 50 days according to days in milk (DIM). Differences (DIFF) in standards (cow vs goat) were analyzed as a repeated measures design using mixed model analysis. The statistical model included doe identity, breed, parity and stage of lactation with doe identity nested within breed as a random effect. There was no effect ($P > 0.10$) of breed or parity, on DIFF for fat, protein or somatic cell count. Stage of lactation affected ($P < 0.01$) DIFF for protein but not for fat or somatic cell count. Test-day samples analyzed with goat standards were regressed on test-day samples analyzed with cow standards to obtain adjustment factors. Multiplicative adjustment factors (cow standards adjusted to goat standards) were 1.027 for fat ($R^2 = 0.85$), 1.164 for protein with DIM less than or equal to 100 d ($R^2 = 0.94$), 1.125 for protein with DIM greater than 100 d ($R^2 = 0.99$), and 0.937 for somatic cell count ($R^2 = 0.96$). It appears that the bias

in goat test-day samples analyzed under conventional DHI laboratory procedures can easily be alleviated using simple adjustment factors.

Key Words: Goat, Adjustment factors, Milk

1172 Metabolizable protein requirements of lactating goats. I. V. Nsahlai^{*1,2}, A. L. Goetsch¹, J. Luo¹, and T. Sahlui¹, ¹E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK, ²Department of Animal and Poultry Science, University of Natal, Scottsville, R. South Africa.

Data from 31 studies with 174 treatment mean observations from goats in different stages of lactation were used to determine the metabolizable protein (MP) requirement for lactation (MP_l). Milk protein yield (MkP) was calculated from milk yield and protein concentration. The MP supply, the sum of digestible ruminally undegraded dietary and microbial true protein, was estimated from ingredient composition and a database of CP degradability properties and ruminal fermentable energy concentration derived from literature values when not provided in the original publication. MP_l was estimated from MP by subtracting MP used for maintenance functions (scurf (g CP), $0.2 \times \text{kg BW}^{0.6}$; endogenous urinary (g CP), $1.031 \times \text{kg BW}^{0.75}$; metabolic fecal (CP), 2.67% DM intake; 67% efficiency of use) and adjusting for BW change (14.3% protein). MP_l was regressed against MkP, and after removing observations with residuals greater than 1.5 times the residual SD, the refitted equation was: $MP_l = 10.2$ (SE = 8.13) + 1.18 (SE = 0.095) \times MkP (n = 149, adjusted $R^2 = 0.51$); the intercept was not different from zero ($P > 0.05$). Based on a no-intercept equation, 1.30 (SE = 0.034) g of MP_l were required for 1 g of MkP, corresponding to milk protein efficiency of 0.77. In conclusion, these results suggest an MP_l requirement for goats of 1.30 g/g of MkP. Although this approach and estimate of the MP_l requirement should have utility in expressing needs for protein and/or predicting milk production by lactating goats, improvements in accuracy from refined assumptions are desirable and will likely occur with future research. Supported by USDA project No. 9803092.

Key Words: Goats, Lactation, Protein

1173 Effect of ruminally degraded nitrogen source and level in a high concentrate diet on site of digestion in Boer # Spanish wethers. S. A. Soto-Navarro^{*}, A. L. Goetsch, T. Sahlui, R. Puchala, and L.J. Dawson, E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK 73050.

Eight yearling Boer # Spanish goat wethers (35.3 ± 6.6 kg average initial BW) with ruminal and duodenal cannulas were used in an experiment with two simultaneous 4 # 4 Latin squares to study effects of supplemental ruminally degraded N (DIP) source and level on sites of digestion. Diets were (DM basis) 9.2% CP, without inclusion of urea (U0) or soybean meal (S0); 11.3% CP achieved with 0.73% urea (U1) or 4.48% soybean meal (SBM; S1); 13.3% CP via use of 1.46% urea (U2) or 8.90% SBM (S2); or 15.2% CP derived through use of 2.16% urea (U3) or 13.2% SBM (S3). The ratio of DIP:TDN was 0.073, 0.104, 0.136, 0.167, 0.073, 0.093, 0.113, and 0.132 for U0, U1, U2, U3, S0, S1, S2, and S3, respectively. Microbial OM and N flows to the duodenum linearly decreased as ($P < 0.05$) CP level increased (N: 8.8, 7.6, 7.8, 6.7, 7.4, 6.0, 6.7, and 6.7 g/d for U0, U1, U2, U3, S0, S1, S2, and S3, respectively). Apparent ruminal OM digestibility increased linearly as CP level increased, and there was an interaction between the quadratic effect of CP level and source in total tract OM digestibility ($P < 0.05$). With urea diets, total tract OM digestibility plateaued at U1, while the peak with SBM was at S2 (71.3, 78.0, 77.7, 77.8, 71.5, 73.1, 74.7, and 75.0% for U0, U1, U2, U3, S0, S1, S2, and S3, respectively; SE = 0.14). There were interactions between linear and quadratic effects of CP level and source in true ruminal and postruminal N digestibilities ($P \leq 0.08$). With urea diets, true ruminal N digestibility linearly increased and postruminal N digestibility linearly decreased as CP level rose, whereas there were marked effects of SBM inclusion but no differences among S1, S2, and S3. Ruminal and total tract NDF digestibilities (total tract: 51.3, 57.6, 57.7, 57.4, 49.7, 52.3, 53.2, and 53.2% for U0, U1, U2, U3, S0, S1, S2, and S3, respectively) increased linearly ($P < 0.05$) with increasing CP level, although differences tended to be greater for urea or SBM inclusion than among U1, U2, and U3 or S1, S2, and S3 (quadratic, $P \leq 0.13$). N recycling in yearling goats appears adequate to support high microbial growth with a high concentrate diet, although OM and NDF

digestion may be enhanced by additional DIP for a DIP:TDN ratio of 0.10 to 0.11. Supported by USDA project No. 98-38814-6240.

Key Words: Goats, Ruminally degraded N, Soybean meal, Urea

1174 A comparison of two heart rate monitoring systems for goats. R. Puchala*, I. Tovar Luna, A. L. Goetsch, T. Sahu, and J. Luo, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.*

Heart rate (HR) holds promise as an indirect means of estimating energy expenditure by ruminants. Therefore, two monitoring systems were compared with different goat breeds, diets, and levels of intake. The CP-402 stationary biosignal preamplifier method (BA) of Sable Systems (Henderson, NV) was compared with the human S610 monitor (HM) of Polar (Woodbury, NY). Electrode signals for BA were adjusted and filtered, with less dependence on signal quality relative to HM, whereas measurement with HM was more frequent (1- vs 10.5-min intervals). Heart rate was measured over 48-h periods while goats consumed alfalfa hay or a high concentrate diet for BW maintenance and on d 3 and 4 of fasting. Six Spanish (36 ± 1.3 kg), 7/8 Boer (39 ± 4.4 kg), Angora (23 ± 4.0 kg), and Alpine (41 ± 6.3 kg) wethers, > 1.5 yr of age, were employed. Stick-on ECG electrodes, used for both methods, were attached to the chest just behind and slightly below the left elbow and at the base of the jugular groove on the right side of the neck. Overall HR means were similar between methods (50.5 ± 11.75 and 50.1 ± 11.81 for BA and HM, respectively). Intercepts and slopes of equations for regressions of mean observations (2-day measurement periods) with BA against those with HM were similar among breeds and between diets and levels of intake. Therefore, all observations for BA were regressed against those for HM: BA HR = 1.784 (SE = 1.626) + 0.972 (SE = 0.032) \times HM HR (SE = 0.032) ($n = 48$; $R^2 = 0.954$). Because the intercept was not different from zero, a final no-intercept regression was fitted: BA HR = 1.005 (SE = 0.007) \times HM HR ($n = 48$; $R^2 = 0.998$), with the slope not different from one. In conclusion, BA and HM appear equally effective for measuring HR of goats in confinement, but the small size and light weight of HM may be conducive to use with grazing goats. Supported by USDA project No. 0003835.

Key Words: Goats, Heart rate, Energy expenditure

1175 Effects of ad libitum consumption of concentrate and forage offered separately or mixed on growth of Alpine Doelings. A. L. Goetsch*, G. Detweiler, J. Hayes, R. Puchala, and T. Sahu, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.*

Forty-four weaned Alpine doelings (16 ± 0.19 kg initial BW) were used in a 16-wk experiment to determine how separate free-choice offering of concentrate (C) and forage (F; wheat hay, 14.2% CP and 34.1% ADF) affect performance compared with consumption of mixed diets of different proportions of C and F. Treatments (two groups/treatment) were A-25C: 25% C mixed diet consumed ad libitum; A-50C: 50% C mixed diet consumed ad libitum; A-75C: 75% C mixed diet consumed ad libitum; A-C:A-F: ad libitum consumption of C and F, offered separately; and L-C:A-F: restricted intake of C (approximately 1.5% BW) and ad libitum intake of F. Orts averaged 6.7 \pm 0.58% of diet offered. Intake of DM was similar among treatments (625, 641, 623, 704, and 653 g/d; SE = 38.6); dietary concentrate was 26, 53, 80, 84, and 61% of DM intake for A-25C, A-50C, A-75C, A-C:A-F, and L-C:A-F, respectively; SE = 1.51). Average daily gain was greatest ($P < 0.05$) for A-C:A-F and lowest ($P < 0.05$) for A-25C (53, 71, 81, 105, and 73 g; SE = 5.2), and ADG:DM intake ranked ($P < 0.05$) A-25C < A-50C and L-C:A-F < A-75C < A-C:A-F (85, 110, 130, 149, and 111 g/kg for A-25C, A-50C, A-75C, A-C:A-F, and L-C:A-F, respectively; SE = 5.2). In conclusion, separate free-choice offering of C and F for Alpine doelings appears promising as a simple means of achieving high ADG and efficient feed utilization, and restricted offering of C with separate free access to F can yield ADG and ADG:DM intake similar to ad libitum consumption of a mixed diet providing a comparable dietary concentrate level.

Key Words: Goat, Growth, Diet

1176 Effects of method of offering broiler litter and level of prairie hay intake on growth of Boer \times Spanish wethers. Y. Mekasha, R. C. Merkel, A. L. Goetsch, T. Sahu*, and K. Tesfai, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.*

Thirty-four Boer \times Spanish wethers (18 ± 0.3 kg initial BW) were used in a 12-wk experiment ($2 \times 2 + 1$ factorial arrangement of treatments) to determine effects of ad libitum consumption of broiler litter (B) alone or mixed with corn (60% B; BC) and of ad libitum vs restricted prairie hay (H) intake on feed intake and growth performance. Treatments were ad libitum H + an average of 22 g/d of mineral/vitamin supplement (Control, C); ad libitum H and B (AH-B); ad libitum H and BC (AH-BC); intake of 1% BW (DM) of H + ad libitum B (RH-B); and 1% BW of H + ad libitum BC (RH-BC). Hay DM intake averaged 494, 442, 336, 175, and 160 g/d (SE = 16.7), and total DM intake was 516, 700, 782, 474, and 585 g/d (SE = 26.2) for C, AH-B, AH-BC, RH-B, and RH-BC, respectively. Overall ADG ranked ($P < 0.05$) AH-BC > AH-B and RH-BC > C and RH-B (-6, 34, 79, 3, and 50 g); the ratio of ADG:DM intake ranked ($P < 0.05$) AH-BC and RH-BC > AH-B > C and RH-B (-13, 49, 97, 5, and 85 g/kg) for C, AH-B, AH-BC, RH-B, and RH-BC, respectively. In summary, offering B alone free-choice increased ADG by Boer cross goats when consuming H ad libitum but not with H intake restricted to 1% BW. The lower ADG:DM intake ratio for AH-B vs RH-BC indicates less efficient utilization of H than corn, although similar ADG reflects compensation via greater H intake. Mixing corn with B increased ADG similarly with both ad libitum and restricted H intake. In conclusion, depending on production goals and availability of high-quality feedstuffs such as cereal grains, free-choice consumption of B may be a simple and useful method of supplementing low-quality forage.

Key Words: Goats, Broiler litter

1177 Poultry litter pellets in meat goat diets. D. J. Jackson*, B. J. Rude², K. K. Karanja¹, D. M. Ferara¹, and N. C. Whitley¹, ¹University of Maryland Eastern Shore, ²Mississippi State University.

Female and male crossbred meat goats were used in two experiments to determine if poultry litter pellets could be used as a protein source in the diets of growing meat goats. In Experiment 1 (Exp 1), thirty-eight animals approximately 66.5 ± 0.7 days of age and 14.2 ± 0.3 kg body weight were fed 18% CP diets with 0 (CON; corn/soybean diet with alfalfa pellets; $n = 13$), 20 (20PL; 20% poultry litter pellets, 80% CON; $n = 12$) or 40% poultry litter (40PL; 40% poultry litter pellets and 60% CON; $n = 13$). In Experiment 2 (Exp 2), ten males contemporary to those in Exp 1 fed CON or 40PL ($n=5$ per diet) were used in 2 metabolism trials at 93.7 ± 0.9 and 121.7 ± 0.9 days of age (Trials 1 and 2, respectively). All goats were weaned into 2.4 m \times 2.4 m pens with slatted concrete floors and allowed ad libitum access to feed and water. Goats were allowed a 23-d adjustment period during which their diets were gradually increased to 100% treatment diet ($d=0$). In Exp 1, goat body weights and feed intake were measured every 7 d for 42 d. In Exp 2, animals were placed in metabolism pens and after a 3-d adjustment period, feed intake and fecal and urine output were measured and samples collected daily for 7 d to determine diet digestibility. In Exp 1, average daily gain (54.3 ± 17.1 g) and feed efficiency (35.9 ± 11.5 g kg⁻¹) were not influenced by diet. In Exp 2, organic matter ($80 \pm 1\%$ for Trial 1 and $63 \pm 2\%$ for Trial 2) and CP ($70 \pm 3\%$ for Trial 1 and $75 \pm 7\%$ for Trial 2) digestibility were similar for diets in both Trials. DM digestibility was greater ($p < 0.03$) for CON ($81 \pm 1\%$ and $82 \pm 1\%$ for Trial 1 and 2, respectively) when compared to 40PL ($77 \pm 1\%$ and $75 \pm 1\%$ for Trial 1 and 2, respectively). ADF ($41 \pm 4\%$ for CON and $67 \pm 4\%$ for 40PL) and NDF ($48 \pm 4\%$ for CON and $71 \pm 4\%$ for 40PL) digestibility were greater ($p < 0.01$) for 40PL compared to CON diet in Trial 1 only. Gross energy was higher ($p < 0.04$) for 40PL compared to CON in Trial 2 only ($83 \pm 0.3\%$ and $82 \pm 0.3\%$, respectively). In conclusion, poultry litter is an adequate source of digestible protein and can be fed short-term to growing meat goats.

Key Words: poultry litter, goat, digestibility

1178 Effect of high dietary copper on growth performance and carcass characteristics in goat kids. Carla Hopkins* and Sandra Solaiman, *Tuskegee University*.

An experiment was conducted to determine the effect of high dietary Cu on growth performance and carcass characteristics in goat kids. Fifteen Spanish x Boer goat kids (BW 21.3 ± 0.7 kg) were housed in individual pens and were randomly assigned to three different treatment diets. Treatments consisted of: 1) control (no additional supplemental Cu); 2) 100 mg Cu/d (100Cu) from Cu sulfate (CuSO_4); and 3) 200 mg Cu (200Cu) from CuSO_4 . Copper was placed in gelatin capsules and inserted in the esophagus with balling gun before morning feeding. Animals were fed *ad libitum* twice a day a 70:30 grain: hay, to meet daily requirements of growing kids according to the NRC (1981). Feed intake and refusals were monitored daily and intake was adjusted weekly for 14 wk. Body weight was recorded after 4 h withdrawals from water, for two consecutive days at 2-wk intervals for 14 wk. After 14 wk, animals were slaughtered, carcass hot weight (HW), carcass chill weight (CW), dressing percentage (DP), kidney and pelvic fat (KPF), longissimus muscle area (LMA), back fat and other carcass parameters were measured. Average daily gain over 14 wk was improved by 100 mg supplemental Cu intake (Q , $P = 0.05$). No difference in ADG was observed in kids for first and last 4 wk of Cu supplementation. Average daily feed intake was similar ($P > 0.05$) between animals, however, control group consumed higher concentrate: hay ratio in the diet (L , $P = 0.01$). Gain efficiency tended to be lower ($P = 0.07$) with 200Cu group when compared to 100Cu. No differences ($P > 0.05$) were observed in HW and CW, however, DP tended to be lower ($P = 0.08$) for 200Cu when compared to others. No difference ($P > 0.05$) in KPF was observed, however, body wall fat (L , $P = 0.07$), fat over 9th rib (L , $P = 0.01$) and adjusted fat thickness (L , $P = 0.03$) decreased as Cu supplementation increased. No differences ($P > 0.05$) in LMA were observed, however, percent boneless closely trimmed retail cuts improved (L , $P = 0.04$) as Cu supplementation increased. Copper supplementation at 100 mg Cu/d improved gain and decreased carcass adjusted fat thickness, however, higher Cu supplementation (200 mg/d) was not beneficial.

Key Words: Cu supplementation, ADG, Goat kids

1179 Effect of two types of multivitamin blocks on kids browsing during the dry season. A. Boubaker* and C. Kayouli, *Institut National Agronomique de Tunis*.

The objective was to determine the effect of two types of multivitamin blocks supplementation on growth kids browsing during the dry season in a subhumid region of Tunisia. Twenty one kids were divided into three equal groups. Control group was allowed to graze without any supplementation whereas the others 2 groups were supplemented with either block B1 or B2 in the barn at night. Blocks were mainly made of wheat bran (54 %), molasses (10%), urea (5%), minerals (5%) and without (B1) or with 15 % of PEG(B2). The body weight of kids was recorded every three weeks. Statistical differences ($P < .05$) in kids growth were found between control and supplemented groups. During the first two months, control group lost ($P < .005$) more weight (-21%) than supplemented groups (-6%). The final body weight tended to be higher for B2 than B1. This study showed that feed blocks might be used to maintain kids browsing during the dry season. Further studies are needed to determine the conditions for better use of PEG in blocks.

Key Words: kids, browsing, blocks

1180 Variation in browse nutrient content in western Oklahoma throughout the growing season. R. C. Merkel*¹, A. L. Goetsch¹, M. Moseley², R. Blackwell³, and T. Curtis⁴, ¹*E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK*, ²*USDA, NRCS, Stillwater, OK*, ³*U.S. Forest Service, USDA/Black Kettle National Grassland, Cheyenne, OK*, ⁴*USDA, NRCS, Taloga, OK*.

Leaves of browse species were sampled from May to September in west central (WC) and western OK (W) to determine changes in chemical composition throughout a growing season. Shinnery oak (SH, *Quercus havardi*) and sumac (SU, *Rhus copallina*) were sampled at each site. Blackjack oak (BK, *Q. marilandica*) and post oak (PK, *Q. stellata*) were sampled in WC and locust (LC, *Gleditsia triacanthos*), sand plum (SP, *Prunus angustifolia*), and skunkbush (SK, *R. aromatica*) in W. Sites were divided into three areas for sampling with three replications taken

of each species in each area, frozen, and freeze dried. Samples were analyzed for DM, ash, N, NDF, ADF, ADL, and true IVDMD (NDF as end-point measure). The DM percentage tended to increase throughout the growing season ($P < 0.01$). There was a species by date interaction ($S \times D$) in ash concentration ($P < 0.01$), with level increasing through mid-summer and then stabilizing or declining slightly. There was no difference in N level among WC species ($P > 0.05$), and N level was lowest in August ($S \times D$; $P < 0.01$). In W, LC had higher N ($P < 0.01$) compared with other species. In WC, oak species had higher NDF, ADF, and ADL throughout the growing season compared with SU ($P < 0.05$), while in W NDF concentrations ranked $SH > LC > SU$, SK, and SP ($P < 0.05$). NDF in WC was highest in July and decreased thereafter, whereas in W, NDF concentration tended to increase throughout the growing season ($S \times D$; $P < 0.01$). IVDMD of oak species in WC was lower ($P < 0.05$) than in SU throughout the collection period. Exceptionally high IVDMD, over 90%, was recorded for SU in both WC and W. Trends in nutrient content found over a 5-month sampling period indicate that, in general, tree leaves decrease in N concentration and increase in fiber and lignin contents.

Key Words: Browse, Nutrient content, Growing season

1181 Rumen fermentation parameters in goats fed on a thorn scrubland in North Mexico. G. C. Nevarez¹, M.A. Cerrillo¹, and R.A.S. Juarez*, *Universidad Juarez del Estado de Durango. Durango, Dgo. Mexico*.

Three rumen cannulated grazing goats (38 ± 1.7 Kg BW) fed on a thorn scrubland were used to estimate ruminal VFA and ammonia nitrogen concentrations. Rumen fluid samples were collected once a month at 0, 2, 4, 6, 8 and 10 hours after grazing started for a period of 12 months. Two seasons were considered; dry season from January to June and rainy season from July to December. Data were analyzed using a randomized block design with a split plot in time. Total VFA concentrations were affected by time of sampling ($P < .05$), the highest concentration was registered 8 h after grazing. Mean total VFA concentration was 51.1 mMol/l. Molar concentration of acetate was lower ($P < .05$) for the dry (58.1) than for the rainy season (61.5), whereas the propionate was higher for the dry than for the rainy season (26.8 vs 24.1 respectively). No differences were observed in butyrate among seasons (10.2 and 9.4 for dry and rainy seasons respectively) ($P > .05$). Differences were observed in the A:P ratio (2.3 and 2.6 for the dry and rainy season, respectively). The mean concentrations of $\text{NH}_3\text{-N}$ during the dry season were 4.8 mg/100 ml and 9.7 mg/100 ml of rumen fluid the rest of the year. The latter being superior to the recommended for maximum microbial efficiency. It is concluded that the total concentrations of VFA are lower than normal for high roughage diets. The concentrations of $\text{NH}_3\text{-N}$ during the dry season may limit rumen microbial growth.

Key Words: Goats, Volatile fatty acids, Grazing

1182 In vitro gas production in diets consumed by grazing goats in a semiarid region of North Mexico. O.O. Lopez¹, C.G. Nevarez¹, R.A.S. Juarez¹, and M.A. Cerrillo*¹, *Universidad Juarez del Estado de Durango. Durango, Dgo. Mexico*.

The objective of the present study was to determine the *in vitro* gas production of the diet consumed by grazing goats. Samples from the diet were obtained from three esophageal cannulated goats belonging to a herd of 300 animals. The sampling was performed for two days each month, in the morning and evening during the years 1999 and 2000. The samples (200 mg DM) were incubated in glass syringes using rumen fluid from three goats fed alfalfa hay. The gas volumes were recorded at 0, 3, 6, 9, 12, 24, 48 and 96 h after incubation. The kinetics of gas production were derived from the volumen recordings described by the exponential equation $y = a + b(1 - e^{-ct})$. Data were analyzed by ANOVA according to a randomized block design. Statistical differences were registered ($P > .05$) for the c fraction between the 1999 dry and rainy season. For the year 2000 statistical differences were observed for the fractions b, $a + b$, c and EP (effective production). Results from this study indicate that the *in vitro* gas production kinetics obtained during the dry season may reflect a lesser nutritive value compared to the forage consumed for goats in the wet season.

Year	Season	b	a+b	c	EP
1999	Dry	38.2 ^a	39.9 ^a	0.048 ^b	25.2 ^a
	Wet	43.4 ^a	43.5 ^a	0.071 ^a	30.5 ^a
2000	Dry	33.0 ^b	30.9 ^b	0.049 ^b	18.4 ^b
	Wet	40.9 ^a	40.4 ^a	0.066 ^a	27.6 ^a

EP= Effective gas production; means within a row with same superscript do not differ (P<0.05)

Key Words: goats, gas production, grazing

Horse Species

1183 Effects of feeding a blend of grains naturally-contaminated with *Fusarium* mycotoxins in feed intake, serum chemistry and hematology of horses. S.L. Raymond^{*1}, T.K. Smith², and H.V.L.N. Swamy², ¹Equine Research Centre, University of Guelph, ²University of Guelph.

A study was conducted to determine the effect of feeding mature horses a blend of grains naturally-contaminated with *Fusarium* mycotoxins. Changes in feed intake and metabolism and the efficacy of a yeast cell wall polymer mycotoxin adsorbent were determined. Nine non-exercising, mature mares were randomly assigned to one of three experimental diets for 21 days (d). The experiment was subsequently replicated in time. Diets included: (1) control, (2) blend of contaminated grains (10 ppm deoxynivalenol, DON) and (3) blend of contaminated grains + 0.2% yeast cell wall polymer (MTB-100, Alltech Inc.). All diets included 35% grain + 65% forage. Feeding of contaminated grains to horses resulted in reduced feed intake compared to controls (p<0.05). Supplementation of the yeast cell wall polymer to the blend of contaminated grains significantly improved feed intake compared to the feeding of contaminated grains. Consumption of forage remained unaffected regardless of diet fed. Gamma-glutamyltransferase levels were significantly higher in serum of horses consuming contaminated grain on days 7 and 14 but not on day 21 implying that the horses might be adapting to the hepatotoxicity caused by the mixture of *Fusarium* mycotoxins. It was concluded that the feeding of grains naturally-contaminated with *Fusarium* mycotoxins can decrease feed intake and alter serum chemistry in mature horses. Supplementation of yeast cell wall polymer to contaminated grains was beneficial in alleviating reduced feed intake in mature horses.

Key Words: Equine, *Fusarium*, Deoxynivalenol

1184 Serum vitamin E and trace minerals levels and blood parameters in growing thoroughbred horses during the period of pasture grazing and the stable feeding. C. E. Lee^{*1}, N. K. Park¹, S. B. Ko¹, S. H. Jin¹, D. H. Kang², and K. I. Kim³, ¹National Jeju Agri. Exp. Station, Jeju, Rep. of Korea, ²Korea Racing Association, Jeju, Rep. of Korea, ³Cheju National University, Jeju, Rep. of Korea.

Nutritional adequacy of growing horses raised in an alternate feeding system - grazing during late spring through early fall and stable feeding for the rest season - was assessed by determining vitamin E and mineral levels in serum, and various blood parameters related to nutrition and health. During the stable feeding, 50 growing female horses were fed concentrates (1.4% of their body weight), grass hay (0.62%) and alfalfa hay (0.37%). During the grazing, the same horses were fed supplementary concentrates (1.1%). Blood samples were taken the day before (average BW, 321 kg at the age of 11 to 14 mo) and 45 d after the start of grazing (355 kg). Serum vitamin E increased (P < 0.01) during grazing compared to that found before the initiation of grazing (1.35 vs 0.96 mg/L). Serum Fe, Cu and Zn contents were much lower (P < 0.01) during than before grazing. Blood urea (25.2 vs 31.2 mg/100 mL), GOT (378 vs 407 IU/L), GTP (7.0 vs 9.7 IU/L), T-bilirubin (0.35 vs 0.46 mg/100 mL) and D-bilirubin (0.14 vs 0.18) levels were much higher (P < 0.01) during than before grazing. Blood glucose (120 vs 91 mg/100 mL), creatinine (1.4 vs 1.2) and Ca (14.9 vs 12.9) levels were lower (P < 0.01) during than before grazing. Results indicate that general nutrition in these horses is adequate during both the pasture grazing and stable feeding periods, although vitamin E and some trace minerals in the serum vary with feeding system.

Key Words: Horses, Feeding system, Vitamin E

1185 Pilot study investigating the potential of ginseng (*Panax quinquefolium*) to potentiate routine vaccination in horses. W. O'Neill^{*1}, J. T. Arnason², S. McKee³, and A. F. Clarke⁴, ¹Nutraceutical Alliance Inc., Guelph, Ontario, Canada, ²University of Ottawa, Ottawa, Ontario, Canada, ³Equine Research Centre, Guelph, Ontario, Canada, ⁴University of Melbourne, Melbourne, Australia.

This paper reports a pilot investigation into the potential for using ginseng to potentiate routine vaccination in healthy horses. Ten horses with known vaccination history were included in the randomized, placebo-controlled, double-blind trial. Five horses received ground, powdered ginseng (35mg/kg BW) in molasses carrier, and five horses received a blank molasses carrier (placebo). Ginseng used in the study underwent phytochemical analysis for ginsenoside levels. The study was a double-blind, placebo controlled, completely randomized design. Horses received ginseng or placebo for a total of 28 days, and on Day 14 each horse was vaccinated with rhinophenumonitis vaccine. Measurement parameters included antigen-specific antibody formation, total peripheral T-Cell and B-Cell quantitation, CD4+ and CD8+ presenting lymphocytes, and complete haematology and biochemistry blood screens. Changes in antibody levels and lymphocyte profile parameters were determined by calculating the difference between each test day and day zero. The Wilcoxon rank-sum test was used to determine if there were differences between treatment and control groups at each day. Antibody results were ranked using the ranking procedure in SAS and then the GLM procedure with repeated measures was used to determine differences over time. There was a visual trend to increased antibody formation upon vaccination challenge in ginseng-treated animals compared with control animals, but these data did not reach statistical significance. Based on the clear trend shown when data was graphically displayed, it is concluded that this trial provides adequate rationale for further research into the potential for ginseng supplementation to potentiate the immune response of horses. However, future studies must incorporate a larger sample size, fully standardized experimental subjects, and dose titrations for ginseng dose optimization.

Key Words: Ginseng, Vaccination, Equine

1186 Illinois equine checkoff initiative. K Kline^{*1}, ¹University of Illinois at Urbana-Champaign.

The Horsemen's Council of Illinois, in cooperation with the Illinois Farm Bureau, Illinois Grain and Feed Association, Illinois Department of Agriculture, and representatives of several colleges and universities with equine programs formed a committee in October of 2001 to pursue legislation establishing a Checkoff program to support equine education, promotion and research.

The committee met in December of 2001 to discuss the procedures for developing legislation, defining language, and establishing the structure of the Equine Checkoff Board.

The committee discussed the need to determine board structure as it relates to potential board members, scope of coverage, and authority. Concluding the discussion, the committee reviewed funding and refund procedures to be administered by the board.

Specific recommendations of the committee and subsequent actions of the Equine Checkoff Board will be presented to serve as an example to other states interested in pursuing Equine Checkoffs.

Key Words: Illinois, Equine checkoff, Draft legislation

1187 Development of a light-weight, microwavable equine artificial vagina. K. Bennett-Wimbush*, B. Raimonde, and P. Stull, *Ohio State University Agricultural Technical Institute, Wooster, Ohio USA.*

A light-weight equine artificial vagina (AV) incorporating reusable gel packs (Consolidated Products and Services, Inc. Braintree, MA) as the heat source was constructed and tested for use in teaching breeding laboratories. A Missouri model AV was fitted with a specially constructed leather outer case which housed reusable gel packs. Gel packs were microwaved in order to achieve an internal AV temperature of at least 44° C. The internal size diameter was adjusted using air. Five trials were conducted to compare the length of time that the internal AV temperature remained in breeding range (44 to 52° C) for the gel-pack AV vs. a Missouri model AV. Both AV models were set up with approximately the same internal diameter and placed outside together in ambient temperatures which ranged from -2 to 8° C. The experiment started when the

internal AV temperature reached between 44 and 46° C. A thermometer (Animal Reproduction Systems, Chino, CA) was placed 30 cm inside each AV and the time that each AV remained in the breeding range was recorded. Data was analyzed using student t-test GLM, SAS. The gel-pack AV held its internal temperature longer ($p < .01$) than the Missouri model AV with means of 39.8 ± 7.2 and 18.4 ± 2.7 minutes respectively. Additionally the gel-pack AV weighed 2.8 kg when adjusted for breeding while the Missouri model weighed 4.4 kg., an increase of 57%. Although breeding trials were not conducted, the gel-pack AV was used several times during semen collection with no observable problems. This modified AV offers an alternative to the traditional AV models. Its lighter weight and increased heat retention may be beneficial for students learning collection techniques or on farms where personnel is limited and the AV must be set up in advance.

Key Words: Horse, Semen collection, Artificial vagina

Milk Synthesis

1188 Conjugated linoleic acids (CLA), *trans* fatty acids, and lipid content in milk from Holstein cows fed a high- or low-fiber diet with two levels of linseed oil. J. Looor, A. Ferlay, A. Ollier, M. Doreau, and Y. Chilliard*, *Unite de Recherche sur les Herbivores, INRA-Theix, 63122 St.-Genes Champanelle, France.*

To determine effects on lipid content and fatty acid profiles of milk in response to altered rumen fermentation and 18:3n-3 availability, four Holstein cows were fed a high (65:35 forage to grain; HF) or low (35:65; LF) fiber [derived from grass hay] diet without (HFN, LFN) added oil or with linseed oil (HFO, LFO) at 3% of DM. A 4 × 4 Latin square design was implemented for 4 wk. Milk yield (26.7 kg/d) and DMI (20.2 kg/d) were not affected by treatments. Milk fat percentage and yield, however, were lower in response to feeding LFN or LFO (2.31%, 625 g/d) compared with HFN or HFO (3.38%, 870 g/d). Yield of total CLA in milk averaged 6 g/d due to feeding HFN or LFN, and increased to 13 g/d in response to HFO or LFO. *Cis9,trans11-18:2* accounted for 85-90% of total CLA. Its yield was not affected by fiber level but increased by 116% in response to linseed oil. Feeding low-fiber diets resulted in greater yield of *cis11,trans13-* and *cis9,cis11-CLA*. Linseed oil supplementation further increased yield of *cis9,cis11-CLA*, but also *trans11,trans13-CLA*. The *trans10,cis12-* isomer of CLA was not detectable under any feeding conditions. Yield of *trans11,cis15-18:2*, an intermediate during hydrogenation of 18:3n-3, was 1 g/d in cows fed HFN or LFN compared with 10 g/d due to feeding HFO or LFO. Total *trans-18:1* yield in milk averaged 19 g/d when cows were fed HFN, increased to 30 g/d in response to LFN, and peaked at 89 g/d due to feeding HFO or LFO. Greater yield of *trans10-18:1* (10 vs. 2 g/d) accounted for the increase in total *trans-18:1* when LFN was fed compared with HFN. In contrast, increases in *trans11-18:1* (24 vs. 8 g/d) and *trans13+14-18:1* (40 vs. 4 g/d) yields were primarily responsible for the greater *trans-18:1* yield when linseed oil was fed. Milk fat depression was only observed when diets induced a marked increase in milk *trans10-18:1* but was not related to any increase in *trans10,cis12-CLA*.

Key Words: low-fiber, linseed oil, *trans*-fatty acids

1189 Intestinal supply of *trans10,cis12-18:2* lowers milk fat output in Holstein cows fed a high- or low-fiber diet with two levels of linseed oil. J. Looor, A. Ferlay, M. Doreau, and Y. Chilliard*, *Unite de Recherche sur les Herbivores, INRA-Theix, 63122 St.-Genes Champanelle, France.*

To assess effects of enhanced *trans10,cis12-18:2* (10/12CLA) availability on milk fat content and fatty acid profiles in milk, four Holstein cows fed a high (65:35 forage to grain; HF) or low (35:65; LF) fiber [derived from grass hay] diet without (HFN, LFN) added oil or with linseed oil (HFO, LFO) at 3% of DM were infused (0.208 g/h) with 10/12CLA for 5 d via the duodenum. A 4 × 4 Latin square with repeated measures was utilized. Diets were fed for 4 wk prior to each 5-d infusion period. Infusion of 10/12CLA did not affect DMI or milk yield. Prior to infusion, milk fat concentrations ranked by treatment were HFO (3.82%) and HFN (3.28%) > LFN (2.73%) and LFO (2.43%). Milk fat yield averaged 936 or 766 g/d in cows fed high- or low-fiber diets. Yield of *trans10-18:1* in milk through d 5 of infusion was 9 or 3 g/d when low- or high-fiber diets were fed. *Trans11-18:1* and *cis9,trans11-18:2* yields

averaged 24 and 10 g/d for HFO or LFO compared with 9 and 4 g/d for HFN or LFN through d 5. Although 10/12CLA was not detectable in milk fat prior to infusion, it averaged 0.2% of total fatty acids and 0.9 g/d by d 5. Secretion of this CLA isomer was associated with a 36% decrease in milk fat percentage and yield across diets. A 42% decrease in yield of saturated 4:0 to 16:0 contributed to the reduction in milk fat output. Infusion of 10/12CLA regardless of diet decreased the ratios [indicators of $\Delta 9$ desaturase action] of *cis9-18:1* to 18:0 (0.65 to 0.59) and *cis9,trans11-18:2* to *trans11-18:1* (0.34 to 0.27) in milk fat. Results suggest 18:1 and CLA isomers with a *trans10-* double bond may be involved in milk fat depression. If production of *trans10,cis12-18:2* in the rumen is shown to be high enough to bypass further hydrogenation, it could affect mammary lipid metabolism by simultaneously reducing *de novo* synthesis and desaturation of long-chain fatty acids.

Key Words: low-fiber, linseed oil, *trans10,cis12-18:2*

1190 A dynamic model of concentrate supplementation effects on milk production in high producing ewes. Reza Imamidoost*¹ and John Cant¹, ¹*University of Guelph.*

A computer model was developed to predict lactational performance responses of ewes to concentrate supplementation, whether on pasture or stall-fed, given concentrate once per day or in multiple feedings, and suckling one lamb or up to six. The model considers effects of concentrate supplementation on forage intake, rumen pH and metabolizable energy and protein supply. The user defines ewe bodyweight, feed composition and concentrate feeding times and amounts. The reference ewe has free access to pasture and water. On consumption, forages and concentrates enter into lag pools for 2.0h and 0.24h, respectively. Carbohydrates then enter rumen pools of digestible fiber, indigestible fiber, or non-structural carbohydrate, from which they are degraded or pass to the lower gut. Rumen pools of organic acid from carbohydrate fermentation and buffer from rumination are simulated to determine rumen pH. The pH, in turn, affects fiber degradation rates. Forage intake continues during daylight hours of 5:00 AM to 9:00 PM until rumen dry matter exceeds 1.3% Body Weight, or organic acid concentration exceeds 130 mM. Daily milk production is calculated from the postprandial flow of digestible carbohydrate, absorption of rumen organic acids and intake of protein and fat. The model predicted the substitution effect on forage intake of increasing rates of concentrate supplementation, the temporal pattern of rumen pH fluctuation with multiple concentrate feedings per day, the increase in dry matter intake when concentrate meals increases.

Key Words: Milk Production, Lactating Sheep, Modelling

1191 Effects of two levels of protein and conjugated linoleic acid (CLA) prills on performance, milk composition and fatty acid profile of dairy cows¹. M.A.S. Gama*², S.R. Medeiros², L.J.M. Aroeira³, and D.D.P. Lanna², ¹*Supported by FAPESP and Agribands Int., ²LNCA-ESALQ/USP, SP, Brazil, ³CNPGL-EMBRAPA, MG, Brazil.*

Forty-eight 7/8 Holstein X Zebu cows in early lactation (30±5d) were assigned to four treatments in a factorial arrangement for six weeks: 1) control diet (CD) plus Lac100; 2) CD plus CLA; 3) high protein

diet (HPD) plus Lac100; 4) HPD plus CLA. Calcium salts of soybean oil (Lac100, Yakult) and CLA prills (25% of CLAs, Agribands Int.) were fed at 400g/cow.d. Cows were housed in a free-stall with calan gates. Corn silage and concentrates (corn, soybean meal, soybean hulls and corn gluten meal) were used to formulate diets to supply 100% (CD) or 115% (HPD) of the CNCPS protein requirements. Milk fat content was reduced ($P<.05$) by CLA prills but fat production was unchanged due to a slight increase in milk production. Milk urea nitrogen increased ($P<.01$) in HPD diets while milk production was 2 kg/d higher ($P>.1$). The c9,t11 CLA content in milk fat increased ($P<.001$) with Lac100 supplementation. This indicates that Lac100 (rich in linoleic acid) was dissociated in the rumen. The t10,c12 CLA content in milk fat was increased in all treatments after the start of lipid supplementation ($P<.001$). This suggests that t10,c12 CLA was produced in the rumen of Lac100 supplemented cows under the conditions of this experiment, consistent with the low milk fat content. Amounts of absorbable t10,c12 from all diets were enough to decrease milk fat content. Prills were inefficient in delivering absorbable CLA isomers.

Parameter	Treatment				Effect ^a		
	CD + Lac100	CD + CLA	HPD + Lac100	HPD + CLA	CV, %	CLA	Diet
Milk Yield, kg/d	22.9	23.7	25.3	25.4	22.9	ns	ns
Milk Fat, %	3.02	2.76	3.14	2.90	19.9	<.05	ns
Milk Protein, %	2.91	2.89	2.89	2.85	8.4	ns	ns
Milk Fat, kg/d	0.70	0.66	0.78	0.75	29.6	ns	<.1
Milk Protein, kg/d	0.67	0.68	0.72	0.73	20.8	ns	ns
Milk Urea N, mg/dl	16.7	17.1	18.8	19.2	19.5	ns	<.01
DMI, %PV	3.54	3.38	3.56	3.35	11.2	ns	ns
BSC (1-5)	3.13	3.19	3.20	3.14	15.4	ns	ns
CLA isomers, %							
c9,t11	0.59	0.38	0.57	0.35	37.1	<.001	ns
t10c12	0.05	0.06	0.04	0.05	102.3	ns	ns

^aMain effects (interactions were not significant) ns = Not significant ($P>.1$)

Key Words: CLA, Fatty acids, Dairy cow

1192 Effect of histidine and histamine on mammary blood flow in lactating dairy cows. T. G. Madsen¹, D. R. Trout², S. Cieslar^{*2}, M. O. Nielsen¹, and J. P. Cant², ¹*The Royal Veterinary and Agricultural University, Copenhagen, Denmark*, ²*University of Guelph, Guelph, Ontario, Canada*.

Studies have indicated that concentration of individual nutrients affect mammary blood flow (MBF). In particular low histidine concentration has been shown to increase MBF and it has been suggested that this effect is mediated by histamine. Histamine has vasoactive effects in a number of tissues and in vitro studies have indicated a vasoconstrictive effect in mammary tissue. The objective of the present study was to examine the effect of arterial histidine concentration and histamine on MBF. The experiment was set up as a 4 x 4 Latin square design with four multiparous Holstein cows in mid lactation. The four treatments were arranged in a 2 x 2 factorial fashion, where the two factors were; 1) infusion of an amino acid solution resembling the milk protein profile with or without histidine (40 g/h) and 2) infusion of chlorpheniramine a histamine H1-receptor blocker (150 mg/h). The solutions were infused continuously into the external iliac artery supplying one udder half between morning and evening milking. The cows were milked twice daily at 8:00 and 18:00 h and fed a total mixed ration (14.4 % CP). Arterial and milk vein blood samples were taken simultaneously three times in the afternoon at 15:30, 16:30 and 17:30 h. MBF was measured according to the dilution technique with para-amino hippuric acid as marker. Neither the exclusion of histidine from the solution nor the inclusion of chlorpheniramine affected MBF to the infused udder half (Mean = 327 L/h). Exclusion of histidine from the infusion solution tended to drop the protein contents in milk from the infused udder half ($P=0.0650$) from 4.10 to 3.88 %, indicating that histidine was the limiting amino

acid for synthesis. The inclusion of chlorpheniramine into the infusion solution tended to decrease feed intake ($P=0.0984$), indicating a systemic effect, and decreased milk production ($P=0.0634$) in the infused udder half from 4.6 to 3.5 kg/10 h. In conclusion, the arterial histidine concentrations in the present experiment did not affect MBF and histamine is not involved in regulation of MBF.

Key Words: Histidine, Histamine, Mammary blood flow

1193 Enzyme regulation of mammary fatty acid synthesis in vitro. T Wright^{*}, J Cant, and B McBride, *University of Guelph*.

Acetyl coenzyme A (CoA) carboxylase has been described as the rate-limiting enzyme for the synthesis of mammary produced fatty acids. It is, however, only one of several enzymes involved in this process. More recently, a technique known as metabolic control analysis has determined that the control over pathway flux can be shared by enzymes in a biological pathway. The purpose of this experiment was to inhibit enzyme activity and produce data for control analysis. Mammary tissue was isolated from lactating Holstein cows averaging 21 kg milk/d. Tissue homogenate was prepared by grinding the tissue under liquid nitrogen to a powder that was stored at #70°C. Tissue was homogenized in two volumes of isotonic sucrose containing a protease inhibitor and centrifuged at 15 000 x g. The incubation solution (3.0 ml) contained 80 mM Tris-HCl, 0.80 mM MnCl₂, 20 mM NaHCO₃, 0.05 mM CoA, 1.7 mM ATP, 10 mM sodium citrate, 0.05 mM glucose 6-phosphate, 1.7 mM sodium acetate, 4.2 mM glutathione, 0.05 mM NADP, 20 mg/ml fatty acid free bovine serum albumin, approximately 1 µCi of 1-¹⁴C acetate, and approximately 3 mg of mammary protein. Incubations were conducted for 1h at pH 7.0 and synthesized fatty acids were extracted three times using petroleum ether. One ml of petroleum ether was then analyzed by liquid scintillation spectroscopy and the incorporation of acetate into fatty acids was calculated. Incubations with this system were done with added concentrations of avidin, an inhibitor of the biotin dependent enzyme acetyl CoA carboxylase. Inhibition of the system in this manner progressively reduced acetate incorporation into fatty acids with increasing avidin concentration. Fatty acid synthesis rates were reduced by 9.3% to 72.6% using avidin concentrations from 1 to 10 µg/ml. Data from this system indicated that this model is useful for metabolic control analysis to determine the proportion of control shared by the enzymes present in this in vitro system.

Key Words: acetyl CoA carboxylase, fatty-acid, mammary

1194 Effect of breed, parity, and stage of lactation on milk fat content of CLA in the dairy cow. J.A. Kelsey^{*1}, B.A. Corl¹, R.C. Collier², and D.E. Bauman¹, ¹*Cornell University, Ithaca, NY*, ²*University of Arizona, Tucson, AZ*.

Conjugated linoleic acid (CLA) has been shown to possess a variety of health benefits in biomedical studies with animal models. Foods of ruminant origin are the major dietary source of CLA. Some milk fat CLA originates from CLA that escapes complete rumen biohydrogenation, but the major source is endogenous synthesis via Δ⁹-desaturase from *trans*-11 C_{18:1}. The four primary substrates for Δ⁹-desaturase are C_{14:0}, C_{16:0}, C_{18:0}, and *trans*-11 C_{18:1}. The ratio of these and their products (desaturase index) serves as a proxy for Δ⁹-desaturase activity. Diet has a major influence on milk fat CLA, however the effect of animal-related aspects is largely unknown. Our objectives were: 1) to determine the influence of breed, parity and stage of lactation on milk fat content of CLA and 2) to examine variation among individuals in milk fat content of CLA and desaturase index. Holstein (n = 116) and Brown Swiss (n = 106) cows (University of Arizona herd) were fed the same traditional TMR diet and milk was sampled on the same day to eliminate diet and seasonal effects. Cows ranged from 7 to 522 DIM and varied in parity (primiparous = 97 and multiparous = 125). Fatty acid analysis demonstrated that stage of lactation and parity had minimal effect on CLA. Breed differences were significant ($p<0.05$), but of small magnitude; CLA averaged 4.4 ± 0.1 vs 4.1 ± 0.1 mg/g fatty acid for Holsteins and Brown Swiss, respectively. Similarly, *trans*-11 C_{18:1} concentration was higher in Holsteins than Brown Swiss (11.4 ± 0.2 vs 9.5 ± 0.2 mg/g fatty acid). Overall, the proportion of fatty acids that were <C16, C16, and >C16 were 20.7 ± 0.2, 30.7 ± 0.1, and 48.7 ± 0.3 for Holstein, and 22.5 ± 0.2, 30.7 ± 0.1, and 46.8 ± 0.3 for Brown Swiss. There was a three-fold variation among individuals in milk fat content of CLA and in the desaturase index for all desaturase pairs. Overall,

results indicate that breed, parity and stage of lactation had only minor effects on CLA concentration, but substantial individual variation existed in CLA content and desaturase index of milk fat.

Key Words: CLA

1195 Effect of feeding or abomasal infusion of canola oil on feed intake, digestion and milk fatty acid composition in late-lactation Holstein cows. P.K. Chelikani*, J.A. Bell, and J.J. Kennelly, *University of Alberta, Edmonton, Canada.*

Our objectives were to determine the effects of feeding or abomasal infusion of canola oil on feed intake, rumen fermentation, nutrient digestibility and milk fatty acid composition in late-lactation Holstein cows. Five ruminally and duodenally cannulated late lactation Holstein cows averaging 249 DIM (SE 14 d) at the beginning of the experiment were used in a 3 x 5 incomplete latin square design. The treatments were 1) Control (C): basal diet, 2) Control + abomasal infusion (I) of 1 kg/d of canola oil, and 3) Control + supplementation of canola oil at 1kg/d in the feed (F). Abomasal infusion of canola oil (I) resulted in a 2.7 kg reduction ($P < 0.05$) in DMI compared to the control treatment (C), and a 3.2 kg reduction ($P < 0.01$) in DMI compared to feeding canola oil (F). Rumen fluid concentrations of total VFA ($P < 0.05$), propionate ($P < 0.05$), and acetate ($P = 0.07$) were reduced with I compared to C or F. Mean concentrations of ammonia and rumen pH did not differ ($P > 0.10$) among treatments. There were no differences ($P > 0.10$) among treatments for either ruminal or total tract digestibilities of DM, OM, NDF, ADF and cellulose. Milk yield and 4% FCM tended ($P = 0.09$) to increase with F compared to C or I, but the yields of fat and protein did not differ ($P > 0.10$) among treatments. Saturated fatty acids (FA) in milk were reduced ($P < 0.01$) by 16% with F, and 30% with I. The proportions of medium chain FA were reduced by 25% with F and 36% with I. This decrease was primarily due to a reduction ($P < 0.01$) of C14:0 by 17% with F, 32% with I; and reduction of C16:0 by 29% with F and 39% with I. Compared to C, total C18:1 increased 41% with F and 44% with I, while cis-9 C18:1 increased 26% with F and 44% with I. Compared to C, trans-11 C18:1 increased 196% with F ($P < 0.01$) but was unaffected by I ($P > 0.10$). The proportion of cis-9 trans-11 C18:2 (CLA) increased ($P < 0.01$) by 172% with F compared to C, but was unaffected by I. The proportions of C18:2 and C18:3 were increased ($P < 0.01$) 2-fold with I relative to C. These results suggest that feeding canola oil did not have a major impact on intake or rumen fermentation characteristics but there was a significant effect on milk fatty acid profiles especially CLA.

Key Words: Canola oil, Feed intake & Digestibility, CLA

1196 Effect of different levels of mixed corn plant and tomato pomace on milk production and composition in Holstein dairy cows. R. Tahmasbi, H. Nasiri moghadam, A. Naserian, and B. Saremi*, *Ferdowsi University Of Mashhad, Mashhad, Khorasan, Iran.*

Production of tomato pomace is seasonal and corresponds to the time when corn is harvested for silage. We conducted experiments to determine whether a blend of whole corn plant and wet tomato pomace will ferment properly and to determine the feeding value of whole corn plant and wet tomato pomace mixture silage. The target of this study was to determine the chemical characteristics and nutritive value of this mixed silage and its effect on production performance of Holstein dairy cows. This study was conducted in a change over design by 3 treatments and 3 periods (each period length 21 days). Nine Holstein multiparous dairy cows averaging 31 3.5 kg daily milk production and 65 19 days in milk were used. Whole corn plants were chopped from a single field, mixed with 0, 7.5 and 15% DM tomato pomace and ensiled in 3 surface-walled clamp silos. Increasing the level of tomato pomace decreased cottonseed meal content, but all diets had the same energy and protein content. Dry matter intake and intake of other nutrients were not affected by treatments. Increasing level of tomato pomace had a significant effect on crude protein digestibility ($P \leq 0.05$) but dry matter, organic matter, ADF and NDF digestibility did not show significant differences. Rumen pH, BUN and blood glucose were not affected by treatments, but total plasma protein showed significant differences between treatments ($P \leq 0.05$). Milk production and its performance were increased but an increase in level of tomato pomace decreased feed intake. However, these differences were not significant. Milk protein, fat, NPN, and MUN percentages were not affected by treatment. We suggest that wet tomato

pomace can be blended with corn plant before ensiling without undesirable effects on Holstein dairy cow performance. This has economical benefits because addition of tomato pomace will decrease cost of diet.

Key Words: Dairy cows, Mixed corn silage and tomato pomace, Milk production and composition

1197 Bovine leukemia virus in mammary epithelial cells: Effects on mitosis and lactogenesis. D. Motton* and G. Buehring, *University of California, Berkeley, CA.*

Bovine Leukemia Virus (BLV) is an oncogenic retrovirus that causes B cell leukemias in infected cows. About 92% of U. S. dairy herds are infected but only about 1% of infected cattle develop bovine leukosis and are culled from the herd. A major concern is whether BLV infection of dairy cows alters milk yield. Although several studies have examined the effect of BLV on milk production in vivo, the results were inconclusive. No in vitro studies have been done. The discovery of BLV in mammary epithelial cells (MEC) of infected cows raises the possibility that the virus could affect these cells directly. The purpose of this study was to use an in vitro system to determine if BLV could alter milk yield by altering cell number and/or milk production per cell. A short-term cell line was established from the MEC of a BLV-negative cow. This cell line and a proven casein producer mouse cell line, Comma-D, were successfully transfected with a plasmid containing the entire BLV genome. The transfected cells test positive for the presence of BLV by PCR, whereas the parental (control) lines test negative. The BLV-positive lines do not replicate viral proteins as indicated by immunocytochemistry. The BLV-containing bovine MEC line has altered growth properties: reduced population doubling time, higher saturation density, and increased longevity. The Comma-D line is an already transformed cell line and growth properties did not change after transfection with BLV. Both the bovine and mouse MEC#s undergo differentiation on collagen gels and both lines, when transfected with BLV, displayed a decreased production of casein as analyzed by ELISA and Western blot, when compared to control cell lines without BLV. In addition, both the BLV-containing Comma-D cell line and the BLV-containing bovine MEC#s exhibited little or no casein mRNA when tested by RT-PCR. These data indicate that BLV may enhance cell proliferation and longevity and perhaps in this way increase milk production. However, the direct inhibition of casein synthesis by BLV could contribute to decreased milk production. Our results suggest that the effects of BLV infection on milk production may not be related solely to overall animal health, but may be directly mediated at a cellular level.

Key Words: BLV, Mammary, Casein

1198 Quality control of PCR products for DNA array production by real-time PCR. W. Luo, J.L. Smith, K.M.S. Smuga-Otto*, and L.G. Sheffield, *University of Wisconsin, Madison.*

DNA arrays are a useful technique for analysis of hundreds or thousands of mRNAs simultaneously. DNA fragments used for array production are frequently produced by PCR amplification of plasmid inserts. As a quality control step, gel electrophoresis analysis is usually performed to ensure adequate DNA concentration and appropriate amplification. Recently, we developed a method of assessing the quality of amplified DNA fragments using real-time PCR and melting curve analysis. DNA amplifications were performed in the presence of SYBR Green, which fluoresces in the presence of double stranded DNA. Increase in fluorescence with each cycle of amplification was indicative of DNA amplification. Fluorescence intensity of less than 1.5 relative units was not detectable by PAGE analysis followed by ethidium bromide staining. Those samples also had less than 20 ng DNA (by Hoechst 33258 dye binding) and were unacceptable for array production. When amplification was completed, a melting curve analysis was performed and derivative of fluorescence plotted against temperature to estimate melting point. Appropriately amplified fragments (those that gave a single, well-defined band on PAGE analysis and had > 20 ng DNA) also had a single sharp melting point with a large derivative value ($d\text{Fluorescence}/d\text{Temperature} > 1.6$). Presence of multiple peaks, no peaks or low $d\text{fluorescence}/d\text{temperature}$ were indicative of multiple bands or no amplification. This method provides a rapid and easily automated way to assess quality of hundreds or thousands of DNA fragments prior to array production. The only major caveat is that removal of residual SYBR Green dye should be verified prior to using arrays.

Key Words: DNA Array, Quality Control, Polymerase Chain Reaction

1199 Effect of feeding fish oil on uterine secretion of PGF₂ α , milk composition, and metabolic status of periparturient Holstein cows. R.C. Mattos^{*1}, C.R. Staples¹, A.M. Arteche¹, M.C. Wiltbank², F.J. Diaz², T.C. Jenkins³, and W.W. Thatcher¹, ¹University of Florida, ²University of Wisconsin, ³Clemson University.

Objectives were to determine the effect of dietary fish oil (FO) on secretion of PGF₂ α by the uterus during the periparturient period as well as milk production and metabolic responses postpartum. Holstein cows were assigned randomly to diets containing FO (n = 13) or olive oil (OO, n = 13). Cows were fed prepartum and postpartum diets that provided approximately 200 g/d from 21 days before the expected parturition until 21 days after parturition. The FO used contained 36% eicosapentaenoic acid (EPA, C20:5, n-3) and 28% docosahexaenoic acid (DHA, C22:6, n-3). Blood samples were obtained once daily at 1730 h from 14 days before due date until parturition, and Days 15 to 21 postpartum. Samples were collected twice daily at 0800 and 1730 h from Day 0 to Day 14 postpartum. A total of 6 FO and 8 OO cows without periparturient disorders were used in the statistical analyses of PGFM (PGF₂ α -metabolite) and metabolite concentrations. Length of prepartum feeding with OO (22.5 \pm 2.8) or FO (21.8 \pm 3.3) did not differ. Proportions of individual and total n-3 fatty acids were increased in caruncular tissue and milk of cows fed FO. The combined concentrations of EPA and DHA in caruncular tissue were correlated positively with number of days supplemented with FO ($r^2 = 0.64$, $P < 0.01$). Feeding diets containing FO reduced dry matter intake (DMI) during the prepartum and postpartum periods by 30.3% and 18.1%, respectively. Production of 4% fat-corrected milk, milk protein and milk fat were less in cows fed FO than in cows fed OO and likely a consequence of their lower DMI ($P < 0.05$). Cows fed FO had reduced concentrations of plasma PGFM during the early postpartum period (0, 0.5, 2, and 2.5 days postpartum) compared to cows fed OO ($P < 0.05$). Steady-state levels of prostaglandin H synthase-2 in caruncular tissue was unaffected by diet. Feeding FO reduced plasma concentrations of glucose ($P = 0.03$). This effect could be due to the reduced DMI associated with the FO diet. Results suggest that fatty acids present in the periparturient diet can affect the uterine secretion of PGF₂ α and milk fatty acid composition in lactating dairy cows.

Key Words: fish oil, prostaglandin, milk

1200 Characterization of uterine epidermal growth factor receptor expression during the estrous cycle and early pregnancy in pigs. J.G. Kim^{*}, J.L. Vallet, and R.K. Christenson, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, Nebraska.*

Uterine capacity is a component contributing to litter size in swine. The epidermal growth factor (EGF) gene is located near a uterine capacity quantitative trait locus on chromosome 8. EGF has been reported to stimulate epithelial cell growth, and therefore may influence endometrial function. We have reported the cloning and sequencing of the cDNA for EGF along with changes in EGF mRNA levels in porcine endometrium. For porcine EGF receptor (EGFR), only partial cDNA sequences have been reported previously. Furthermore, the changes in mRNA levels in the endometrium have not been well characterized. The objectives of this study were to 1) clone and sequence the full coding region for EGFR, and 2) determine EGFR gene expression in endometrium during the estrous cycle and early pregnancy. Using iterative screening of a porcine reproductive tissue cDNA library, we obtained a 5037 bp cDNA clone containing the entire coding region for EGFR. The predicted protein sequence of the EGFR contains 1209 amino acids, similar to that of human EGFR (1210 amino acids, 88.3% identity). All the major domains of the EGFR, including three tyrosine residues in the cytoplasmic domain that are autophosphorylation sites in human EGFR, are conserved in porcine EGFR. Twenty μ g of total RNA from endometrium of day 10, 13, and 15 cyclic gilts and day 10, 13, 15, 20, 30 and 40 pregnant gilts were used for Northern blotting. The probe used consisted of the entire EGFR clone. Bands corresponding to EGFR mRNA were determined by densitometry and results were analyzed by ANOVA. EGFR mRNA expression did not change during the estrous cycle and pregnancy between day 10 and 15, and decreased significantly ($P = 0.03$) from day 15 (102 \pm 14) to 20 (72 \pm 10 arbitrary units) of pregnancy. Endometrial

EGFR gene expression coincides with a decrease in conceptus estrogen secretion. Endometrial EGFR gene expression, along with the decrease of EGF mRNA expression from day 13 to 15 of pregnancy, suggests that EGF and EGFR may play a role in the endometrial response to conceptus estrogen.

Key Words: Coding region, Endometrium

1201 Evidence for a intrafollicular role of alpha-2-macroglobulin in regulation of estradiol production. F. Jimenez-Krassel^{*}, M. Winn, J.L.H. Ireland, and J.J. Ireland, *Michigan State University.*

Alpha-2-macroglobulin inhibits protease activity, binds growth factors and cytokines that regulate estradiol production, and is in high concentrations (mg/ml) in follicular fluid. Although alterations in intrafollicular concentrations of alpha-2-macroglobulin could modulate local actions of growth factors and proteases, the physiological role of alpha-2-macroglobulin in dominant follicle development is unknown. Therefore, the objectives of our study were to: a) determine if bovine granulosa cells produce alpha-2-macroglobulin and have alpha-2-macroglobulin receptors, and b) test the effect of alpha-2-macroglobulin on capacity of bovine granulosa cells to produce estradiol. For our studies, ovaries were obtained from an abattoir and granulosa cells and follicular fluid were isolated from individual dominant or subordinate first wave follicles in cattle. Northern blot analyses of polyA⁺ RNA (5 ug) indicated the presence of a 4.8 kb mRNA for alpha-2-macroglobulin and a 15 kb mRNA for the alpha-2-macroglobulin receptor in granulosa cells. Immunoblot analysis of a commercial preparation of bovine alpha-2-macroglobulin (0.5 ug), follicular fluid from dominant or subordinate follicles (10 ug/well), and spent media (20 ug/well) following serum-free culture of bovine granulosa cells from dominant follicles demonstrated the presence of a major 720 kDa protein band in all samples. To test the effect of alpha-2-macroglobulin on estradiol production, granulosa cells (100,000 total cells/200 μ l media) from dominant or subordinate follicles of three cows were treated with 19-OH androstenedione (1 μ M) and with or without 1 mg bovine alpha-2-macroglobulin or bovine immunoglobulins (control). After 18 h serum-free culture, basal estradiol production was 5-fold greater in granulosa cells from dominant compared with subordinate follicles (30 \pm 6 pg/ml vs 6 \pm 2 pg/ml). However, alpha-2-macroglobulin enhanced the capacity of granulosa cells from dominant or subordinate follicles to produce estradiol 30- or 50-fold, respectively, compared with controls (Dominant = 984 \pm 353 vs 30 \pm 6 pg/ml; Subordinate = 309 \pm 30 pg/ml vs 6 \pm 2 pg/ml). We conclude that alpha-2-macroglobulin may have a intrafollicular role in stimulation of estradiol production by bovine granulosa cells.

Key Words: Alpha macroglobulin, Estradiol, Dominant follicle

1202 Placental weights are greater in gilts homozygous for a secreted folate binding protein (sFBP) gene polymorphism. J. L. Vallet^{*}, R. K. Christenson, and B. A. Freking, *USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center.*

Secreted FBP likely plays a role in the transfer of folate to the conceptus during pregnancy in swine. A single nucleotide polymorphism (SNP) exists in the sFBP gene that encodes amino acid 175 as either a serine (C allele) or an arginine (A allele). Genomic DNAs from one-half Meishan, one-half white crossbred gilts were used as templates to amplify the region containing the SNP, and the products were sequenced for each gilt to determine the alleles present. The gilts were unilaterally hysterectomized-ovariectomized (UHO), mated, slaughtered on approximately d 105 of gestation, and litter size for each gilt and placental weights, fetal weights, fetal hematocrits, fetal plasma iron, and fetal plasma folates for each fetus were recorded. In addition, a subset of gilts were mated, laparotomized on d 11, the remaining uterine horn was flushed, and the gilts were remated to obtain the uterine capacity and fetal information described above at d 105. For these gilts, conceptus diameters and total intrauterine acid phosphatase (tAP), retinol binding protein (tRBP), and sFBP were measured at d 11. Based on sequence analysis, gilts were divided into 3 groups according to genotype: CC (n = 87 total; 37 d 11), CA (n = 11 total; 7 d 11), and AA (n = 6 total; 4 d 11). Data were analyzed using ANOVA and the following

orthogonal contrasts were used to compare means for each trait: (1) CC gilts vs CA gilts; (2) CC and CA gilts combined vs AA gilts. Litter size, fetal weights, fetal hematocrits, fetal plasma iron, fetal plasma folate, conceptus diameters, tAP, and tRBP did not differ between genotypes. Placental weights were greater ($P < 0.01$ using litter size as a covariate) in AA gilts (202 ± 20 g) compared to CC (153 ± 5 g), and CA (156 ± 16 g) gilts. Total sFBP was also greater ($P < 0.05$ using tRBP as a covariate) in AA gilts (13.5 ± 3.1 μ g) compared to CC (6.3 ± 1.0 μ g), and CA (7.0 ± 2.3 μ g) gilts. Although animal numbers were small, the results suggest that sFBP containing arginine at amino acid 175 is associated with large placentas, which may have an influence on uterine capacity and litter size.

Key Words: Uterus, Folic Acid, Conceptus

1203 Cervical responses to a graded dose of genistein in postpubertal gilts. J.A. Ford, Jr.* and W.L. Hurley, *University of Illinois, Urbana, Illinois.*

Genistein, a soybean phytoestrogen, has a range of estrogenic actions. Little is known about the effects of genistein in swine. This project was designed to characterize the effects of administration of a graded dose of genistein on cervical wet and dry weights. Thirty postpubertal gilts were ovariectomized in order to remove endogenous estrogen. Gilts were randomly assigned to one of six treatment groups 15 d post ovariectomy. Treatment groups received either no hormone (negative control; NC), β -estradiol 3-benzoate at 2 mg/d (positive control; PC), or genistein at 50 mg/d (G50), 100 mg/d (G100), 200 mg/d (G200), or 400 mg/d (G400). Genistein and estradiol were solubilized in DMSO prior to mixing with peanut oil vehicle. Treatments were administered by IM injection at 12-h intervals for 10 d. Gilts were slaughtered after the 10 d of injections and cervixes collected at the time of slaughter, trimmed of all extraneous tissue, and weighed. Dry weights were determined by freeze-drying a portion of the sample. Cervical wet weights (g/100 kg bw) increased as the dosage of genistein increased ($p < .01$; NC = 25.3 ± 5.3 , G50 = 33.3 ± 6.8 , G100 = 39.8 ± 6.8 , G200 = 46.5 ± 6.0 , and G400 = 54.7 ± 5.0). Cervical wet weights from PC gilts (92.3 ± 8.0 g/100 kg bw) were greater than from either the NC or genistein treated gilts ($P < .01$). Cervical dry weights (g/100 kg bw) increased as the dosage of genistein increased ($P < .01$; NC = 5.5 ± 1.0 , G50 = 6.3 ± 1.3 , G100 = 8.0 ± 1.3 , G200 = 8.9 ± 1.1 , and G400 = 10.2 ± 0.9). Cervical dry weights from the PC gilts (17.9 ± 1.5 g/100 kg bw) were greater than from either the NC or genistein treated gilts ($P < .01$). A graded dose of genistein causes an increase in cervical wet and dry weights, although estradiol treatment induces an even greater response. Administration of high doses of the soybean phytoestrogen, genistein, may affect reproductive tract development and function.

Key Words: Gilt, Cervix, Genistein

1204 The use of a deslorelin implant during the late embryonic period to enhance embryo survival. JA Bartolome*¹, S Kamimura¹, FT Silvestre¹, ACM Artech¹, TR Bilby¹, LF Archbald¹, TE Trigg², and WW Thatcher¹, ¹*University of Florida, Gainesville, Florida*, ²*Peptech Animal Health, North Ryde, Australia.*

Late embryonic/fetal loss (PL) diminish reproductive efficiency. Follicular growth is suppressed in the ovary ipsilateral to the pregnant uterine horn and estradiol may be detrimental for embryo survival. The hypothesis was that administration of a Deslorelin (GnRH agonist) implant on d 27 of pregnancy would induce accessory corpora lutea (CL), suppress follicular growth and reduce PL. Objective was to evaluate PL between d 27 and d 45 and d 45 to d 90 in lactating dairy cows receiving a 2.1 mg Deslorelin implant on d 27 of pregnancy. The study included pregnant cows detected by ultrasonography (US; 5 MHz, Aloka 500®) on d 27 after insemination. A total of 179 pregnant cows were assigned randomly to receive a 2.1 mg, s.q. Deslorelin Implant (Implant; n=89; Ovuplant®, Peptech, Animal Health, North Ryde, Australia) on d27, or no treatment (Control; n=90). On d 27 and d 45, cows were diagnosed pregnant by US. The number of class 2 follicles (6-9 mm), class 3 follicles (≥ 10 mm), and CL were recorded at d 27 and 45. On d 90, pregnancy was determined per rectal palpation. PL was compared by logistic regression adjusted by parity, previous services and breeding type (Proc Genmod, SAS), and the number of follicles and CL were analyzed by the repeated measures and counted data procedures (Proc Mixed and Genmod, SAS). PL between d 27 and d 45 were 15.5% (14/90) for Control and 20.2% (18/89) for Implant (OR=0.8; 95%CI=0.34,1.75; $P=0.54$).

PL between d 45 and d 90 were 10.5% (8/76) for Control and 7% (5/71) for Implant (OR=1.44; 95%CI=0.44,1.84; $P=0.76$). Overall PL (d 27 to d 90) was 24.4% (22/90) for Control and 25.8% (23/89) for Implant. On d 45, the number of class 2 (0.72 ± 0.19) and class 3 (0.86 ± 0.12) follicles for Implant were lower ($P < 0.01$) than class 2 (1.90 ± 0.18) and class 3 (1.92 ± 0.12) follicles for Control. On d 45, the number of CL for Implant was higher than Control ($1.80 \pm 0.07 > 1.31 \pm 0.07$; $P < 0.01$). In conclusion, a Deslorelin Implant administered on d 27 of pregnancy was able to increase the number of CL and reduce follicular growth, but did not increase embryo/fetal survival between d 27 to d 90 of gestation.

Key Words: Embryonic/fetal losses, GnRH agonist, Ovarian structures

1205 Nuclear transfer using nonquiescent bovine cumulus cells from primary cell populations. M. Murakami*, O. Perez, C.E. Ferguson, R.S. Denniston, and R.A. Godke, *Louisiana State University, Baton Rouge, LA, USA.*

Cumulus granulosa cells from oocytes were used to reconstruct bovine cytoplasts using nuclear transfer (NT) from primary cell (PC) populations and early cell passages (1-2); their development was compared with embryos derived from adult skin fibroblasts at later passages (7-9). Cumulus cells were obtained from *in vitro* matured oocytes collected by transvaginal ultrasound-guided aspiration from beef cows (n=4). The cells were used for NT 2 to 4 days after seeding onto a tissue culture plate (CUM; primary cells, PC) or after being subpassed once or twice (CUM; 1-2 passages). Fibroblasts obtained by skin biopsy from a mature cow were used for NT after being subpassed 7 to 9 times. The donor cumulus cells were continuously cultured with 10% fetal bovine serum (FBS). Oocytes (n=570) were enucleated after *in vitro* maturation (20 to 22 h). Couplets were induced to fuse with two DC pulses of 2.25 kV/cm for 15 μ sec, delivered by ECM 200 in buffer. All the fused couplets were activated in 5 μ M of ionomycin for 4 min followed by 2 mM DMAP for 3 h, and cultured in CR1aa supplemented with 5% FBS under 5% CO₂ in air. Number of fused couplets was greater ($P < .05$) in the CUM (PC) group than in the Fibroblast group. Number of cleaved embryos was greater ($P < .01$) in the CUM groups than in the Fibroblast group. Percentage of embryos developed to Grade-1 blastocysts was greater ($P < 0.05$) in the CUM (PC) group (27%) than in the Fibroblast group (15%), there was no difference among the groups for the total number of blastocysts or both morulae and blastocysts. A total of 46 embryos were nonsurgically transferred to 23 cows on days 7 to 9 of their estrous cycle (2/female). Of those, 33.3%, 66.7% and 27.2% were diagnosed pregnant on day 40 by ultrasonography in CUM (PC), CUM (1-2) and Fibroblast groups, respectively. None of the females reached 90 days of gestation in Fibroblast group, while one female remained pregnant in each CUM group. A female in CUM (PC) group subsequently delivered a single heifer calf by C-section.

Key Words: Nuclear Transfer, Embryo, Bovine

1206 Large-scale generation and analysis of expressed sequence tags from porcine ovaries or ovarian follicles at different stages of development. H. Jiang*¹, K. M. Whitworth¹, N. Bivens¹, J. Ries¹, J. A. Green¹, L. J. Forrester¹, G. K. Springer¹, A. Guillen¹, B. A. Didion², and M. C. Lucy¹, ¹*University of Missouri-Columbia*, ²*Monsanto Company.*

The factors and mechanisms controlling ovarian follicular development are not well understood. In the present study, cDNA libraries from fetal, neonatal, and prepubertal porcine ovaries as well as ovarian follicles (2, 4, 6, and 8 mm diameter) were constructed and sequenced. Clustering of cDNA sequences from the three ovary-only libraries and the four follicle-only libraries identified a set of 3,187 and 4,251 unigenes, respectively. Clustering of cDNA from all of the seven libraries identified a set of 6,443 unigenes. The rate of unigene discovery was 55% (6,433 unigenes from 11,634 clones). Thirty-five percent (2,266) of the clustered cDNA were not discovered previously in any species. The unigene set included genes associated with common cell functions such as protein synthesis and processing, cell structure, cell signaling and communication, energy metabolism, and cell division and differentiation, as well as genes associated with ovary-specific functions such as steroidogenesis. Analysis of the cDNA frequency across different libraries revealed that 47 ovary cDNAs and 73 follicle cDNAs were not uniformly represented ($P < 0.05$) in libraries from different stages of ovarian development (fetal, neonatal, or prepubertal) or different stages of follicular development (2 to 8 mm follicle). Twenty-seven genes decreased from the fetal to neonatal

or prepubertal stage, 14 genes increased from the fetal or neonatal to prepubertal stage, and 6 genes increased from the fetal to neonatal stage and then decreased from the neonatal to prepubertal stage. Within follicle libraries, 25 genes decreased and 48 genes increased as follicles grew from 2 mm to larger sizes. The expression of the selected genes (analyzed by ribonuclease protection assay) was generally consistent with the frequencies of their respective cDNA in the individual libraries. This 6,443 member porcine ovary/follicle unigene set and the information on changes in expression for individual clones should be useful in identifying factors and mechanisms controlling ovarian follicular development in a variety of species.

Key Words: Follicular Development, Expressed Sequence Tags, Porcine

1207 Transplantation of testicular explants from prepubertal bulls to nude mice and *ex situ* production of haploid germ cells over a 20-week period. Michael T. Kaproth^{1,2}, Dong Ryul Lee¹, and John E. Parks¹, ¹Cornell University, Ithaca, NY, ²Genex Cooperative, Inc, Shawano, WI.

Directed genetic modification of the bovine germline would be facilitated by routine methods for accessing premeiotic germ cells, promoting meiosis of committed cells, identifying and harvesting postmeiotic germ cells for use as gametes for embryo production by ICSI. Study objective was to develop procedures achieving germ cell progression through meiosis within explants of bovine prepubertal testicular tissue transplanted to sites in the athymic nude mouse. Testes from bulls of 19 weeks age (generally with only Sertoli cells and spermatogonia in seminiferous tubules) were dissected aseptically to recover 2-3 mm³ cubes of testicular tissue. Under sterile conditions the tissue was surgically transplanted to the host mouse. Variables included transplantation site (subcutaneous flank, sites within the host mouse testis), number of sites per mouse, effect of exogenous testosterone, time to analysis post-surgery. Most flank explants successfully vascularized. Two but not six flank sites were tolerated. Seminiferous tubules in some explants contained only Sertoli cells. We observed fully developed sperm heads in the majority of flank explants carried out to 20 weeks. None were found in flank explants supplemented with testosterone or in sites within the host mouse testis. Round spermatids and elongated spermatids were first observed at 12 and 20 weeks respectfully. Round spermatids obtained at 15 weeks were injected into the cytoplasm of chemically activated oocytes. Sixty oocytes survived injection and 19 embryos developed to day 10 expanded blastocysts. Nested PCR analysis for a Y-chromosome specific DNA sequence identified 4 Y-chromosome positive embryos. A companion analysis of activated oocytes injected with somatic (XY) cells was not Y positive. These results demonstrate that access to premeiotic germ cells is possible and the resulting postmeiotic cells can be harvested and used as gametes in an ICSI procedure to produce embryos.

Key Words: Meiosis, Transplantation, Testis

1208 Mechanism by which high progesterone levels reduced diameter of dominant follicle during the growing phase of wave 1. L.F. Uribe-Velázquez^{*1}, E. Oba², H. Villa-Velázquez², M.I.L. Souza², L.C. Lara-Herrera², and L.D.S. Murgas³, ¹University of Caldas, Manizales, Caldas, Colombia, ²UNESP, Botucatu, Sao Paulo, Brazil, ³Federal University of Lavras, UFLA, Lavras, Minas Gerais, Brazil.

Pulsatile secretion of pituitary luteinizing hormone (LH) is the result of an interplay between a stimulatory input from the brain and an inhibitory feedback from the gonads. In the female, the inhibitory effect of the gonads is thought to result from the negative feedback action of two steroids, estradiol and progesterone. The aim of this study was determined how application of progesterone exogen affect the growth of the dominant follicle of wave 1. Estrous cycle of 14 ewes were synchronized using prostaglandin (PGF2α). Then, ewes were randomly in two groups (n=7/group); control Group (G1) and progesterone-treated Group (G2) with CIDR (AHI Plastic Moulding Company, Hamilton, New Zealand) after ovulation (day zero). From 1 d before PG injection until d 10 daily ultrasonic examinations were done to establish follicular growth. The pattern of ovarian follicle development was characterized using the definition of a follicle wave as the changes in the number of follicles among the days of the estrous cycle Blood samples by jugular venipuncture for progesterone (P4) plasma concentrations determinations were collected from 1 d before PG until day 10 postovulation. For LH pulse profiles, collection of blood was at 30-min intervals for a period of 8 h on the

days 1 and 6. The mean emergence day of wave 1 was 0.7 ± 0.7 vs 0 ± 0.6 , respectively, for G1 and G2. P4 treatment decreased the growing rate ($p < 0.001$) with values of 0.7 ± 0.2 (G1) and 0.9 ± 0.7 mm/d (G2) and lengthened the duration of its static phase ($p < 0.05$). Mean maximum diameter size attained by the dominant follicle tended to be larger ($p < 0.001$) in the G1 (5.5 ± 0.5 mm) group than in G2 (4 ± 0.5 mm). Mean concentrations of P4 ($p < 0.001$) were different among treatments. Number of LH pulses during 1 d in G2 (1.49 ± 0.11 pulses/8 h) was less ($p < 0.01$) than that of G1 (2.55 ± 0.09 pulses/8 h). Number of LH pulses during 6 d was different ($p < 0.05$) among treatments with a mean of 1.22 ± 0.11 and 2.20 ± 0.09 pulses/8h for G2 and G1, respectively. In conclusion, the inhibitory effects of exogen P4 on the diameter of dominant follicle was mediated by reduced LH pulse frequency. This work was supported by FAPESP - Sao Paulo - Brazil.

Key Words: Dominant follicle, LH, Sheep

1209 Differential expression of pyruvate carboxylase 5'UTR variants during transition to lactation. C. Agca^{*} and S.S. Donkin, Purdue University, West Lafayette, IN.

Pyruvate carboxylase (PC) is regulated in some species through preferential translation of 5' untranslated region (UTR) variant forms of PC mRNA. Bovine liver expresses six PC 5# UTR transcript variants: bPC5#A, bPC5#B, bPC5#C, bPC5#D, bPC5#E, and bPC5#F which are 68, 253, 363, 89, 274, and 178 bp respectively. Despite sequence differences in the 5# UTR regions of mRNA these variants contain an identical coding sequence. The objective of this experiment was to determine the relative abundance of PC transcripts in bovine liver during the transition to lactation. A ribonuclease protection assay (RPA) was developed to investigate the changes in abundance of each 5# UTR transcript and total PC mRNA. Liver biopsy samples collected from seven cows on -28, -14, +1, +28, and +56 days relative to parturition were pooled and analyzed by RPA to determine the change in PC 5# UTR variants during transition to lactation. Samples from seven cows collected one day after parturition were analyzed individually to determine variation among individual cows. Results show that the six bovine PC 5# UTR variants and the coding region can be determined using two related riboprobes in two parallel RPA analysis. Expression of all PC variants was greatest one day after parturition and followed changes in total PC mRNA. Transcript bPC5#A responded least and transcript bPC5#C increased the most during parturition. Transcripts bPC5#A, bPC5#B, bPC5#D, bPC5#E and bPC5#F increased 8, 58, 8, 49, 18 fold at calving compared to 28 days prepartum whereas the coding region increased 13.5 fold. Transcript bPC5#C could not be detected in samples obtained on #28 days relative to calving. Data indicate that the shortest PC transcripts, bPC5#A and bPC5#D are the most abundantly expressed, transcripts bPC5#E and bPC5#C are least abundant, and bPC5#F and bPC5#B are intermediate. The lack of uniformity in the pattern of PC 5# UTR variants across the transition to lactation suggests a complexity for control of PC expression during this period at either through transcriptional control, mRNA processing or both.

Key Words: Pyruvate carboxylase, 5' UTR, Bovine

1210 Manganese inhibits in vitro nuclear maturation in cumulus-enclosed bovine oocytes through the cAMP/protein kinase A pathway. S. Bilodeau-Goeseels^{*}, Agriculture and Agri-Food Canada Reserach Centre, Lethbridge, Alberta, Canada.

It was recently discovered that manganese can inhibit *in vitro* nuclear maturation in bovine cumulus-enclosed oocytes (CEO) but not in denuded oocytes (DO). The goals of the present study were: (1) to determine if the effect of manganese on nuclear maturation is dependant upon protein kinase A (PKA) activity; (2) to compare the effects of manganese and activation of adenylate cyclase with forskolin (FSK) on nuclear maturation and cAMP levels in DO and cumulus-oocyte complexes (COC); and (3) to determine if protein kinase C (PKC) activation can reverse manganese-maintained meiotic arrest in bovine CEO. A total of 2052 oocytes were evaluated. The PKA inhibitor H-89 significantly decreased the percentage of CEO maintained at the germinal vesicle (GV) stage by manganese during a 9-h culture period (1, 82, 14, and 37% CEO at the GV stage for control, 0.05 mM MnCl₂, 125 μM H-89 and 0.05 mM MnCl₂ + 125 μM H-89 respectively). The adenylate cyclase activator FSK (20 and 100 μM) and MnCl₂ (0.5 mM) had the same inhibitory effect on nuclear maturation in COC, and MnCl₂

significantly increased cAMP levels in COC but to a lesser extent than FSK (4.8, 28.7, 346.3, 631.0 fmol/COC for control, 0.5 mM MnCl₂, 20 μM FSK and 0.05 mM MnCl₂ + 20 μM FSK respectively). In DO, MnCl₂ decreased the percentage of oocytes at the GV stage compared to control medium and FSK (54, 26, 81 and 51% DO at the GV stage for control, 0.5 mM MnCl₂, 100 μM FSK and 0.5 mM MnCl₂ + 100 μM FSK respectively); however, neither MnCl₂ or FSK had a significant effect on cAMP levels compared to control. The PKC activator PDDβ reduced the percentage of CEO maintained in meiotic arrest by MnCl₂ (5, 5, 68 and 42% of CEO at the GV stage for control, 0.05 mM MnCl₂, 10 μM PDDβ and 0.05 mM MnCl₂ + 10 μM PDDβ, respectively). In conclusion, manganese activates the adenylate cyclase enzyme in cumulus cells to generate cAMP which in turn activates PKA and this would lead to maintenance of meiotic arrest.

Key Words: Oocyte, Meiosis, Cyclic AMP, Manganese

1211 Interferon tau does not regulate integrin αVβ3 expression in bovine endometrium. Sarah Kimmins and L.A. MacLaren*, Nova Scotia Agricultural College, Truro, NS Canada.

The integrin αVβ3 is a cell and extracellular matrix adhesion molecule present at the fetomaternal interface at implantation in several species. In cattle, this integrin is transiently downregulated on day 16 of the estrous cycle, but not on day 16 of pregnancy. Expression of integrin αVβ3 increases in the subepithelial stroma over the peri-implantation period (days 18-30). In other cell systems interferons have been shown to regulate this integrin. To test whether the pregnancy recognition factor interferon tau (IFNτ) was regulating integrin αVβ3 in bovine endometrium, primary cultures of intercaruncular stromal cells were treated in triplicate for 48 h with 50 ng/μl of recombinant ovine IFNτ. In addition, beef heifers (n=6) with estrous cycle lengths of 19-20 days were synchronized and treated via intrauterine infusion with IFNτ (5x10⁷ antiviral units per day) or saline from days 14 -16. On day 16, endometrial samples were dissected and snap frozen in liquid nitrogen. Differences in β3 integrin subunit mRNA expression between treatments were determined by reverse transcriptase PCR and northern blotting. Immunohistochemistry was used to localize integrin αVβ3 protein expression. Data were analysed by analysis of variance to determine effects of IFNτ in comparison to controls. Cultured intercaruncular stromal cells treated with IFNτ expressed levels of β3 mRNA that were not different from untreated cells (P≥0.10). Similarly, uterine infusion of IFNτ did not change β3 subunit mRNA expression (P≥0.10) or affect immunohistochemical scores for integrin αVβ3 protein in vivo, despite influences on estrogen receptor expression. The results indicate that IFNτ is not an important regulator of integrin αVβ3 expression in bovine endometrium.

Key Words: Uterus, Ruminant, Cell adhesion molecule

1212 Suppression of basal and pulsatile LH with a GnRH antagonist is not sufficient to initiate ovulatory cycles in all cows with ovarian follicular cysts (cysts). MD Calder*, BE Salfen, M Manikkam, J Bader, RS Youngquist, and HA Garverick, University of Missouri.

Cows with cysts have follicular waves, but new dominant follicles often develop into cysts. Cows with cysts have high mean and pulsatile serum LH (Cook et al., 1991). Recently, use of intravaginal progesterone (P) decreased LH and restored ovulation in cows with cysts (Calder et al., 1999). In the current study, cows with cysts were given a GnRH antagonist (s.c.; SB-75; Asta Medica; Germany) to reduce LH in the absence of P. Cysts were induced hormonally and ovaries were monitored with ultrasonography. Cows were diagnosed with cysts when single (>20mm) or multiple (>15mm) follicles persisted for 7d when serum P concentrations were low. Three treatment groups were: cows with normal estrous cycles, [CYC; estrus (d 0) synchronized with prostaglandin; n=6]; cows with cysts that received carrier only from d 1-7; (CYST; n=7); and cows with cysts treated from d 1-7 with 10μg/kg SB-75 in 5% mannitol (SB-75; n=7). Blood samples (every 12 min for 8h) were collected for LH analysis in CYST and SB-75 cows on d 0, and from all cows on d 1, 4, 7, 10 and 13. CYC cows were injected with prostaglandin on d 11 following estrus to induce follicular phase LH patterns. Cows in all treatments initiated a new follicular wave about two days after study initiation. The mean diameter of the first wave dominant follicle was not different in SB-75 (10.90.8 mm) and CYC cows (13.50.8mm); both were smaller than in CYST cows (19.61.3mm, P < 0.05). A second follicular wave

was initiated later in SB-75 (17.41.6d) and CYST (17.22.8d) cows than in CYC cows (10.80.2d, P < 0.05). Mean LH and LH pulse frequency was reduced in SB-75 cows from d 1 until at least d 13. Four SB-75 cows ovulated a second wave dominant follicle. In conclusion, SB-75 decreased LH concentrations, which restricted the growth of the first dominant follicle, but only 4/7 SB-75 cows ovulated within 30d compared to 2/7 CYST cows. Suppression of LH may not be sufficient to restore ovulatory cycles in all cows with cysts.

Key Words: Cysts, LH, follicular wave

1213 Assessment of the effects of flavonoids on the post-thaw motility of cryopreserved bovine spermatozoa. J. A. Pitchford*, S. A. Ericsson, K. K. Korth, L. L. Green, and W. T. Campbell, Sul Ross State University, Alpine, Texas.

The objective of this study was to determine if the flavonoids catechin, epicatechin, and silibinin were capable of maintaining the post-thaw motility of cryopreserved bovine spermatozoa. Semen samples (n=30) were collected from 14 beef bulls using electro-ejaculation. Samples were extended in Triladyl extender (Minitube of America, Inc., Verona, WI) containing 0 (control), 10, 100, 1000, or 10000 μM catechin, epicatechin or silibinin. Extended samples were slowly cooled for 3 hours to 5°C, prior to packaging in 0.5 mL polyvinyl straws and freezing with liquid nitrogen. Microscopic analyses (250X) of the percentage of motile spermatozoa were obtained after 24 hr by thawing straws for 1 minute in a 37°C water bath. The percentage data were arcsine transformed and analyzed using ANOVA for differences among flavonoid levels. Samples extended with 10 μM (mean ± SD: 31.1% ± 14.6, P < 0.0001), 100 μM (27.7% ± 15.2, P < 0.0005), or 1000 μM (28.3% ± 14.5, P < 0.0001) catechin resulted in greater motility than the control (20.6% ± 11.4). Samples containing 10 μM (27.8% ± 14.3, P < 0.0001) and 100 μM (30.6% ± 13.3, P < 0.0001) epicatechin exhibited higher sperm motilities than the control. Similarly, extenders containing 10 μM (30.5% ± 14.5, P < 0.0001), 100 μM (32.6% ± 15.5, P < 0.0001), 1000 μM (31.4% ± 15.6, P < 0.0001) or 10000 μM (38.7% ± 17.1, P < 0.0001) silibinin retained greater motility than the control. The percentage of motile spermatozoa were significantly lower in samples containing 10000 μM catechin (7.0% ± 7.9, P < 0.0001) or epicatechin (3.1% ± 3.9, P < 0.0001) when compared to control. The samples containing 1000 μM (23.4% ± 11.9) epicatechin were not significantly different from control samples. These results suggest that catechin, epicatechin, and silibinin have a dose related effect on the post-thaw motility of cryopreserved bovine spermatozoa.

Key Words: Flavonoid, Spermatozoa, Bovine

1214 Stress during behavioral estrus delays the preovulatory surge of LH and ovulation in sheep. D. Wolfenson*¹, B.M. Adams², M.R. Dally², and T.E. Adams², ¹Hebrew University, Rehovot, Israel, ²University of California, Davis, CA.

The effect of stress during behavioral estrus on ovulation in prolific sheep was examined in two studies. The estrous cycles of Finnish Landrace sheep were synchronized using intra-vaginal progesterone (P4) implants and the onset of estrus was determined using vasectomized rams. All ewes displayed estrus 20-36 h after implant removal. In studies I and II, bacterial endotoxin (LPS) was administered iv at 2 h intervals (200 ng/kg/injection) for 12 h beginning at onset of estrus (study I; n = 6) or 12 h thereafter (study II; n = 5). Control animals in studies I (n = 5) and II (n = 5) received saline. Blood samples were collected at 2-4 h intervals beginning at estrus and continuing for 3 d thereafter. Ovulation was assessed by laparoscopy 5 d after implant removal. A preovulatory surge of LH was evident in all control animals, with peak levels of LH (44.7 ± 4.7 ng/ml) noted 22.6 ± 1.9 h after the onset of estrus. In study I, stress at the onset of estrus delayed the LH surge in all ewes, with 2 LPS-treated ewes exhibiting an apparently normal LH surge 41 h after the onset of estrus. None of the 4 remaining LPS-treated ewes showed an LH surge during frequent blood collection. Although serum levels of P4 in these ewes increased after estrus, secretion of P4 was delayed 4 d relative to control animals (P<0.05). This is consistent with our view that ovulation was delayed in LPS-treated animals. Serum levels of P4 in LPS-treated ewes tended to be higher than in control ewes. In study II, administration of LPS beginning 12 h after onset of estrus also delayed ovulation in all ewes. Moreover, only 2 of the 5 LPS-treated ewes exhibited an LH surge (peak LH = 7.9 ± 0.4 ng/ml) during the period of frequent blood collection. Taken together, these results indicate that

stress during behavioral estrus interrupts the terminal stages of follicle development and delays the preovulatory surge of LH and ovulation.

Key Words: Endotoxin stress, Delayed ovulation, Sheep

1215 The effects of a chronic elevation in plasma insulin during the early postpartum period on luteinizing hormone pulsatility and plasma estradiol in dairy cows. S.T. Butler* and W.R. Butler, *Cornell University, Ithaca, NY.*

Early lactation in dairy cattle is associated with a prolonged period of anestrus due to attenuated pituitary LH release and impaired ovarian LH responsiveness. Using the hyperinsulinemic-euglycemic clamp technique we previously demonstrated that an 8-fold increase in plasma insulin resulted in a marked decline in DMI in early lactation cows (2001; J. Dairy Sci. 84 (Suppl. 1): 34), thus negating any potential benefits on LH pulsatility and LH responsiveness. We have conducted another clamp experiment with a more moderate increase in plasma insulin to determine if alterations in LH pulsatility or responsiveness could be observed. Holstein cows (n=10) were subjected to either a hyperinsulinemic-euglycemic clamp (INS) or saline infusion (CTL) for 96-hours starting on day 10 postpartum. Insulin was infused continuously (0.3 µg/kg BW/hr) via a jugular catheter. Blood samples were collected hourly, and euglycemia was maintained by infusion of exogenous glucose. During infusion, insulin concentrations were increased 2.3-fold in INS cows over those in CTL cows (0.70 ± 0.05 vs. 0.30 ± 0.05 ng/ml; P<0.001), while blood glucose concentrations were not different between treatments. Blood samples were collected at 10 minute intervals for 8 hours immediately prior to commencement (PRE) and termination of infusions (END). In addition, 10 minute blood samples were collected from INS cows for a further 8 hours immediately following the commencement of the insulin infusion (START). Relative to values measured during PRE, the number of LH pulses, pulse amplitude and mean LH were not different (P>0.05) during END for either treatment or during START for the INS cows. Plasma estradiol levels declined in CTL cows during the infusion period, but increased in the INS cows following the onset of insulin infusion (treatment x time, P<0.001). The results indicate that insulin is an important metabolic hormone for determining ovarian responsiveness to LH, but do not implicate a role for determining LH pulsatility.

Key Words: Luteinizing hormone, Estradiol, Insulin

Production, Management, and the Environment
Dairy Management

1217 Non-nutritional factors that influence milk urea nitrogen concentration. P.M. Meyer*¹, P.F. Machado¹, A. Coldebella¹, C.H. Corassin¹, L.D. Cassoli¹, and P.H.M. Rodrigues², ¹*Clinica do Leite. Escola Superior de Agricultura Luiz de Queiroz/University of Sao Paulo, Brazil,* ²*Faculdade de Medicina Veterinaria e Zootecnia, University of Sao Paulo, Brazil.*

The purpose of this study was to determine which non-nutritional factors have most influence on milk urea nitrogen (MUN) and further to establish targets concentration. Data from approximately 500 Holstein cows were collected for 10 months (n=5082) from a farm in Sao Paulo state (Brazil). Factors studied were: milk production (MP), days in milk (DIM), lactation number (LN), somatic cells count (SCC) and milk fat (F), protein (P), lactose (L) and total solids (TS) percentage. The association of MUN concentration (dependent variable) and the other variables studied (independent variables) was estimated using the multiple linear regression analysis. To identify among independent variables those that could best explain variability in MUN concentration, coefficients of determination (R²) and adjusted coefficients of determination were estimated for the several equations. Maximum R² obtained was 0.1285, when all independent variables were included in the model, which can be considered low. The highest R² value found was for MP (R²= 0.0987), which indicates that MP explains 9.9% of the total variability of MUN. The other variables studied are responsible for the remaining 2.9% of the variability. It was concluded that the best factor to correct MUN target, among the ones studied, is MP. Financial support: FAPESP and CNPq (Brazil). Table. Coefficient of determination (R²) of multiple linear regression analysis for maximum R² in the model, using MUN as dependent variable.

1216 Effects of GnRH administered at onset of estrus on endocrine responses and conception in lactating cows. M. Kaim¹, A. Bloch², D. Wolfenson*², M. Rosenberg¹, H. Voet², and Y. Folman¹, ¹*Agricultural Research Organization, Bet-Dagan, Israel,* ²*Hebrew University, Rehovot, Israel.*

Two studies examined the effects of GnRH injection at onset of estrus on LH surge, progesterone concentrations, interval to ovulation, and conception rates, in Holstein cows. In study I, cows were monitored for estrus, blood samples were taken, and ovulation was checked by ultrasound. Treated (n=24) and control (n=25) cows were injected with GnRH analogue (Buserelin, 10 mg) or saline at onset of estrus. 19 control cows had a normal estrus-ovulation (E-O) interval (<30 h) and 6 (24%) had a long interval (>30 h). All GnRH-treated cows had a normal E-O interval (26.10.5 h). GnRH-treated cows showed a higher LH surge than control cows (P<0.05). Control cows with a long E-O interval had lower preovulatory estradiol (P<0.05), and progesterone levels in the subsequent mid-luteal phase were about 2 ng/ml lower (P<0.05) than in control cows with a normal E-O interval and GnRH-treated cows. In study II, in summer and winter, 152 primiparous and 211 multiparous synchronized cows at 60-100 days post-partum were used. Estrus was monitored frequently, and randomly assigned GnRH-treated cows were injected, as above, within 2.5 h of onset of estrus. Overall, in both seasons, conception rates (first 2 inseminations) of multiparous cows did not differ between groups, whereas that of GnRH-treated primiparous cows was higher than that of control cows (42.2 and 63.2%; P<0.05). GnRH increased conception rates in cows with low body condition (BCS; 36 vs 62%, P<0.05). In summer, conception rates of 31% of all control primiparous cows and of multiparous cows with low BCS, were increased to 56% by GnRH (P<0.05). In winter, GnRH was less effective. Results suggest that administration of GnRH at estrus is likely to shorten long E-O intervals and to increase low P4 post-ovulation in cows exhibiting a low preovulatory LH surge; these changes could be associated with fertility improvement by GnRH, mainly in cows with low BCS and in the summer season.

Key Words: GnRH at estrus, LH surge, Fertility

Variables included	R ²	Adj. R ²
MP	0.0987	0.0985
MP, P	0.1113	0.1109
MP, P, L	0.1139	0.1134
MP, P, L, CCS	0.1160	0.1153
MP, P, L, CCS, ST	0.1180	0.1171
MP, P, L, CCS, ST, F	0.1259	0.1249
MP, P, L, CCS, ST, F, DIM	0.1282	0.1270
MP, P, L, CCS, ST, F, DIM, LN	0.1285	0.1271

Key Words: MUN, dairy cows, target concentration

1218 Relationship among having mud in milking-cow barns, somatic cell counts and decreased milk yield in Thai dairy herds. W. Suriyasathaporn*¹, P. Maneeratanarungroj¹, S. Sangmaneedej¹, P. Tungtanatanich¹, S. Takong¹, U. Parinyasutinun², and S. Pangjuntuk², ¹*Faculty of Veterinary Medicine, Khonkean University, Thailand,* ²*Dairy Farming Promotion Organization of Thailand.*

The objective of this study was to evaluate relationship among having mud in milking-cow barns, somatic cell count, and milk yield in Thai dairy herds. Milk samples were collected from 78 dairy cows from 6 small dairy holders in the Northeast Thailand, a tropical country where a difference of temperature among seasons is relatively small. Farm environment, individual milk yield, calving date, and parity of the cows were recorded. Characteristics of the barns in this study were loose housing with ground floor, partial roof, and no wall. Each farm was

visited 4 times during the study. Somatic cell count (SCC) in the milk samples was measured using Fossomatic® (Foss-electric, Denmark) and then transformed to logarithmic scale in order to obtain normally distributed data. Repeated measures analysis (general linear mixed model) was used to evaluate relationships of having mud in the barns to SCC and milk yield of individual cows. Independent variables included in the model were month in milk, parity, and having mud in cattle barns. The free entering method was used and the restricted maximal likelihood was calculated to identify significant levels. The number of farms having mud in cattle barns in September, October, November, and December was 6, 4, 0, and 0 farms, respectively. The average test day milk yield on each of the four farm visits was 13.5, 13.1, 14.6, and 14.7 kg/day, respectively. Stepwise forward regression analysis showed that only having mud in cattle barns was associated with increased SCC ($P < 0.01$). The factors associated with test day milk yield were month in milk, parity, and log SCC. Milk yield was peaked during the second month of lactation, and declined significantly during the following months. Milk yield of a heifer was less than that of a cow. The increase of SCC was associated with decreased milk yield. No effect of having mud in cattle barns on milk yield after adjusting for log SCC was observed. The study concluded that having mud in cattle barns may result in increased SCC and consequently decrease milk yield.

Key Words: Mud, Somatic cell count, Milk yield

1219 Interpretation of protein-energy balance of feeding by milk urea nitrogen and milk protein contents of lactation Holstein cow in Korea. J. S. Moon^{*1}, Y. S. Joo¹, G. C. Jang¹, J. M. Kim¹, B. K. Lee², B. W. Yoo², and Y. H. Park³, ¹National Veterinary Research and Quarantine Service, MAF, ²Agrigrands Purina Korea, Inc., ³College of Veterinary Medicine and School of Agricultural Biotechnology, Seoul National University.

Milk data including milk protein (MP), milk urea nitrogen (MUN) are being used as indicators of the protein-energy balance and for actual farm feeding practices. The purpose of this study was to investigate the MUN and MP concentrations of individual and bulk milk by month and by region and to evaluate the protein-energy balance for feeding according to the level of MP and MUN by stage of lactation in Holstein cows. MP and MUN contents were determined using automated infrared procedures. Mean MUN and MP concentrations in the bulk milk samples obtained from 128,997 cows of 4,731 herd during Jan., 1999 to Dec., 2001 were 15.974.2 mg/dl and 3.3070.18%, respectively. The highest values were found during spring and lowest valued during winter in MUN. But, the average contents of MP were the highest during winter and the lowest during summer. Of total herds surveyed, 10.7% had MUN values lower than 12.0 mg/dl and 39.7% had values higher than 18.0 mg/dl and 53.0% of total herd have not met with standard criteria of MP values. In order to evaluate protein-energy balance for feeding, we determined the level of standard range for MP as 2.9073.29% in early lactation considering dairy cows to experience a negative energy balance. The level of MP in mid-lactation and late lactation were determined as 3.1073.49%, and 3.3073.69%, respectively. Standard MUN of 12718 mg/dl was determined through the whole lactation period. Milk yield, body condition score and milk composition were analyzed by the 9 types based on the levels of MP and MUN. The lower body condition score was associated with low MP, high MUN content and decreased milk yield. Among the total herds investigated, 26.8%, 25.8%, and 22.2% have shown the standard criteria of MP and MUN values, respectively. The study has indicated many dairy farms in Korea showed variable MP and MUN values by herd, season and individual physical condition.

Key Words: Milk Urea Nitrogen, Milk Protein

1220 Effect of duration of sequential teat cleaning by two rolling brushes on milking characteristics in a single stall automatic milking system. A. Dzidic¹ and R.M. Bruckmaier^{*1}, ¹Institute of Physiology, Tech. Univ. Munich - Weihenstephan, Freising, Germany.

In automatic milking systems (AMS) teats are cleaned by water, towel or brush. The stimulatory effect of teat cleaning induces milk ejection. The goal of this study was to evaluate the effect of the number of cleaning cycles on milking characteristics in forty-eight German Fleckvieh cows milked in a single stall AMS (Merlin, Lemmer-Fullwood). Cows were randomly assigned to the treatments B0 (no brushing), B1 (1 brushing

cycle for 16 s, 4 s per teat), B2 (2 brushing cycles), B4 (4 brushing cycles) and B6 (6 brushing cycles). Each treatment period lasted for two days. Quarter milk yield and milk flow was recorded during milking. Time needed for attachment of all four teat cups was similarly short in all treatments (19 to 23 s). Total milk yield and milk production rate (kg/h) did not differ between treatments. Milking time was prolonged ($P < 0.05$) in all quarters in B0 as compared to the other treatments. Time from the start of cleaning until the end of milking was 6.8 ± 0.2 , 6.4 ± 0.2 and 6.6 ± 0.2 min with 0, 1 and 2 cleaning cycles respectively, i.e. 1 and 2 cleaning cycles reduced the total time required for milking. Milking time was shorter in front (4.4 ± 0.1 min) than in rear quarters (5.6 ± 0.1 min). Peak and average milk flow rates were lower ($P < 0.05$) in B0 than in all other treatments. Two cleaning cycles resulted in the highest peak flow rates (3.0 ± 0.1 kg/min) as compared to the other treatments. In conclusion, duration of teat cleaning in AMS had a crucial influence on milking characteristics (milking time, peak and average milk flow rate). Optimal milk removal in most cows was observed after two cleaning cycles i.e. a pre-stimulation time of 32 s.

Key Words: Milking characteristics, AMS, Pre-stimulation

1221 Effects of manure handling systems on volatile nitrogen loss from dairy manure. V.R. Moreira^{*2} and L.D. Satter^{1,2}, ¹U.S. Dairy Forage Research Center USDA-ARS, ²Dairy Science Department, University of Wisconsin, Madison.

The objective was to evaluate the effect of manure handling systems on nitrogen (N) loss from dairy manure. The nitrogen to phosphorus ratio (N:P) in manure was used as the basis of system comparison. N:P in dairy manure at time of excretion is likely to range between 6-7. As N is volatilized from manure, the N:P is reduced, since P does not volatilize. This assumes neither N nor P is lost due to runoff during collection and storage of manure. A set of 778 manure analyses from four laboratories located in MN, OH, PA, and WI was used. Individual analyses within laboratory source was used as error term, and samples deviating more than 2.5 x SDM were deleted from each laboratory data set. Manure storage systems from PA and WI were identified as earthen basin (EB), daily haul (DH), bedded pack (BP) and stack (S). EB (N:P=5.37, n=183) had higher ($P \leq .004$) N:P than BP (4.53, n=30), but did not differ from DH (5.12, n=77, $P \geq .25$) or S (4.64, n=9, $P \geq .14$). No differences were found between bedding type (inorganic vs. organic, n=53 and 71, $P \geq .36$) in WI samples, or covered and uncovered storage (n=10 and 35, $P \geq .99$) in PA samples. Method of loading manure into slurry storage (bottom loading vs. top loading) from PA samples affected N loss, with bottom and top loading having N:P of 5.35 and 4.73 (n=27 and 51, $P \leq .02$). Manure samples submitted for analyses during the summer (4.90, n=107) or fall (4.67, n=240) had a lower N:P (spring, 5.05, n=267; winter, 5.61, n=132). If we assume an average N:P of 6.5 in dairy manure at time of excretion for samples analyzed by these commercial laboratories, then N losses from time of excretion until removal of manure from storage ranged between 2-36%. Based on manure sampled from 7 dairy farms in WI, and information about the diets fed on these farms, excreted N:P was estimated to be 6.78 ± 0.88 . Manure sampled from these farms in the spring of 2001 when storage facilities were being emptied indicated that N losses ranged from 4% (twice daily free stall scraping with DH) to 23.5% (twice daily free stall scraping and top-loading of a 2-3wk storage pit).

Key Words: Nitrogen, Phosphorus, Manure

1222 An evaluation of the cost of feeding dairy cows in Ragusa, Italy. G. Azzaro^{*1}, D.T. Galligan², J.D. Ferguson², R. Petriglieri¹, S. Carpino¹, and G. Licita³, ¹Consorzio Ricerca Filiera Lattiero-Casearia, Ragusa, Italy, ²University of Pennsylvania, ³University of Catania, Italy.

Fifteen farms were visited to collect feeding management and production data. For lactating and dry cows, each feed ingredient fed, its amount (kg/d) and cost (#/kg) were recorded. General herd information regarding average herd size, production/cow/day, average milk price, milk fat%, milk protein% were also recorded and all data were stored in an Excel data base. An index of the marginal cost of milk production was calculated within each farm by using the dry cow ration cost/day as an estimate of maintenance cost and the ration cost for the production realized. Forage ration cost was on average 44% (STD = 6) of the valued milk production. The average marginal cost of milk production was 0.12 #/kg, (STD = 42). Average lactation ration cost was

5.31 #/cow/d (STD= 0.63) with an average production of 30.7 kg/d. A correlation analysis was done on monitored and calculated variables. Lactating ration costs were positively correlated with forage costs (.62), marginal costs of milk production (.65), and milk price (.58). Herd size was weakly correlated with marginal cost of milk production (.10) but strongly correlated with milk price (.51). Milk production (kg/d) was moderately correlated (.46) with forage ration cost and average herd size (.41) and mildly correlated with total lactating ration cost (.32). This index of the marginal cost of milk production can be easily calculated on most dairy farms in Ragusa.

Key Words: Marginal costs, Ration cost, Economics

1223 Environmental stress on N'Dama cattle raised in tropical conditions and its implications on production and traditional management. P. Ezanno^{*1}, A. Ickowicz², and P. Lecomte¹, ¹CIRAD-EMVT, Montpellier, FRANCE, ²CIRAD-EMVT, ISRA-LNERV, Dakar, SENEGAL.

Under the tropics, cattle are traditionally raised on rangelands. Environmental stress is principally due to climate, which is strongly seasonally marked. In Kolda area (Senegal), the rainy season (RS) mostly occurs from June to October (950 mm), resulting in seasonal forage, water availability and recurrent health problems, such as high pressure in parasites during the RS or feed shortage in late dry season (DS). As a local breed, N'Dama cattle is well-adapted to its environment and relatively tolerant to heat, humidity and local diseases. However, input technologies are low under traditional management with few veterinary interventions, no artificial insemination and no supplementary feeding. Hence, the seasonal environment sharply influences calves growth, cow milking and herd management. A survey has taken place on 3 herds (165 cows) from one village in Kolda area from 1993 to 1996 to study cattle herd routes, seasonal use of land components and performances. Botanical composition of the forage diet varies over year: cattle are mostly fed in the forest-savannah in RS and harvesting period (82% and 95% of crossing time (ct), respectively); during the DS they use crops residues and fallows (75% of ct). Moreover, quality of the diet and forage intake influence body condition score and milk production. Whereas reproduction is not controlled, calving does not take place all year round. It principally occurs between July and October, also strongly related to cows body condition status (GLM; $p < 0.001$). This results in a decrease in milk production as only a few calving occur and body condition is not high enough to allow fat mobilisation in early lactation. Milk being the principal source of animal protein for farmers, their strategies are also related to environmental stress. Hence, to bridge the gap between late RS and harvesting, they sell then unproductive cows or bulls and buy young ones during the good season, which is not economically interesting. Low input technologies as rational supplementation could alleviate these stress and result in a better distribution of productions among seasons.

Key Words: Tropical Environment, N'Dama Cattle, Seasonal Productions

1224 Effect of β -carotene supplementation on milk yield and reproductive function of Holstein cows exposed to heat stress in a semi-arid environment in northern Mexico. R. Rodriguez-Martinez^{*1}, P.A. Robles-Trillo¹, G. Castillo², R. Bañuelos-Valenzuela³, and C.F. Arechiga³, ¹Universidad Autonoma Agraria Antonio Narro-UL, ²Syntex-Roche, ³Universidad Autonoma de Zacatecas.

A total of 339 Holstein cows [Multiparous (M, n=131); Primiparous (P, n=208)] were included in a study to determine the effect of β -carotene supplementation on productive and reproductive function of dairy cows exposed to heat stress in a subtropical-semiarid environment in Mexico (26 NL). Cows were assigned randomly to one of two groups: 1) Control (n=179), receiving a total-mixed ration (TMR) for lactating cows or 2) β -carotene (n=161), receiving 400 mg/d of supplemental β -carotene in addition to TMR from parturition throughout 90 days postpartum (PP). The TMR, based on chopped alfalfa, corn silage, and a concentrate-mineral mix, was offered twice daily; access to fresh water and shade was ad libitum. Blood samples were collected from tail-vein puncture to evaluate progesterone (P4) concentrations on d 0, 30, 60 and 90 days PP. Reproductive variables included open days, days to first service, number of services per conception, vaginal discharges (i.e., clean or dirty), pregnancy rate at 60, 90, 120 and 150 d PP, and culling rate.

Continuous variables were analyzed for M- and P-cows through linear-general models using a split-plot design which evaluated the effect of treatment (β -carotene vs. Controls) upon productive and reproductive parameters. Categorical data were analyzed by Chi-square. Neither milk yield nor P4 levels, were different between treatments ($P > 0.05$) at any measurement period or for any physiological status (M or P). For M, there was a trend ($P > 0.05$) for β -carotene to reduce the number of days open (126 vs. 140 d) and increase cumulative pregnancy rate at 150 d PP (59 vs. 48%). For P, β -carotene caused a greater proportion of cows to have clean vaginal discharges at first estrus (80.6 vs. 59.6%; $P < 0.001$) and more pregnant cows ($P < 0.05$) between 120 and 150 d PP (15.2 vs. 9.1%). The cumulative pregnancy rate at 150 d PP was 81.8 vs. 79.8% for β -carotene vs. control ($P > 0.05$). β -carotene reduced culling rate ($P < 0.05$) for both P- and M ($P = 46.2$ vs. 53.9% ; $M = 43.7$ vs. 56.3%), and there was also a slight increase in total cumulative pregnancy rate (70.4 vs. 64.2%) ($P > 0.05$). These results could be of economical significance for dairy producers.

Key Words: Dairy Cow, Heat Stress, Mexico

1225 The level of inbreeding of Senepol bulls in a closed herd in the US Virgin Islands. R.W. Godfrey^{*} and R.E. Dodson, *Agricultural Experiment Station, University of the Virgin Islands.*

The effect of inbreeding coefficient (IC) on the results of Breeding Soundness Evaluation (BSE) exams was determined in Senepol bulls from a closed herd on St. Croix. Bulls were evaluated at 12, 16, 20 and 24 mo of age using the BSE over a 2-yr period and given a rating of satisfactory or unsatisfactory based the BSE guidelines. The number of bulls tested was 214, 92, 40 and 20 at 12, 16, 20 and 24 mo of age, respectively. The number of sires represented at each age was 10, 11, 13 and 12 for 12, 16, 20 and 24 mo old bulls, respectively. The decrease in number of bulls as age increased was due to culling. Data were analyzed using GLM and chi-squared procedures of SAS. The IC of bulls tested at 12, 16, 20 and 24 mo was 2.6 ± 0.2 , 2.6 ± 0.3 , 2.7 ± 0.4 and $2.6 \pm 0.6\%$, respectively. The proportion of bulls receiving a satisfactory BSE increased ($P < 0.0001$) with age (1.9, 23.9, 30.0 and 40.0 % at 12, 16, 20 and 24 mo, respectively). There was no difference ($P > 0.10$) in IC between bulls receiving a satisfactory or unsatisfactory BSE rating at any age. There was a difference in IC among sire lines at 12 ($P < 0.001$) and 16 ($P < 0.0007$) mo but not at 20 and 24 mo. Scrotal circumference was different among sire lines at 12 ($P < 0.0006$), 16 ($P < 0.02$) and 24 ($P < 0.004$) mo but not at 20 mo. Paired testes volume was different among sire lines at 12 ($P < 0.001$), 16 ($P < 0.07$) and 24 ($P < 0.002$) mo but not at 20 mo. The proportion of bulls having uneven or missing testicles was 4.2 and 4.3 % at 12 and 16 mo of age. There were no bulls at 20 or 24 mo of age with missing or uneven testicles. Sperm motility was negatively correlated with IC in 12 ($R = -.69$, $P < 0.04$) and 20 ($R = -.36$, $P < 0.05$) mo old bulls. Scrotal circumference was negatively correlated ($R = -.44$, $P < 0.05$) with IC in 24 mo old bulls. These results indicate that the low level of inbreeding in a closed herd of Senepol cattle did not have any detrimental effects on the breeding potential of the bulls as evaluated using the BSE.

Key Words: Bull, Inbreeding, Testes

1226 The efficacy of a reduced dose of GnRH on ovulation rate and time of ovulation in Jersey and Holstein dairy cows. A. Ahmadzadeh¹, R. Manzo^{*1}, C. B. Sellars¹, L. E. Palmer¹, and R. L. Nebel², ¹University of Idaho, Moscow, ID, ²Virginia Tech, Blacksburg, VA.

To decrease the cost of artificial insemination (AI), a reduced dose of GnRH has been utilized in timed AI. However, the efficacy of the lower dose of GnRH on ovulation rate and time of ovulation relative to GnRH administration may differ between Jersey (JE) and Holstein (HO) cows. The objectives were to determine the effect of reduced dose of GnRH (50ug) on the ovulation rate and the time of ovulation following the implementation of modified OvSynch[®] (MOVS) protocol and whether there is a breed difference in response. Fifteen JE and seventeen HO cows were used. Fifty-five days postpartum (d #14) cows received (i.m.) 25mg PGF2 α . Fourteen days later (d 0) all cows were treated with MOVS as follow: GnRH (50ug)-7d→PGF2 α (d7)-2d→GnRH (50ug;d 9). Ovarian activity was monitored by ultrasound on d 0, 7, and 9 and 16. To determine ovulation time ultrasonography were conducted at 12 h, 20 h and then every 3 h until 39 h after second GnRH. Blood samples

were collected on d 7 and 9 for serum progesterone (P4). Mean BW was different ($P < 0.01$) for JE and HO (435 ± 14 vs 610 ± 13 kg, respectively). On day 7, all cows had a CL and mean P4 was 3.7 ± 2.7 ng/mL and did not differ by breed. On d 9, P4 concentration decreased to 0.13 ± 0.03 ng/mL and was similar for JE and HO. Mean diameter of the ovulatory follicles were 16.1 ± 4.19 for JE and 18.6 ± 3.18 mm for HO, ($P > 0.2$). Rate of ovulation did not differ between the breeds and was 93% for JE and 94% for HO. Mean ovulation time relative to second GnRH did not differ between the two breeds (26.5 ± 4.2 h JE vs. 25.9 ± 5.0 h HO). No cow exhibited estrus. Cows that ovulated developed a CL by d 16 (7 d after ovulation). These results indicated that although HO, on dose per kg BW basis, received a lower dose of GnRH the reduced dose of GnRH did not affect ovulation time relative to the second GnRH and did not compromise ovulation rate and luteal development. Therefore, 50ug GnRH is as effective in synchronizing ovulation in a MOVS protocol.

Key Words: Timed AI, GnRH dose, Ovulation

1227 Dairy MAP: udder health module for evaluating dairy herd management. L. O. Ely^{*1}, W.D. Gilson¹, J. W. Smith¹, A. M. Chapa², and S. Chandrasekaran¹, ¹University of Georgia, Athens, GA, ²Mississippi State University, Mississippi State, MS.

DHI records provide a wealth of information for monitoring and managing the dairy herd. A computerized system has been developed to assist producers in analyzing data from their herd. The program also provides specific recommendations based on the DHI information and additional information provided by the producer to an expert system. A module has been included to assist producers and their advisors in monitoring the udder health management program for a herd. The first phase of the program compares information from the producer's herd summary report with similar herds. The first benchmark table provides a comparison with herds of similar size and within the same region for the herd's SCC, weighted SCC, percent scores 0-3 and percent scores 7-9. The second table compares the herd's cell count information with herds of various levels of milk production. The user may continue with more detailed benchmarking by answering additional questions. The detailed benchmarks compare specific groups of cows with their counterparts in similar herds. The detailed tables provide an analysis of cell count by lactation group (first, second, third+) and stage of lactation. The data analyzed includes herd SCCS, percent 0-3 and percent 7-9. The output presents the deviations from expected values as a series of asterisks ranging from 1=poor to 6=excellent to assist in identifying areas for improvement. The second phase of the program consists of an expert system, which requests additional information before providing recommendations. The information requested includes culture results, milking practices, housing and therapy. Questions are grouped to include specific areas of management such as dry cow management, freestall management and milking procedures. The questions are further customized to account for variations in facilities and management styles. Recommendations are generated based on the information derived from the herd summary report and the answers given to the questions. The questions and recommendations were developed by a group of dairy scientists and veterinarians. The program is not designed to supplant the need for technical assistance but to augment existing programs and focus attention on management areas needing attention.

Key Words: Udder health, Expert system, Mastitis

1228 Incorporating estradiol cypionate (ECP[®]) into the OvSynch[®] (OVS) protocol to improve conception rates in dairy cattle. C. B. Sellars^{*1}, A. Ahmadzadeh¹, R. Manzo¹, J. C. Dalton², and J. Day³, ¹University of Idaho, Moscow, ID, ²Southwest R & E Center, University of Idaho, Caldwell, ID, ³Dairy Health Services, Jerome, ID.

There is evidence that induction of ovulation by GnRH during proestrus, as occurs in OVS [GnRH-7d→PGF2α-2d→GnRH→Timed AI], may impair ovarian estradiol secretion and shorten the subsequent luteal phase in cattle. It was hypothesized that administration of a small dose of ECP at the time of the second GnRH injection would effectively synchronize ovulation and increase conception rate. The objectives were to determine the effect of ECP incorporation into OVS on ovulation time, ovulation rate, luteal development, and conception rate in dairy cows.

In Exp 1, twenty-three lactating Holstein cows (~58 DIM) were synchronized with 25mg PGF2α (d -10). Ten days later 100mg GnRH was given (d 0) followed by 25mg PGF2α on d 7. On d 9 cows were assigned randomly to receive either GnRH + 0.25mg ECP (OVS-ECP; n=11) or GnRH + placebo (OVS; n=12). Ovarian activity was recorded once daily with ultrasound on d 0, 7, and 9. To determine ovulation time, ultrasound examinations were conducted at 12 h, 20 h, and then every 3 h until 35 h after treatment or until ovulation. Presence of a CL was determined on d 16. Blood samples were collected on d 0, 7, 9, 10, and 16 for serum progesterone (P4). Serum P4 concentration did not differ between groups at any time. Cows that ovulated exhibited CL on d 16. Ovulation rate did not differ between groups (100% OVS-ECP vs. 92% OVS). Mean ovulation time relative to last injection was similar between groups (26.3 ± 0.5 OVS-ECP vs. 27.3 ± 0.5 h OVS). In Exp 2, 282 lactating cows on three farms were assigned randomly to either OVS-ECP (n=143) or OVS (n=139) as described in Exp 1. Cows received AI 12-24 h post treatment. Conception rates were not different between groups (29.4% OVS-ECP vs. 35.3% OVS). Incorporation of ECP into the OvSynch protocol did not change ovulation time, ovulation rate, or luteal development, and no improvement in conception rate was observed.

Key Words: Timed AI, Estradiol cypionate, Conception rate

1229 Evaluation of dried whole egg and egg components in calf milk replacers. D. R. Catherman^{*}, Strauss Feeds, Watertown, WI.

One hundred twenty Holstein heifer calves (average 36.7 kg BW) were used to evaluate the effects of addition of dried egg or egg components to milk replacer (MR) on health and performance. Calves were allotted by weight to one of five treatment groups. Milk replacers were formulated at 20% crude protein and 20% fat and contained the following: treatment 1, all milk protein control; treatment 2, 15% inedible whole egg; treatment 3, 9% edible egg albumin; treatment 4, 6% edible egg yolk; and treatment 5, 9% edible egg albumin and 6% edible egg yolk. Milk replacer was fed at 454 g/d in 3.8 l of water. Calves were weaned at 35 d with feed intake recorded for 42 d. Calves were weighed at 0, 21 and 42 d. Water and starter grain (18% crude protein) were offered free choice from d 3. Total MR intake was 13.8 kg for each treatment. Starter intake was higher ($P < .05$) for treatment 4 (29.2 kg) than for treatments 2 (21.9 kg) and 3 (23.3 kg). Intakes for calves in treatments 1 (27.4 kg) and 5 (23.4 kg) were not different from the other treatments. Weight gains between d 0 and d 21 were greater ($P < .05$) in treatments 1 (8.1 kg) and 4 (8.4 kg) than in treatments 2 (5.4 kg) and 3 (5.2 kg), with treatment 5 (6.0 kg) being similar to all. Overall weight gains (d 0 to 42) were higher ($P < .05$) for treatments 1 (19.5 kg) and 4 (19.6 kg) than for treatments 2 (12.0 kg), 3 (11.5 kg) and 5 (13.8 kg). Feed cost per kg of gain was lower ($P < .05$) for treatments 1 (\$1.63) and 4 (\$1.67) than for treatments 2 (\$2.27), 3 (\$2.62) and 5 (\$2.24). Scour scores were not different. Medication costs per calf were \$13.65, \$16.67, \$18.06, \$14.24 and \$19.22 for treatments 1 through 5, respectively. These data indicate that incorporation of whole egg into calf milk replacer results in a significant reduction in performance and an increase in cost per kg of gain. This response appears to be associated with the albumin fraction of the egg. Egg yolk seems to be an acceptable ingredient for use in calf milk replacers.

Key Words: calves, milk replacer, egg

1230 Contacts between milking cow husbandry and vertical co-operation. Huda F. Salem, Sandor J. Dr. Zsarnoczai^{*}, Laszlo Dr. Villanyi, and Endre Dr.(DSc)Szucs, Szent Istvan University, Godollo, Hungary.

"The study analyses contacts of producers on milking cow husbandry farms with dairy processors based on vertical co-operation in Hungary. The analysis emphasizes bargain position of milk producers and their favourable and unfavourable conditions concerning to processors. Within vertical co-ordination 90 % of purchased milk were bought by milk collecting units and from them to processors based on purchasing and sale contracts. Purchasing price of raw milk is free price, which depends on characteristics of milk. 76 % of purchased milk was of extra quality in 1998. By the end of 1990s 40 % of cows was in co-operatives, 27 % was in companies and 33 % was on family farms. Farms owning average more than 200 cows provided 78,6 % of milk production. The milk production is concentrated. The share of milk producer-ownership in

milk processing, namely the co-operatives, small and medium scale farms owned 5,4 % of subscribed capital of milk processing. Ownership-part and favourable bargain position can be strengthened by co-operative contacts between producers. Housing and management system applied in Hungary meets the directives of EU in term of management policy: feeding, milking system, manure disposal and treatment, cows have individual place demand is for rest, feeder and moving, computer controlling system for farms, production technology and animal health condition control."

Key Words: Milking cow husbandry, Bargain position, Computer controlling system

1231 Vertical co-ordination in the Hungarian milk production. H. F. Salem, L. Villanyi, I. Feher, and J.S. Zsarnoczi*, *Szent Istvan University, Godollo, Hungary.*

The study compares and analyses several main Hungarian and EU experiences of vertical co-ordination and vertical integration in milk production based on EU qualitative demands. Compare data based on economic role and bargain position of participants of product-way before transition and during transition. Before the transition share of agricultural co-operatives was 55 % of milk production, 15 % of dairy processing, 25 % of retail trade 25 %, share of state-farms was 20 %, 85 %, and 60 % as mentioned branches. Dairy family farms provided 25 % of milk production, hotels-restaurants provided 10 % of retail trade. By the end of 1990s share of co-operatives was 40 % of production, 15 % of processing, 20 % of retail trade, private companies provided 32 %, family farms provided 25 % of milk production. Processing companies provided 85 % of dairy processing. Large chain stores' share was 35 %, independent retailers' share was 25 %, hotels-restaurants' share was 10 %, whole traders' share was 10 % of retail trade. In EU milk producers control 70 % of milk-selling within co-operative, in Hungary it was less than 5 % of processing. Processing has concentrated in Hungary, first largest four processing companies provided 38 % in 1998 and 53 % of processed milk in 1999. In 1998 the records of the National Tax Authority showed 100 milk processing companies, of which only 85 were active. Favourable trends were also reflected in investments. More than 5 billion HUF in 1998 and 6,6 billion HUF in 1999 were invested in the milk sector, of which 69-74 % was for machinery and equipment and 26-31 % was for constructions. Vertical co-ordination makes easier to keep EU qualitative demands, and bargain position of processors became stronger than producers, but large chain stores' one became stronger than processors' one. Type of vertical co-ordination inside a company is vertical integration, which can be base on co-operative model, as in EU.

Key Words: Vertical co-ordination, Agricultural co-operatives, Retail trade

1232 Withdrawn. . .

1233 Lactose concentration in milk from Quebec dairy cattle. D.M. Lefebvre*, R.K. Moore¹, and R.I. Cue², ¹PATLQ-Quebec Dairy Herd Analysis Service, ²McGill University, Ste-Anne-de-Bellevue, QC, Canada.

Lactose is quantitatively the most important constituent of milk. As such it makes an important contribution to the energy value of milk. Its concentration in milk is generally assumed to be relatively constant. However, little is reported in the literature about the factors affecting it. Between June and December 2001, lactose was analyzed by infrared spectroscopy together with fat, total protein, lactose, urea N and somatic cells on 341278 samples submitted for analysis for milk recording (MR). Lactose percentage was lowest for the Ayrshire breed (4.48 ± 0.30 , $n=15091$), values for other breeds were: Holstein (4.56 ± 0.25 , $n=322538$), Brown Swiss (4.57 ± 0.25 , $n=2183$), Jersey (4.56 ± 0.24 , $n=1232$), Canadienne (4.61 ± 0.28 , $n=234$). Other descriptive statistics are presented for the Holstein breed. Lactose concentration was higher in primiparous cows (4.69 ± 0.19) and declined with parity number (parity 2: 4.55 ± 0.22 , parity 3 and greater: 4.47 ± 0.27). Stage of lactation was examined in blocks of 30 days. Lactose percentage was highest (4.68 ± 0.19) in the second period (30-59 DIM), with the average concentration declining and variability increasing as DIM increased (for DIM 270-300, 4.49 ± 0.28). Values were slightly higher in the summer (4.58 ± 0.24) than in the fall (4.55 ± 0.26). Concentration of lactose was lower and more variable (4.37 ± 0.43) in samples associated with test day yields rejected

as abnormal by MR than for than for normal test yields (4.57 ± 0.24). Lactose was positively correlated with milk yield (.30) but negatively with concentration of fat (-.12) and protein (-.19) and with SCS (-.40). In the 2001 edition of the NRC Nutrient Requirements of Dairy Cattle, lactose can be included in the estimation of the NEL value of milk. The default value suggested when lactose concentration is unavailable is 4.85%. Using this default value rather than the actual analysis results in a slight overestimation of the energy value of milk (0.733 vs. 0.721 Mcal/kg for average composition of Holsteins).

Key Words: Milk, Lactose, Dairy cattle

1234 Determining the relationships among milk urea nitrogen and milk production, milk protein, milk fat and somatic cells counts from lactating cows in Texas. G. M. Goodall*, M. A. Tomaszewski¹, E. M. Sudweeks¹, J. W. Stuth¹, L. W. Green², and R. B. Schwartz¹, ¹Texas A&M University, ²Texas A&M University and Extension Research Center.

The objective of this study was to determine the relationship among MUN, milk production, somatic cell counts and milk components. The potential impact of elevated MUN levels on milk production, somatic cell counts and milk components directly affects the mailbox milk check. Overfeeding rumen degradable protein (RDP) can upset normal rumen function and potentially result in changes in milk production, its components and MUN levels. Excess nitrogen from the RDP can result in elevated environmental nitrogen. During this 3-year study, 18092 cow production and reproduction records were accumulated with their respective MUN levels. The cows were from Central and East Texas dairies where either a Total Mixed Ration or a grazing feeding system was being utilized. There were Jersey and Holstein cows in the study. MUN levels were significantly affected by date of test, parturition date, days in milk (DIM), and breed. The average MUN levels for the Holstein and Jersey grazing feeding systems were 16.89 mg% and 14.14 mg%, respectively. The average MUN levels for the TMR feeding system was 15.26 mg%. The 18.6 mg% peak MUN level occurred at 81 DIM. Milk production was significantly higher ($P > .001$) in TMR feeding system, 33.27 kg, than the grazing feeding system, 19.68 kg. MUN significantly was affected by milk production levels in the grazing herds ($P > .0001$). Milk protein and parity significantly affected MUN ($P > .0001$). The overfeeding of RDP in the grazing feeding system typically occurred with the grazing of high quality lush winter pasture and resulted in higher MUN levels compared to lower quality summer pastures. Pasture quality was in excess of 25% protein. This would indicate the need to carefully monitor commodities and other feed inputs to reduce MUN levels without significantly affecting milk production.

Key Words: Dairy-cows, environmental nitrogen, grazing, Monitoring #milk, feeds and MUN

1235 Incidence of metabolic and reproductive conditions and mastitis in Holsteins and impact on performance during the first 100 days of lactation. R. K. McGuffey*, R. R. Hozak¹, J. I. D. Wilkinson¹, and H. B. Green¹, ¹Elanco Animal Health.

Production and health incidents were monitored in control multiparous (M=152) and primiparous (P=84) Holstein cows from a study at 9 locations in the United States (n=6) and Canada (n=3). Health incidents categorized as RE (dystocia, retained placenta, and metritis), ME (ketosis, displaced abomasum, and milk fever) and mastitis (MA) were monitored for 100 days of lactation (DIM). Twenty-one (M=12; P=9) cows failed to reach 100 DIM for various health reasons. Of the 215 survivors, milk (kg/d) DMI (kg/d) and body weight (BW) loss (kg) for those that experienced no health problems during the first 100 DIM averaged 39.9, 22.0 and #31.1 for M (n=61) and 30.2, 17.8 and #5.5 for P (n=34). Numbers of cows affected by disease category were: ME: M=28, P=17; MA: M= 52, P=25; and RE: M=26, P=11. Effects of parity, the three categories of health incidents and all interactions were examined for milk, DMI and BW loss during 100 DIM. Significance was declared at ($P < 0.05$). ME was associated with reduced DMI (19.0 versus 17.1) and greater BW loss (-22.9 versus #46.5). ME was also associated with reduced milk for M cows ($P < 0.02$) but not for P cows ($P > 0.7$). Milk for M cows averaged 38.0 and 34.9 without and with ME, respectively.

Milk for P cows averaged 27.5 and 28.1 without and with ME, respectively. MA and RE had no effect on milk, DMI and BW loss. Metabolic diseases can have significant impact on productivity of dairy cows.

Key Words: Metabolic Disease, Early Lactation, Performance

1236 The impact of tunnel ventilation on heat stress in lactating dairy cows: Effects on intake, milk production and composition. T. R. Smith^{*1}, S. Willard¹, A. Chapa¹, R. J. Williams¹, T. Riley², and D. Pogue², ¹Mississippi State University, Starkville, ²North Mississippi Branch Experiment Station, Holly Springs.

In lactating dairy cows, the response to heat stress includes a decrease in feed intake, milk production and reproductive efficiency and an increase in the incidence of mastitis. To evaluate the potential for tunnel ventilation to alleviate the symptoms of heat stress in dairy cows, two groups of 10 lactating Holsteins were housed in a 20-cow freestall barn equipped with tunnel ventilation cooling and two similar groups were housed in adjacent freestall barns cooled with sprinklers and fans. Cows were randomly assigned to groups which were balanced for production, parity, and DIM. The 10-week study began June 25, 2001 and during the study, daily minimum and maximum ambient temperatures averaged $20.7 \pm 2.2^\circ\text{C}$ and $32.4 \pm 1.9^\circ\text{C}$, respectively. Within the tunnel barn, wind speed averaged 6.9 ± 1.2 km/h and the maximum daytime temperature in the tunnel barn averaged $5.4 \pm 1.3^\circ\text{C}$ below that in the outdoor freestall barns. Exposure time to conditions of moderate heat stress (80-90 THI) was reduced from an average of 342 min/day outside to 55 min/day inside the tunnel barn. Rectal temperatures and respiration rates were collected three times weekly between 1400 and 1600. For cows housed in the tunnel barn, rectal temperatures averaged $0.34 \pm 0.02^\circ\text{C}$ lower ($P < 0.0001$) and respiration rates averaged 10.6 ± 0.92 breaths/min lower ($P < 0.0001$) than for cows housed outside. Intake of the silage-grain mix was 2.1 kg/cow/d greater ($P < 0.0001$) for cows housed in the tunnel barn than for outside cows. Milk production for cows housed in the tunnel barn averaged 1.88 kg/cow/d greater ($P < 0.0001$) than for cows housed outside, however there were no differences in milk composition between treatments. These results suggest that tunnel ventilation cooling has the potential to decrease the exposure to and alleviate the symptoms of heat stress in lactating dairy cows under the environmental conditions found in the southeastern U.S.

Key Words: Lactation, Heat Stress, Tunnel Ventilation

1237 Characteristics of expansion in the Utah-Idaho dairy industry. J. W. MacAdam^{*}, D. Jackson-Smith, C. Groseclose, and R. Krannich, *Utah State University.*

Rapid expansion has occurred in the last decade within the dairy industry in the Intermountain West. However, patterns of dairy structural change appear to be quite diverse within the region. For this study, two geographic areas with long histories of dairy production were compared: a three-county area including Twin Falls in south-central Idaho (TF), where there has been a boom in the construction of very large (up to 10,000-cow) dairies, and an area including two contiguous counties on the northern Utah-southeast Idaho border (U/I), where small dairies are more reliant on family labor and residential development competes for agricultural land. Data were collected by mail survey from 101 TF farms and 144 U/I farms; response rates were 56% and 62%. Descriptive results confirm that the two study areas have very different dairy production systems. Dairy farms in both regions raised similar amounts of corn, grains, and soybeans (mean = 55 ha), TF farms had more cows per farm (mean = 771 cows) and less land in hay and pasture and thus much higher levels of animal/land intensity than the U/I farms (mean = 145 cows). Nearly one-third of TF farms reported they raised no feed. These differences are also reflected in the technology and management practices used on farms in each region. TF farms were more likely to have larger parlors and higher use rates of TMR machinery, computers, rBST, and expanded ration analysis. TF farms relied heavily on hired labor. Data on recent expansions suggest there has been widespread growth in herd size in both study areas. However, the rate of expansion (as well as the absolute size of herd growth) was higher for TF. Fewer U/I farms have recently expanded, were less likely to be planning a significant herd expansion, and were more likely to plan to exit or sell land to a developer in the next 5 years. In both areas, modest, incremental herd growth was the most common pattern, while most new cows came in through fewer dramatic expansions. Despite these differences,

the vast majority of dairy farms in both regions expect to remain in business for at least another 5 years.

Key Words: Dairy farms, Expansion, Demographics

1238 The effect of the amount of sawdust on geotextile mattresses on free stall preference and usage. Cassandra Tucker^{*} and Daniel Weary, *University of British Columbia, Vancouver BC Canada.*

Geotextile mattresses have gained popularity in recent years. Although mattresses are thought to provide financial benefits to producers, there are concerns that bare mattresses not compatible with cow comfort. Eleven dry, multiparous cows were housed individually in pens with access to three free stalls. Each stall was fitted with a geotextile mattress covered with either 0, 1 or 7.5 kg of kiln-dried sawdust. The animals were restricted to each stall in turn, in a random order, for 3 days. Behavioral data was collected during the last 2 days of restriction to each stall using time-lapse video recording. During the restriction phase, time spent lying and the number of lying events increased with the amount of sawdust and were lowest on bare mattresses (11.6 h and 7.8 per 24h, respectively) and highest in stalls with 7.5 kg of sawdust (13.8 h and 10.4 per 24h, respectively) (ANOVA, $P < 0.05$). After the restriction phase, the animals were allowed access to all three stalls for three days. During the last two days of this phase, the animals were video taped and preference for amount of bedding, based on lying times, was determined. All eleven animals spent at least 85 % of their lying time in the stall bedded with 7.5 kg of sawdust and clearly preferred this treatment to mattresses covered w

Key Words: Free-stall design, Cow comfort, Preference testing

1239 The effects of strategic cooling on thermal balance of late gestation dairy cows. E Oetting, J Spain, and J Sampson^{*}, *University of Missouri-Columbia/USA.*

This study measured the effects of cooling on thermal balance of and production by dairy cows. Twenty-four primiparous ($n = 21$ Holstein, 3 Guernsey) and twenty multiparous cows ($n = 19$ Holsteins, 1 Guernsey) were paired on the basis of parity, breed, and expected calving date and assigned to one of two groups. The control group received no supplemental cooling. The treatment group was sprayed with water and exposed to fan cooling for one hour at 0700 h and 1900 h three times per week. Pre-cooling (0600 h and 1800 h) and post-cooling (0800h and 2000h) measurements were recorded for both groups. Thermal balance measurements include skin (shoulder, rump, and tail head) and rectal temperatures and respiration rates. After calving, both groups were housed in the same freestall facility with 24-h fan cooling. Blood samples were collected at d 14 and d 7 prepartum, day of calving (DOC), and at d 3, d 7, and d 14 postpartum. Plasma non-esterified fatty acids (NEFA), ketones, glucose, and urea-nitrogen were quantified. Pre-cooling rectal temperatures were similar for both groups. Prior to cooling, respiration rates of cooled cows were higher than control cows in the morning and evening. Cooling reduced respiration rates from 58.4 to 51.5 bpm (a.m.) and from 66.2 to 53.7 (p.m.). Prepartum ketone levels were higher for cooled animals than for control animals (7.26, 11.34, 13.28 mg/dL vs. 2.01, 2.97, 7.71 mg/dL). On DOC, cooled animals had lower NEFA levels than control animals (0.35 versus 0.42 mEq/L). Postpartum NEFAs were higher for cooled animals than control animals. Ketone levels from DOC to d 7 declined for cooled animals (12.41, 10.09mg/dL), and increased for control animals (7.31, 11.88mg/dL). From d 7 to d 14, ketones of cooled animals increased to a similar concentration as that at d 3 postpartum (12.90 mg/dL), while ketones of control animals declined to a level below the d 3 postpartum level (6.22 mg/dL). Average daily milk yield was 1.5 kg higher for cooled animals than for control animals. These results indicate that prepartum cooling improved energy balance during heat stress. Cooling prepartum animals increased postpartum milk production by decreasing the prepartum negative energy balance in late gestation, heat-stressed animals.

Key Words: Strategic cooling, Late Gestation Dairy Cows, Heat stress

1240 Use of management practices to define Friesian and Brown Swiss herd environments in Southeastern Sicily. E. Raffrenato^{*1,2}, R. W. Blake², and P. A. Oltenacu², ¹*Consorzio Ricerca Filiera Lattiero-Casearia, Ragusa, Italy,* ²*Cornell University, Ithaca, NY.*

A 2000 survey of 250 herds (175 Friesian and 75 Brown Swiss; 84% of the total enrolled in the dairy recording program) was conducted using a questionnaire describing practices of milking, nutrition, housing, health, and reproduction. Subsets of 24 and 17 practices were utilized to differentiate high and low opportunity environments. A dissimilarity coefficient, the distance of Jaccard, was created among all farms. An asymmetric binary variable was assigned to each practice to describe its presence or absence in each herd. A distance matrix described the separations among all farm pairings, and farms were clustered in two groups using the Lance-Williams flexible-beta method. This resulted in 95 and 73 Friesian herds and 27 and 44 Brown Swiss herds allocated to low and high opportunity environments. High opportunity herds outperformed the low ones for all yield traits. Average ME yields of milk, fat and protein were 8544, 290 and 257 kg/cow and 9851, 329 and 300 kg/cow for low and high opportunity Friesian herds; and 6120, 228, and 203 kg/cow and 7064, 259 and 240 kg/cow for Brown Swiss herds. These results showed good separation in actual herd performance using *a priori* management information.

Key Words: management practices, herd environment, milk production

1241 Impact of regrouping on feeding behaviour of early lactation cows. L.G. Baird^{*1}, M.A.G. von Keyserlingk¹, D.M. Weary¹, J.A. Shelford¹, and K.A. Beauchemin², ¹*The University of British Columbia, Vancouver, Canada,* ²*Agriculture and Agri-Food Canada, Lethbridge Research Centre, Canada.*

Regrouping cows is a regular management practice that occurs at different stages of lactation and is thought to influence feeding behaviour and subsequent productivity. These concerns are of particular importance during the transition period, when animals are faced with an increased risk of metabolic disorders and loss of body condition, in addition to the challenges of a new social group. These problems are intensified for primiparous cows that have increased energy demands due to growth and lactation. These animals are also believed to be less dominant when mixed with older multiparous cows and therefore may have greater difficulty accessing the feed bunk at prime feeding times. In this study, 11 primiparous and 12 multiparous early lactation cows were housed in two adjacent pens. All animals were fitted with transponders that allowed for computerized monitoring of the location and duration of each visit to the feed bunk. Individual feeding behaviour and social status were monitored for four days prior to mixing. The effects of mixing were assessed by switching two animals from each pen into the adjacent pen for 4 days. Cows were then returned to their original pen and monitored for an additional four days. No significant differences ($P > 0.05$) in feeding frequency or duration were found when cows were mixed into the unfamiliar group. Over the course of the experiment, feeding frequency (visits to the feed bunk) and daily feeding duration (total time spent at the feed bunk) averaged (mean \pm S.D.) 7.75 ± 1.59 meals and 333.60 ± 65.01 min per 24h, respectively. Social order within the group had no effect on feeding frequency or duration when cows were regrouped. These data indicate that mixing cows into an unfamiliar group has little or no effect on feeding behaviour.

Key Words: feeding behaviour, early lactation, social order

1242 A systems on farm comparison between confinement and management intensive grazing for dairy heifers. M. Rudstrom¹, H. Chester-Jones², R. Imdieke³, D.G. Johnson^{*1}, A. Singh¹, G. Cuomo¹, and M. Reese¹, ¹*University of Minnesota, WCROC,* ²*SROC,* ³*Dairy Progeny Management.*

Two groups of 72 Holstein heifers (av initial BW, 218 kg) were used in a 145-d study to evaluate the economics of integrating a grazing enterprise versus a traditional open-front confinement feedlot with corn, soybeans and alfalfa crop rotations on a commercial Minnesota livestock and crop farm. Replicated groups of 36 heifers were assigned to either the feedlot (FDLOT) or pasture (MIG). MIG heifers were transitioned from a feedlot total mixed ration (TMR) over a 10-d period. MIG heifers were grazed over 11.3 hectares (ha) of established alfalfa pasture (6.4 heifers/ha) and supplemented daily with .45 to 1 kg of cracked corn

containing an ionophore and hay, the amount varying with pasture availability. Heifers on both systems performed similarly ($P > .05$), av .92 kg/d gain. Total feed, labor, machinery use, and equipment costs were documented over the 145-d trial. Two MIG heifers died during the trial.

	Feedlot		Pasture	
	Total Cost	\$/hd/day	Total cost	\$/hd/day
Feed Cost	\$7,636.15	\$0.73	\$2,804.96	\$0.28
Labor	\$2,675.25	\$0.26	\$815.63	\$0.08
Machinery	\$3,429.61	\$0.33	\$1,296.09	\$0.13
Health Costs	\$360.00	\$0.03	\$432.00	\$0.04
Facilities	\$1,000.00	\$0.10		
Bedding	\$730.80	\$0.07		
Fencing, bunks, water			\$810.53	\$0.08
Pasture charge			\$19,125.50	\$0.19
Death Loss			\$1,550.00	\$0.15
Total cost	\$15,831.01	\$1.52	\$9621.71	\$0.95
Manure credit	\$359.52	\$0.03		
Net cost	\$15,471.49	\$1.49		

Key Words: Dairy replacement management, Confinement vs. grazing, Replacement economics

1243 Factors affecting conception rate and pregnancy loss in lactating holstein cows. R. Chebel^{*1}, J. Santos¹, J. Reynolds¹, M. Overton¹, R. Cerri¹, and S. Juchem¹, ¹*University of California Davis.*

In study 1, conception rate (CR) was evaluated in a commercial dairy farm in which 7,384 lactating cows were examined for pregnancy by rectal palpation 393 d after AI. Ambient temperature was recorded for the following periods: day -50 to AI, and from AI to pregnancy diagnosis. In study 2, 1,503 Holstein cows on three commercial dairy farms were examined by ultrasonography on day 303 d after AI and pregnancy was reconfirmed 14 d later by rectal palpation. Ambient temperature was also recorded for the periods described above. Parity, DIM at AI, milk production, and AI protocol (timed AI vs estrus detection) were recorded for each individual cow. Heat stress (HS; $T > 29$ C) prior to or after AI was categorized based on the mean daily average maximum temperature (MDAMT) for each period. Exposure to HS was defined as following: daily maximum temperature < 29 C (NHS) and no single daily maximum temperature > 29 C; exposure to at least one day of maximum temperature > 29 C and MDAMT < 29 C (HS1); and exposure to MDAMT > 29 C (HS2). In study 1, CR was decreased by HS prior to AI (32.3 vs 24.7; $P < 0.001$). Cows not exposed to HS prior to AI had higher CR compared to HS1 and HS2 (32.3 vs 29.0 vs 23.5; $P < 0.01$). Post-insemination HS exposure did not affect CR ($P < 0.27$). Mean maximum temperature for HS and no HS periods were 33.6 and 22.9 C ($P < 0.001$). Neither parity (23.7 vs 27.4% for multiparous and primiparous; $P < 0.24$) nor insemination protocol (25.6 vs 24.3% for estrus detection and timed AI; $P < 0.33$) affected CR. Cows with production below the mean milk yield achieved higher CR than those with production above the mean (26.5 vs 23.9%; $P < 0.02$). In study 2, pregnancy loss was not influenced by HS prior to AI ($P > 0.15$), but cows not exposed to HS had lower pregnancy loss than HS2 (9.6 vs 14.0%; $P < 0.07$). When DIM at pregnancy diagnosis were divided into quartiles, cows with advanced lactation experienced higher pregnancy losses (10.4 vs 11.4 vs 14.5 vs 16.4%; $P < 0.01$). Neither parity no AI protocol had any effect on losses of pregnancy ($P > 0.15$). Exposure to HS prior to AI reduces CR, and exposure after AI increases pregnancy losses in lactating dairy cows.

Key Words: Conception rate, Pregnancy loss, Heat stress

1244 A non-linear approach to modeling methane emissions from dairy cows. J. A. N. Mills^{*}, E. Kebreab, L. A. Crompton, C. M. Yates, and J. France, *The University of Reading.*

Conventional linear models of methanogenesis have suffered from an inability to give reliable predictions outside the range of intake used in their formulation. It is well established that as intake increases, the percentage of GE lost as methane declines. This implies that any model of methane production based on DMI, GEI or MEI should be non-linear.

The objective of this research was to compare linear regression methods with non-linear techniques and to develop a model with universal application across the full range of intake. Data from 11 trials (n = 159) conducted at the Centre for Dairy Research (CEDAR) UK, were used to develop the models. The backward elimination procedure for multiple regression in SAS was used to produce the linear models and the criteria for selecting the best-fit model were as described by Oldick et al. (1999). The main effects were analysed using Proc Mixed procedure of SAS (2000). The best fit model was as follows: CH_4 (MJ/d) = 5.93(SE 1.60) + 0.92(SE 0.08) × DMI (kg/d) ($r^2=0.60$; RMSE = 1.82). The Mitscherlich model was also chosen to represent methane production and parameterized according to the CEDAR data as follows: CH_4 (MJ/d) = $CH_4max \# (CH_4max + CH_4min)e^{(-axMEI)}$ ($r^2 = 0.66$; RMSE = 1.8). Where CH_4max (MJ/d) = 39.9, $a = 0.0039$ and CH_4min (MJ/d) = 0. The Mitscherlich model was evaluated alongside the linear model using an independent dataset comprising trials conducted at the Agricultural Research Institute of Northern Ireland (ARINI) (n = 62) and the Grassland Research Institute, Hurley, UK (n = 44). These data were from Holstein cows fed typical grass or grass silage based diets. The Mitscherlich model improved methane prediction in comparison to the linear model ($r^2 = 0.81$ vs 0.78). The root mean square prediction error as a % of the observed mean (rootMSPE%) was lowest for the Mitscherlich model (12.2 vs 14.9) and this was combined with the lowest proportion of MSPE due to bias (0.10 vs 0.24) and regression (0.10 vs 0.14). In contrast to linear models, the Mitscherlich model was able to predict methane over the full range of intake whilst applying parameters with a biological basis.

Key Words: Methane, Dairy cow, Modeling

Ruminant Nutrition Fat and Intake

1246 Partial replacement of corn grain by calcium salts of unsaturated fatty acids in grazing dairy cows: 1- Dry matter intake, milk production and composition. L.I. Vidaurreta¹, G.A. Gagliostro², G.F. Schroeder^{*1-3}, and G. Eyherarvide², ¹Fac. Cs. Agrarias. UNMdP, ²INTA EEA Balcarce, ³CONICET, Argentina.

The effect of replacing fermentable energy (corn grain) by calcium salts of unsaturated fatty acids (UFA-Ca) on DM intake, milk yield and milk composition was studied in grazing dairy cows in midlactation (116 DIM). Two groups of seven multiparous Holstein cows (588 62 kg BW) were assigned to one of two treatments in a cross-over design. The cows grazed a fresh winter oat pasture (DM= 20.5%, NDF= 33.3%, CP= 19.4%, IVDMD= 73.2%) with an herbage mass averaging 1535 kg/DM/ha. Treatments consisted in two isoenergetic concentrates composed by 7 kg/d of ground corn grain and 0.4 kg/d of fish meal (T0) or 4.8 kg/d of corn grain, 0.4 kg/d of fish meal and 0.9 kg/d of UFA-Ca (T1). Fat energy represented about 13% of total metabolizable energy requirement of the cows. Neither pasture, DMI nor energy total intake were affected by fat supplementation. Yields of milk and milk protein were increased by feeding UFA-Ca. Milk fat yield was not increased and milk fat concentration was reduced. Milk protein content tended to be lower when UFA-Ca were fed. Changes in BW and BCS did not differ between treatments. Concentrations of plasma NEFA, glucose, triacylglycerides, total cholesterol and urea were not affected. Replacing rumen fermentable energy by UFA-Ca slightly increased milk and milk protein yields but decreased milk fat content in midlactation dairy cows in grazing conditions.

1245 Physiological variations of milk components in relation to seasonal changes over two years. F. Brulisaer¹, J. Moll², and R. Eicher^{*3}, ¹Swiss Federal Veterinary Office, Berne, Switzerland, ²Swiss Braunvieh Cattle Association, Zug Switzerland, ³University of Berne, Switzerland.

Nutritional and metabolic imbalances can be diagnosed by analysing milk components (fat, protein, urea) on a herd base. However, physiological changes and non-nutritional factors have to be taken into account for a precise evaluation. The goals of this study were to investigate physiological variation of milk components according to non-nutritional factors like individual and herd level of production, somatic cells counts, climate zone, and seasonal effects. Study data included more than 33'000 lactations of Swiss Braunvieh cows from totally 1000 farms. Samples were taken monthly over 2 years, divided in 2 time periods each (green forages/pasture vs. conserved forages). The dairy farms were randomly chosen from 3 different land registers based mainly on altitude (500 farms in the valley zone, 250 farms in the mountain 1 zone, and 250 farms in the mountain 2-4 zones). Data analysis was mainly descriptive: median and interquartile range were calculated for the different levels. Special focus was set on seasonal variations. Results did not differ a lot between corresponding periods of the 2 years, although statistics of forage analyses were quite better in the second year. This can be mainly explained by a higher volume of sales of concentrates in the first winter. In valley zone the percentage for milk fat stayed relatively constant during summer (3.8-4.1%), during winter feeding there was a tendency of decrease, but on a higher level (4.4-3.9%). Fat values tended to be lower in mountain zones 2-4 (3.8-4.1%) in winter. Herds with high annual milk yield generated similar, in winter even slightly higher percentages of milk fat than herds with lower milk yields. Milk protein increased in the end of summer and decreased during winter. Valley farms had higher protein than mountain farms. Herds with high annual milk yield generated equal or higher protein values. Milk urea increased markedly during summer and was relatively stable in winter. Urea level in summer milk didn't vary in the different yield categories. In winter high yield cows produced higher urea values than cows with low yields.

	T0	T1	SEM	P≤
Intake (kg DM/d)				
Pasture intake	19.1	18.9	0.77	0.92
Total DMI	23.6	22.4	0.80	0.39
Milk yield, kg/d	20.4	21.7	0.18	0.01
Milk Fat				
kg/d	0.61	0.60	0.01	0.22
%	3.08	2.72	0.07	0.01
Milk Protein				
kg/d	0.70	0.74	0.01	0.01
%	3.52	3.45	0.02	0.06

Key Words: milk production, fat supplementation, grazing

1247 Partial replacement of corn grain by calcium salts of unsaturated fatty acids in grazing dairy cows: 2- Milk fatty acid composition. L.I. Vidaurreta¹, G.A. Gagliostro², G.F. Schroeder^{*1-3}, A. Rodriguez⁴, and P. Gatti⁴, ¹Fac. Cs. Agrarias. UNMdP, ²INTA EEA Balcarce, ³CONICET, ⁴INTI CITIL PTM, Argentina.

The aim of the study was to determine the effect of partial replacement of corn grain by calcium salts of unsaturated fatty acids (UFA-Ca) on milk fatty acid composition in grazing dairy cows in midlactation (116 DIM). Fourteen multiparous Holstein cows (588 62 kg BW) were assigned to one of two treatments in a cross-over design. All cows grazed an oat (*Avena sativa*, L) pasture (DM= 20.5%, NDF= 33.3%; CP= 19.4%; IVDMD= 73.2%, availability = 1535 kg/DM/ha) and were supplemented with two isoenergetic concentrates composed by 7 kg/d of ground corn and 0.4 kg/d of fish meal (T0) or 4.8 kg/d of corn grain, 0.4 kg/d of fish meal and 0.9 kg/d of UFA-Ca (T1). Fatty acid composition of the UFA-Ca used was: C14:0 (1.6%), C16:0 (16%), C16:1 (1.6%), C18:0 (13.5%), C18:1 (32%), C18:2 (30%), C18:3 (0.8%) and C20:0 (0.3%). Milk concentration of long-chain FA resulted higher,

whereas concentration of short-chain (C6 to C10) and medium chain FA (C12 to C16) were lower in cows that received UFA-Ca. Milk content of conjugated linoleic acid (CLA) was increased (58%) by UFA-Ca. Overall secretion of short and medium FA resulted lower in T1 cows whereas long-chain FA yield was increased by UFA-Ca feeding. Yields of C18:2 (T0= 12.1 and T1= 25.2 g/d) and CLA (T0= 7.3 and T1= 11.5 g/d) were increased by feeding UFA-Ca. In grazing dairy cows, partial replacing of rumen fermentable energy (corn grain) by UFA-Ca (30% of C18:2) seemed to be an effective way to increase the content and secretion of FA that may have positive effects on human health.

	T0	T1	SEM	P≤
Milk Fatty Acids, %				
C4:0	2.11	1.96	0.12	0.20
C6:0	1.98	1.45	0.04	0.01
C8:0	1.38	0.93	0.02	0.01
C10:0	3.21	2.08	0.04	0.01
C12:0	3.69	2.42	0.06	0.01
C14:0	10.8	8.11	0.13	0.01
C16:0	24.2	20.2	0.28	0.01
C16:1	1.43	1.43	0.08	0.96
C18:0	10.4	11.5	0.23	0.01
C18:1	21.9	25.0	0.24	0.01
C18:2	2.01	4.30	0.01	0.01
C18:3	0.61	0.75	0.02	0.01
CLA (cis-9. trans-11)	1.25	1.97	0.06	0.01

Key Words: Fat supplementation, Milk fatty acids, Grazing

1248 Ruminal environment and pasture digestion in grazing dairy cows supplemented with calcium salts of unsaturated fatty acids. L.I. Vidaurreta¹, G.F. Schroeder*¹⁻², and G.A. Gagliostro³, ¹*Fac. Cs. Agrarias. UNMDP*, ²*CONICET*, ³*INTA EEA Balcarce, Argentina.*

The effect of partial replacement of ground corn by calcium salts of unsaturated fatty acids (UFA-Ca) on ruminal environment and forage NDF and CP digestion was studied in grazing dairy cows. Four Holstein cows fitted with ruminal cannulas were used in a two treatments two periods cross-over design. Cows grazed a fresh oat pasture (DM= 20.5%, NDF= 33.3%; CP= 19.4%; IVDMD= 73.2%) with an average herbage mass of 1535 kg/DM/ha. Treatments were : T0= 7 kg/d of ground corn and 0.4 kg/d of fish meal; T1= 4.8 kg/d of ground corn and 0.9 kg/d of UFA-Ca. Fatty acid composition of UFA-Ca was: C14:0 (1.6%), C16:0 (16%), C16:1 (1.6%), C18:0 (13.5%), C18:1 (32%), C18:2 (30%), C18:3 (0.8%) and C20:0 (0.3%). Nylon bags containing fresh forage (5 g DM/bag) were incubated in the rumen and removed at 0, 3, 6, 9, 12, 16, 20, 28, 48, and 72 h to estimate the in situ disappearance of NDF and CP. Ruminal pH, NH3-N and total VFA concentrations did not differ. Parameters of in situ disappearance of forage NDF and CP were not affected by UFA-Ca. Calcium salts of UFA did not alter rumen fermentation or parameters associated to forage digestion when dairy cows grazed a high quality pasture even when low values of ruminal pH were recorded.

	T0	T1	SEM	P≤
pH	5.55	5.72	0.02	0.22
NH3-N (mg/dl)	11.1	12.2	0.47	0.26
Total VFA (mmol/L)	126.1	127.3	5.72	0.89
Acetate: Propionate ratio	2.64	2.80	0.09	0.33
Pasture NDF Fractions				
Soluble, %	1.00	4.19	1.39	0.25
Degradable, %	83.3	78.1	4.75	0.52
Rate of digestion (%/h)	0.13	0.11	0.02	0.67
Effective degradability, % 1	33.2	39.6	4.62	0.43
Pasture CP Fractions				
Soluble, %	59.4	60.8	1.73	0.62
Degradable, %	90.9	90.8	0.88	0.97
Rate of digestion (%/h)	0.13	0.11	0.02	0.67
Effective degradability, % 1	76.9	78.1	2.24	0.74

1-Rate of passage assumed: 7%/h

Key Words: Fat supplementation, Ruminal digestion, Grazing

1249 Reproduction of dairy cows fed flaxseed, Megalac or micronized soybeans. H. V. Petit*¹ and H. Twagiramungu², ¹*Agriculture and Agri-Food Canada*, ²*L'Alliance Boviteq.*

One-hundred forty-one Holstein cows were allotted at calving to 47 groups of three cows each to determine the effects of fat source on reproduction of the dairy cow. Cows within groups were allotted to one of three isonitrogenous, isoenergetic, and isolipidic supplements based on either whole flaxseed (FLA), Megalac (MEG) or micronized soybeans (SOY). Diets were fed as total mixed diets for ad libitum intake from calving up to d 50 of gestation. Body weight of cows was determined weekly. Cows were bred after the onset of estrus and pregnancy diagnosis was performed at 30 and 50 d by rectal palpation. Embryo mortality was calculated as the difference between the number of cows pregnant on d 30 and those not pregnant on d 50. The number and percentage of cows pregnant were tested using a chi-square test. Fisher's exact test of PROC FREQ was used to compare on a 2 x 2 basis the effects of treatment on gestation rate, embryo mortality, and pregnancy rate when the Fisher's exact test was significant at P < 0.05. Interval between calving and the first breeding and interval between the first and second breeding were similar (P > 0.05) among treatments. Cows fed FLA had a greater (P = 0.06) number of follicles equal or greater than 10 mm compared to those fed MEG (1.7 vs 1.0). Cows fed SOY had a similar number of follicles equal or greater than10 mm (1.2) to those fed either FLA or MEG. The corpus luteum diameter was significantly greater (P < 0.05) for cows fed FLA compared to those fed SOY (19.7 vs 16.9 mm) and there was no difference (P > 0.05) between cows fed MEG (17.5 mm) and those fed either FLA or SOY. Diets tended (P = 0.11) to have an effect on embryo mortality with FLA resulting in lower value (0%) than either MEG (15.4%) or SOY (13.6%). These results suggest that the decrease in embryo mortality that was observed when feeding greater levels of alpha-linolenic acid in the present experiment may partly result from lower levels of production of the dienolic prostaglandin PGF₂, alteration in corpus luteum regression, and increase progesterone concentration as observed in earlier work.

Key Words: Dairy cattle, Flaxseed, Soybeans

1250 The effect of different types of dietary fat on rumen fermentation and total tract digestion of sheep. H. Febel*¹, E. Andrasofszky², and Sz. Huszar¹, ¹*Research Institute of Animal Breeding and Nutrition, Herceghalom*, ²*Szent Istvan University, Faculty of Veterinary Science, Budapest, Hungary.*

Dietary fat is used to increase the energy value of dairy diets, but its use may cause digestive problems. The effects of different fat sources were evaluated in a 5 x 5 Latin square with 21 d periods using five rumen cannulated wethers. Treatments were: C) control diet (no added fat), CS) C + calcium salts of palm oil fatty acids, SO) C + soybean oil, HA) C + hydroxyethylsoyamide, and BA) C + butylsoyamide. Fat content in DM was 2.3% for diet C, 5.7% for supplemented diets. The basal diet consisted of a 50:50 mixture of meadow hay and concentrate fed in equal amounts daily, at 080 and 2000h. Ruminal pH and total VFA concentration were not different among treatments (P>.05). However, the proportion of propionate was higher with fat supplementation (P<.01). The acetate:propionate ratio was highest for C, intermediate for CS, BA and HA, and lowest for the SO diets (4.29, 3.97, 3.65, 3.44 and 3.21, respectively). Rumen ammonia N concentration decreased due to fat supplementation (P<.05). Total tract digestibilities of DM and OM were reduced by SO and HA (P<.05). Higher total N digestion was observed in sheep fed the CS and HA diets (P<.05). Digestibility of ether extract (EE) was similar for the C and BA diets. However, the addition of CS, SO and HA significantly increased (P<0.001) total tract EE digestibility. Fat sources appeared to have no negative effect on apparent digestion of NDF (P>.05). The diet containing HA resulted in the lowest total tract ADF digestibility (P<.05). The results indicate that CS was the most inert fat source. The negative effect of HA on ruminal VFA and fiber digestion could be explained by the microbial breakdown of the amide with release of antimicrobial fatty acids. It is presumed that the ruminal breakdown of BA was avoided because this amide had fewer detrimental effect on ruminal fermentation than HA. Project was supported by Hungarian Scientific Research Fund (T 029043).

Key Words: Digestibility, Oleamide, Sheep

1251 Conjugated linoleic acid (CLA) content of milk from cows on different ryegrass cultivars. V. R. Loyola^{*1,4}, J. J. Murphy², M. O'Donovan², R. Devery³, M. D. S. Oliveira⁴, and C. Stanton¹, ¹Teagasc, Dairy Products Research Centre, Moorepark, Fermoy, Ireland, ²Teagasc, Dairy Production Research Centre, Moorepark, Fermoy, Ireland, ³Dublin City University, Ireland, ⁴Universidade Estadual Paulista, UNESP, Jaboticabal, Brasil.

Milk fat CLA arises from microbial biohydrogenation of dietary linoleic acid in the rumen and also by endogenous synthesis in mammary tissue by $\Delta 9$ desaturase activity on vaccenic acid. CLA has exhibited a number of health benefits /italicizein vitro and /italicizein vivo, including anticarcinogenic activity. Therefore, strategies for optimising the CLA and vaccenic acid content of milk fat may provide means of enhancing its nutritional and health promoting properties. In this study, the effects of ingestion of four ryegrass cultivars, consisting of two diploid, Spelga (S) and Portstewart (P), and two tetraploid, Napoleon (N) and Millennium (M), with different heading dates (intermediate and late) on milk fat CLA concentrations were investigated. Four herds of 20 cows each were blocked onto the four ryegrass cultivars in March and throughout the season were rotationally grazed /italicizead libitum at a stocking density of 4.2 cows per hectare. Milk fatty acid composition was analyzed at 2 times during the grazing season (July and September). The linoleic and α -linolenic acid content of the ryegrass varieties were similar. The /italicizecicis-9, /italicize trans-11 CLA content of the milk fat averaged for the 2 sampling times was significantly lower ($P < 0.01$) from cows grazing N (1.35 g/100g FAME) than from cows grazing either M (1.72) or P (1.71), while CLA from S (1.54 g/100g FAME) did not differ from any other cultivar. Vaccenic acid content was also lower on this cultivar ($P < 0.05$). There was no difference in milk fat CLA between the two sampling times. The heading date effect was significant ($P < 0.05$), with late heading cultivars resulting in higher CLA. There was no significant difference in the milk fat CLA between diploid and tetraploid cultivars. These data suggest that ryegrass variety may influence the CLA and vaccenic content of milk fat in a similar manner.

Key Words: CLA, Ryegrass Cultivars, Bovine Milk Fat

1252 In vitro ruminal biohydrogenation of n-3 fatty acid from two fish oils as influenced by inclusion levels. F. Dohme^{*1}, V. I. Fievez², K. Raes², and D. I. Demeyer², ¹Swiss Federal Research Station for Animal Production, ²Ghent University, Belgium.

One major limitation in the incorporation rate of n-3 fatty acids into milk and body fat is their biohydrogenation by rumen micro-organisms. The aim of the study was to determine whether release rate from triacylglycerols (TG) and biohydrogenation of eicosapentaenoic (EPA) and docosahexaenoic acids (DHA) varied between two fish oils (FOa; FOb) differing in their levels of EPA and DHA (FOa: 18.7% EPA, 11.7% DHA; FOb: 5.8% EPA, 7.6% DHA) and supplied at six levels (12.5, 25, 50, 75, 100, 125 mg). Using the batch cultures technique, FOa and FOb were incubated for 24 or 48 h in 25 mL buffer-rumen fluid-mixture and 0.4 g of ground hay. TG and free fatty acids were separated by TLC and the fatty acid composition was determined by GLC. Release rate and biohydrogenation of EPA and DHA were expressed as the ratio of the incubated and unincubated samples. Linoleic acid (LA) from soy oil has shown to be highly biohydrogenated and therefore was used as a reference. Although EPA and DHA concentration was markedly higher in FOa, release rate from the oils did not differ. Regardless of the oils supplied, EPA and DHA release rate decreased with increasing level ($P < 0.001$) and increased with extended incubation time ($P < 0.001$). The rate of free LA was on average 90% and was not affected neither by incubation time nor by inclusion level. EPA and DHA from FOb were biohydrogenated at a greater extent than those of FOa ($P < 0.001$). Increasing oil supplementation caused a decreased biohydrogenation rate of EPA and DHA ($P < 0.001$). Compared to 24 h, incubation during 48 h enhanced the amount of EPA and DHA being biohydrogenated ($P < 0.001$). Biohydrogenation rate of LA was nearly complete and numerically higher than that observed for EPA and DHA from the fish oils. In conclusion, the release from TG of EPA and DHA and their biohydrogenation depended on the inclusion level. Furthermore, biohydrogenation rate was affected by the fatty acid composition of the supplied fish oils.

Key Words: Fish oil, n-3 fatty acids, Biohydrogenation

1253 Effects of DMI, addition of buffer, and source of fat on duodenal flow and milk concentration of conjugated linoleic acid and trans-C_{18:1} in dairy cows. X. Qiu^{*1}, M. L. Eastridge¹, J. L. Firkins¹, K. E. Griswold², and G. A. Apgar², ¹The Ohio State University, Columbus, ²Southern Illinois University, Carbondale.

Four ruminally and duodenally cannulated multiparous Holstein cows averaging 106 ± 17 DIM were used in a 4×4 Latin Square with the treatments as follows: control (CON) = diet with 2% fish oil (FO) and fed ad libitum; buffer addition (BUFF) = CON with 0.8% of DM as NaHCO_3 ; low DMI (LDMI) = dietary concentration of nutrients and FO increased from the CON and DMI was restricted to 80% of the CON; and soybean oil (SBO) = CON with 2% SBO instead of FO. The diet was a 36:3: 63.7 forage: concentrate ratio TMR with 32.1% NDF and 3.3% fatty acids. Periods were 18 d with the last 7 d for data collection and the first 4 d for determining the appropriate feed offered for the LDMI treatment. Duodenal conjugated linoleic acid (CLA) flows were 6.04, 3.73, 4.27, and 0.89 g/d, for CON, BUFF, LDMI, and SBO, respectively. *Trans*-C_{18:1} flows were 147.7, 142.3, 76.0, and 27.8 g/d, respectively. In milk, CLA concentrations were 24.5, 17.9, 18.5, and 10.1 mg/g of FA, respectively; and *trans*-C_{18:1} FA concentrations were 95.6, 99.5, 70.7, and 35.8 mg/g of FA, respectively. Feeding buffer at 0.8% of DM neither significantly increased ruminal pH nor decreased duodenal flows of *trans*-C_{18:1} and CLA, although the duodenal flows were numerically lower than CON. Restriction of DMI decreased duodenal flow of *trans*-C_{18:1} but did not significantly decrease duodenal flow of CLA from CON. However, both BUFF and LDMI tended to result in lower CLA concentration in milk fat than CON. Compared to SBO, FO was more effective in increasing duodenal flows of CLA and *trans*-C_{18:1} and, thus, concentration of CLA in milk. Cows fed FO had higher duodenal flow and milk concentration of n-3 polyunsaturated fatty acids than the cows fed SBO. Estimated by subtracting duodenal CLA flow from milk CLA production and then dividing by milk CLA production, endogenous synthesis of CLA by Δ^9 desaturase activity, averaging across the treatments, accounted for at least 72.1% of the CLA secreted in milk. The contribution of endogenous CLA varied as the source of dietary fat changed, with SBO (86.4%) being much higher than the other treatments (averaging 67.3%).

Key Words: conjugated linoleic acid, *trans* fatty acid, milk fat

1254 Performance of lactating holstein cows fed catfish oil in summer. A.K.Amorocho^{*} and C.R. Staples. Department of Animal Sciences, University of Florida, Gainesville. A . K . Amorocho^{*} and C. R. Staples, University of Florida, Gainesville, Florida.

The objective was to evaluate the effect of dietary catfish oil on milk production and composition, dry matter intake, plasma glucose and urea, and pH of rumen fluid, urine, and feces of 12 multiparous Holstein cows (six ruminally fistulated and six nonfistulated) (average of 195 days in milk). The fatty acid profile of catfish oil was 19% palmitic, 47% oleic, and 14% linoleic. Catfish oil (0, 1.5, and 3% of dietary DM) was suspended in liquid molasses, mixed with grain, and fed as a TMR containing corn silage and alfalfa hay. Treatments were arranged in a 3×3 Latin square design replicated four times. Each period lasted 27 days, 14 days for adaptation to a new diet and 13 days for data collection. Milk production and dry matter intake was measure daily. Blood was collected on days 12 and 13. Urine and fecal samples were collected and measured for pH on days 8 and 9. Rumen fluid was collected hourly for 8 hours on day 1. Intake of dry matter increased linearly ($P < 0.05$) as intake of catfish oil increased (23.0, 24.4, and 25.4 kg/d). Production of milk was unchanged by the feeding of catfish oil (28.9, 28.9, and 29.4 kg/d). Concentrations of milk fat (3.57, 3.60, and 3.48%) and protein (3.21, 3.18, and 3.23%) were similar across the catfish oil diets. Concentrations of plasma glucose (57.2, 55.1, and 56.0 mg/100 ml) and urea nitrogen (11.6, 11.0, and 12.0 mg/100 ml) were not affected by dietary treatments. The pH of urine (8.05, 8.05, and 8.06) and feces (6.73, 6.67, and 6.67) were unchanged by feeding of increasing amounts of catfish oil. Average ruminal fluid pH decreased linearly ($P < 0.0001$) as intake of catfish oil increased (6.40, 6.20, and 6.15). The treatment by square interactions were not significant. Catfish oil was successfully mixed with liquid molasses and fed to lactating Holstein cows at up to 3% of dietary dry matter, stimulating dry matter intake.

Key Words: lipids, dairy cows, rumen fluid

1255 Patterns of biohydrogenation and duodenal flow of *trans* fatty acids and conjugated linoleic acids (CLA) are altered by dietary fiber level and linseed oil in dairy cows. J. Looor*, K. Ueda, A. Ferlay, Y. Chilliard, and M. Doreau, INRA, *Unite de Recherche sur les Herbivores, 63122 St.-Genes Champanelle, France.*

Duodenal flows of hydrogenation intermediates in response to altered rumen fermentation and 18:3n-3 availability were evaluated using four lactating Holstein cows fed a high (65:35 forage to grain; HF) or low (35:65; LF) fiber [derived from grass hay] diet without (HFN, LFN) added oil or with linseed oil (HFO, LFO) at 3% of DM. A 4 × 4 Latin square design was implemented for 4 wk. Total fatty acid content in the DMI (20 ± 1 kg/d) ranked by treatment was HFO and LFO (4.6, 5.1%) > LFN and HFN (1.9, 1.6%). Feeding LFN increased intake of 18:2n-6 (142 vs. 97 g/d) but reduced 18:3n-3 (55 vs. 82 g/d) compared with HFN. Intakes of 18:2n-6 and 18:3n-3 increased further when HFO (361, 154 g/d) or LFO (404, 115 g/d) were fed. Greater hydrogenation of 18:2n-6 (77 vs. 74%) and 18:3n-3 (89 vs. 84%) was observed in response to HFN compared with LFN. Whereas hydrogenation of 18:2n-6 increased (92%) due to HFO or LFO, 18:3n-3 hydrogenation decreased (73%) but only in response to LFO. Duodenal flow of total CLA averaged 1.8 g/d due to feeding HFN or LFN and increased to 3.1 g/d in response to HFO or LFO. C9,c11- plus *t,t*-CLA were 75 or 55% of total CLA flow for HFN or LFN. C9,t11- was 5% of total CLA when HFN or LFN were fed compared with 16% due to HFO or LFO. Feeding LFN or LFO doubled flow of *t*10,c12-CLA (0.06 g/d). Flow of *t*11,c15-18:2 was 1.3 g/d in cows fed HFN or LFN compared with 9.6 or 65 g/d for HFO or LFO. Total *t*-18:1 flow was 40 g/d in cows fed HFN, increased to 77 and 135 g/d in response to LFN and HFO, and peaked at 290 g/d due to feeding LFO. Flows of *t*10- and *t*11-18:1 were lower for HFN (3.0, 22 g/d) compared with LFN (20, 26 g/d). Feeding HFO (6.7, 63 g/d) and LFO (68, 122 g/d) further increased their flows. Data show, low-fiber diets enhanced rumen production of *t*10-18:1 and to a lower extent *t*10,c12-CLA. Supplemental 18:3n-3, however, was hydrogenated to *t*11,c15-18:2 and *t*11-18:1, primarily, but led to minor increases in c9,t11-CLA.

Key Words: hydrogenation, *trans* FA, linseed oil

1256 Effect of linseed oil supplementation to different forage/concentrate ratio diets on ruminal digestion in dairy cows. K. Ueda, A. Ferlay, J. Looor*, Y. Chilliard, and M. Doreau, INRA, *Unite de Recherche sur les Herbivores, 63122 St.-Genes Champanelle, France.*

The effect of linseed oil supplementation on digestibility and rumen characteristics was investigated in dairy cows, when offered diets with different forage to concentrate ratios (F/C). The experiment was conducted in a 4 × 4 Latin square design with four lactating Holstein cows. Cows received diets: F(F/C=65/35), FO(F/C=65/32, 3% linseed oil), C(F/C=35/65), and CO(F/C=35/62, 3% linseed oil). Diets contained natural grassland hay, a grain mixture and soybean meal to meet energy and protein requirements. Total feces excretion and duodenal digesta flow were measured to obtain the digestibility in the total tract and the rumen for OM, NDF and starch. In situ DM degradation parameters were measured for hay, and the effective degradability was calculated assuming $k_p=0.04$. Rumen fluid pH, VFA and protozoa concentration were also measured. Daily DM intake was not different among diets (F: 20.4, FO: 19.6, C: 20.5, CO: 20.4 kg). Total tract digestibility of OM (68.5, 70.0, 70.0, 73.3 %) and NDF (61.4, 63.3, 51.0, 54.0 %) were significantly higher ($P<0.01$) with oil supplementation for both F/C ratios. There was a tendency of interaction between oil supplementation and F/C for the ruminal digestibilities of OM ($P=0.06$; 52.3, 59.8, 60.7, 54.1 %) and NDF ($P=0.06$; 37.8, 55.7, 42.9, 31.0 %). Ruminal starch digestion was almost complete for all diets and the digestibility was not affected by oil supplementation (89.0, 87.7, 91.6, 94.3 %). Oil supplementation did not affect ruminal pH and VFA concentration. Total protozoa concentration for CO was numerically lower than for other diets (89, 95, 83, 14 × 10³/mL). The difference among treatments in the effective degradability of hay DM was similar to those of ruminal OM and NDF digestibility (48.0, 54.0, 46.9, 46.8 %). In conclusion, linseed oil supplementation had no negative effects on total tract digestion in dairy cow. However, ruminal OM and NDF digestion tended to be reduced when cows were offered concentrate-rich diets.

Key Words: Linseed oil, Forage ratio, Ruminal digestion

1257 Milk fatty acid composition from cows fed a total mixed ration or grazing different pasture species. C. Benchaar*¹, T. D. Whyte², R. Berthiaume¹, T. Astatkie², G. F. Tremblay³, A. H. Fredeen², R. C. Martin², and P. Y. Chouinard⁴, ¹Agriculture and Agri-Food Canada, Lennoxville, QC, ²Nova Scotia Agricultural College, Truro, NS, ³Agriculture and Agri-Food Canada, Ste-Foy, QC, ⁴Universite Laval, QC.

The objective of this study was to evaluate the potential use of different pasture species to manipulate milk fatty acid (FA) composition. Thirty-two lactating Holstein cows were randomly assigned to one of four treatments: 1) total mixed ration (TMR), 2) permanent pasture (PP) containing a mixture of grasses and legume species, 3) pasture consisting of red clover (RC), and 4) PP during the day and annual ryegrass at night (PP/ARG). All cows received a supplement mix of similar composition. From the last week of June to the end of August, milk samples were collected from four consecutive milkings at wk 0 (covariate), 2, 4, 6, and 8 of the experiment. Data were analysed as repeated measures using Proc Mixed of SAS. Effects of treatments were determined by orthogonal contrasts: TMR vs all pastures, PP vs (RC+PP/ARG), and RC vs ARG/PP. Milk from cows on pasture was lower in C16:0 (27.9 vs 34.1%, $P<0.01$) and higher in C18:0 (13.5 vs 10.5%, $P<0.01$) than milk from cows fed TMR. Pasture-fed cows produced milk with higher contents of CLA (1.1 vs 0.4%) and *trans*-C18:1 (2.7 vs 1.2%) than cows fed TMR ($P<0.01$). Concentrations of these FA increased linearly over the grazing season. The proportion of *cis*-C18:1 was higher (25.4 vs 19.3%, $P<0.01$) for grazing cows than for confined cows, and the proportion of this FA decreased linearly over time for both groups. Milk fat content of C18:2 was increased in cows grazing pasture at wk 2 (2.8 vs 2.6%, $P=0.05$) and at wk 8 (2.8 vs 2.5%, $P=0.05$). The proportion of C18:3 was enhanced ($P<0.01$) by pasture treatments at wk 2, 4, and 8 of the trial. Milk FA profile was relatively similar between cows grazing PP and those grazing (RC+PP/ARG). Only CLA and C18:3 were slightly increased ($P=0.08$ and 0.03, respectively) in cows grazing RC or PP/ARG at wk 6 (1.3 vs 1.1%, CLA) and wk 8 (0.6 vs 0.5%, C18:3). Cows grazing RC had higher CLA (wk 6, $P=0.03$), C18:3 (wk 2, 4 and 8, $P<0.05$) and *trans*-C18:1 (wk 2 and 4, $P<0.01$) than cows consuming ARG/PP. This study showed important differences in milk FA composition between cows fed TMR and cows grazing different pasture species.

Key Words: Milk fatty acids, TMR, Pasture

1258 Effect of linoleic or oleic acid-rich oils on conjugated linoleic acid (CLA) content of adipose and muscle of finishing cattle. M.A. McGuire*, A.N. Hristov, L.R. Falen, L. Kennington, C.W. Hunt, and J.K. Ropp, *University of Idaho, Moscow.*

Enhancing the CLA content of beef may be beneficial to human health. Impacts of biohydrogenation in the rumen could affect CLA content since CLA is formed as an intermediate in the biohydrogenation of linoleic acid. We examined whether linoleic (LIN) or oleic (OLE) acid-rich oils altered the CLA profile of muscle and adipose tissues of finishing cattle. Two groups of 8 Angus cattle (423 ± 7.4 kg initial BW) blocked by sex and BW were randomly allocated to two dietary treatments: LIN (76.5% linoleic acid safflower oil) or OLE (76.5% oleic acid safflower oil) fed at 5% of dietary DM. The remainder of the diets was 78% rolled barley grain, 15% wheat silage and alfalfa hay, and 2% minerals and vitamins (DM basis). Cattle were gradually adapted to the diet and fed individually for 116 days. Oils were fed during the last 86 days of the trial. Tissues were collected 24 h post slaughter and included kidney-pelvic fat (KP), subcutaneous fat (SQ) over the 12th rib, longissimus dorsi (LD), semitendinosus (ST), and semimembranosus (SM) muscle. Lipids were extracted by a modified Folch procedure and methyl esters formed using Na methoxide. Gas chromatography of the methyl esters was performed. Concentrations of the major CLA isomer (*cis*-9, *trans*-11) were greater ($P<0.005$) in KP (0.25 vs 0.15% total fatty acids), SQ (0.42 vs 0.23%) and LD (0.34 vs 0.21%) but not ($P>0.1$) in ST (0.31 vs 0.27%) or SM (0.37 vs 0.25%) from cattle fed LIN compared to OLE. The second most abundant CLA isomer was *trans*-7, *cis*-9 CLA. Treatment did not ($P>0.1$) alter *trans*-7, *cis*-9 CLA content averaging 0.19, 0.27, 0.14, 0.13 and 0.21% in KP, SQ, ST, SM and LD, respectively, for both treatments. The *trans*-10, *cis*-12 CLA isomer was greater ($P<0.05$) with LIN compared to OLE only in KP (0.05 vs 0.03%) and SQ (0.05 vs

0.02%). In conclusion, linoleic acid-rich safflower oil added to a barley-based diet enhanced the concentration of CLA isomers in most tissues of finishing cattle.

Key Words: Dietary oil, CLA, Cattle

1259 Effect of fat sources differing in fatty acid profile on lactational and reproductive performance of Holstein cows. S.O. Juchem^{*1}, J.E.P. Santos¹, R. Chebel¹, R.L.A. Cerri¹, E.J. DePeters¹, K.N. Galvao¹, S.J. Taylor¹, W.W. Thatcher², and D. Luchini³, ¹University of California Davis, ²University of Florida, ³Bioproducts Inc..

Five hundred multiparous Holstein cows were randomly assigned to one of the two treatments at calving after blocking according to parity and previous lactation milk yield. Treatments consisted of a diet containing either tallow (TA; 1.3% DM) or a Ca salt of palm and fish oils (CaS; 1.6% DM), to provide equal amounts of fatty acids (FA). The Ca salt supplement provided 20 g/d of eicosapentaenoic (EPA) and docosahexaenoic (DHA) FA combined. Cows were milked 3-x daily and production of milk and milk components were measured monthly for the first 130 DIM. All cows were timed artificially inseminated after the Presynch/Ovsynch protocol at 703 DIM. Pregnancy was diagnosed at 28 d after AI by ultrasonography and reconfirmed at 39 and 65 d after AI by rectal palpation. Milk and blood samples were collected for determination of FA profile. Coccygeal blood was also collected for measurements of plasma progesterone, glucose, and nonesterified FA. On day 15 of a synchronized estrous cycle, 20 cows were challenged with estradiol and oxytocin, and blood was collected sequentially for determination of plasma PGF_{2a} metabolite. Individual cow DM intake and diet digestibility were determined twice in a subset of 30 cows (15/trt) using Alkane as a marker. Continuous data were analyzed by the PROC MIXED procedure of SAS, and binomial variables by logistic regression. Preliminary data are presented from 120 cows. Yields (kg/d) of milk, 3.5% fat-corrected milk, milk fat and true protein did not differ ($P > 0.15$) and were, respectively, 49.4, 52.6, 1.93, 1.38 for cows fed CaS, and 48.2, 52.0, 1.93, 1.38 for cows fed TA. Plasma glucose tended to be higher for cows fed CaS (60.0 vs 57.4 mg/dl; $P < 0.10$). Concentrations of n-3 FA in milk tended to increase for cows fed CaS (0.46 vs 0.42%; $P < 0.10$), but milk EPA (0.043 vs 0.037%), DHA (0.024 vs 0.014%) and CLA (0.76 vs 0.53%) were higher for CaS compared with TA ($P < 0.01$). Conception rate at d 28 after AI was similar for cows fed CaS and TA (42.6 vs 40.7; $P < 0.83$), but pregnancy loss from d 28 to 39 after AI was reduced for CaS compared with TA (0 vs 15%; $P < 0.10$).

Key Words: Fatty acid, Reproduction, Cows

1260 Breed of dairy cows has influence on conjugated linoleic acid (CLA) content of milk. T. R. Dhiman^{*1}, M. S. Zaman¹, L. Kilmer², and D. Gilbert³, ¹Utah State University, ²Iowa State University, ³New Generation Genetics, Inc., Wisconsin.

Two experiments were conducted to determine the conjugated linoleic acid (CLA) content of milk from different breeds of dairy cows. In experiment-1, five cows each of Brown Swiss, Holstein-Friesian and Jersey breed were grazed on pasture and fed 8.6 kg of supplemental grain and 4.5 kg of alfalfa hay daily. The pasture contained predominantly perennial ryegrass, white clover and fescue. Grain supplement contained corn, barley and soybean meal. The duration of the experiment was 10 weeks. First 6 weeks were for adaptation to the diets and milk samples were collected during the last 4 weeks of the experiment from two consecutive a.m. and p.m. milkings. Weighted composite milk samples were analyzed for fat, protein, lactose and CLA content. In experiment 2, twenty lactating cows (five each of Ayrshire, Guernsey, Holstein-Friesian and Jersey breeds) were fed total mixed ration containing 34% conserved forage and 66% grain and by-product feeds (DM basis) for 7 weeks. First 3 weeks were considered for adaptation to the diets and milk samples were collected during the last 4 weeks of the experiment from consecutive a.m. and p.m. milkings for fat, protein, lactose and CLA analysis. In experiment 1 the CLA contents were 1.22^a, 0.86^b and 0.77^b g per 100 g of fat in milk from cows in Brown Swiss, Holstein-Friesian and Jersey breeds, respectively ($P < 0.05$). In experiment 2, milk from Ayrshire, Guernsey, Holstein-Friesian and Jersey had 0.57^b, 0.36^c, 0.78^a and 0.33^c g per 100 g of fat, respectively ($P < 0.05$). The Brown Swiss cows grazing on pasture and fed supplemental grain had higher levels of CLA in milk fat than Holstein-Friesians and Jerseys fed

similar diets. The CLA content of milk from Holstein-Friesians and Jersey cows was not different in experiment 1. Experiment 2, milk from Ayrshire and Holstein-Friesian cows fed conserved forage and grain had higher level of CLA compared with cows in Guernsey and Jersey breeds fed similar diets. The CLA content of milk from Guernsey and Jersey cows fed conserved forage was not different. Results suggest that breed can influence CLA content of milk from cows fed similar diets.

Key Words: CLA, Milk, Breed

1261 Effect of tallow and Ca-salts of fatty acids on milk production and nutrients digestibility in lactating Holstein cows. Eeman Noorae^{*}, Abbasali Naserian, and Reza Valizadeh, Ferdowsi University Of Mashhad, Mashhad, Khorasan, Iran.

Nine multiparous cows in midlactation were utilized in 3×3 change over design with 21-day periods to study the effects of two supplemental fat sources (tallow and Ca-salts of fatty acids) on production and nutrients digestibility. Treatments were : 1) no added fat (control), 2) 4% tallow (DM basis), 3) 4% Ca-salts of fatty acids (DM basis). Cows were fed as TMR. Although Milk yield was increased about 4% by fat supplementation but differences among treatments were not significant ($P \leq 0.05$). 4%FCM, milk fat percentage, fat yield, dry matter intake and apparent digestibilities of DM, OM and CP did not differ among treatments. Protein, SNF and casein percentages were reduced in fat included treatments significantly ($P \leq 0.05$), but yields of milk protein, SNF and casein did not differ among treatments. Digestibilities of EE, NDF, ADF and Ca were affected by treatments ($P \leq 0.05$). Digestibility of ether extract in fat included treatments were higher than control treatment. Concentrations of glucose, triglyceride and BUN in plasma were not affected by treatments, but concentrations of cholesterol were elevated by fat supplementation significantly ($P \leq 0.05$). Thermal and humidity index had significant effect on percentages of milk fat, SNF, Casein, ($p \leq 0.05$) and milk yield, 4%FCM, DMI and ADF, NDF, EE intakes ($p \leq 0.01$).

Key Words: Dairy cows, Fat supplementation, Heat stress

1262 Modifications in the percentages of the C18 milk fatty acids due to the unsaturation level of dietary fats fed to dairy goats at the onset of lactation (linseed vs rapeseed). S. Giger-Reverdin¹, C. Duvaux-Ponter¹, P. Morand-Fehr¹, P. Weill², and D. Sauvant^{*1}, ¹UMR INRA - INAPG Physiologie de la Nutrition et Alimentation, ²Valorex-Prodex.

Today, consumers are fond of dietary products rich in unsaturated fatty acids, because these types of products might decrease the cardio-vascular risks. Dietary fat from animal products is generally rich in saturated or monounsaturated fatty acids, especially with 18 atoms of carbon. As dietary composition of feeds allowed to the animals influences the composition of animal products, it was of interest to test the influence of the replacement of rapeseed grains (rich in C18:1) by linseed ones (rich in C18:3) for dairy goats in early lactation. Two groups of 13 dairy goats were fed with complete diets containing 50 % corn silage (DM basis), 10 % dehydrated alfalfa and a compound feed with 20 % extruded oilseeds (linseed or L vs rapeseed or R). Goats received the diets during the four weeks before kidding and the first six weeks of lactation. Oilseeds had similar fat content, as did the diets (5.75 %/DM). Each goat was sampled at the third and at the fifth weeks of lactation. Analyses of milk fat were performed on a capillary column of a gas chromatograph. The following effects were tested: diet (linseed vs rapeseed), stage of lactation (third vs fifth week after parturition), parity of goats (primiparous vs multiparous) and the interactions between these factors. The sums of the percentages of short and medium chains fatty acids did not significantly differ between the two groups, such as the sum of the C18 (55.5 %). The percentages of the different C18 acids were expressed as their sum. The percentage of the stearic acid was similar for the two diets: 27.5 % for L diet and 28.9 % for R one. The oleic percentage was lower for the L diet (61.2 % vs 64.0 %). Percentages of linoleic acid was higher for the L diet (6.6 % vs 5.8 %), as was % of linolenic acid (4.7 % vs 1.3 %). The other factors tested had no significant effect on any of the parameters. In this experiment, the modification of only 8%DM of the diet had a significant influence on C18 milk fatty acids composition: the use of linseed seeds increased significantly the percentages of unsaturated fatty acids in agreement with the consumer's wishes. Moreover,

these grains are also rich in energy; this is useful in early lactation, when the animals have high energy requirements.

Key Words: milk fatty acids, unsaturation of dietary fat, goats

1263 Milk fatty acid profiles of cows fed fish oil with fat sources that differed in fatty acid profiles. A. A. Abu-Ghazaleh^{*1}, D. J. Schingoethe¹, A. R. Hippen¹, K. F. Kalscheur¹, and L. A. Whitlock¹, ¹South Dakota State University.

The objective of this experiment was to examine the effect of feeding fish oil (FO) along with fat sources that varied in their fatty acid compositions (high stearic, high oleic, high linoleic, or high linolenic acids) in order to determine which combination will lead to maximum conjugated linoleic acid (*cis-9, trans-11* CLA) and transvaccenic acid (TVA) concentrations in milk fat. Twelve Holstein cows (eight multiparous and four primiparous cows) at 73 (33-130) DIM were used in a 4 × 4 Latin square with 4 wk periods. Treatment diets were 1) 1% FO plus 2% fat source high in stearic acid (HiS); 2) 1% FO plus 2% fat from high oleic acid sunflower seeds (HiO); 3) 1% FO plus 2% fat from high linoleic acid sunflower seeds (HiLO); and 4) 1% FO plus 2% fat from flax seeds (high linolenic; HiLN). Diets formulated to contain 18% crude protein were composed of 50% (dry basis) concentrate mix, 25% corn silage, 12.5% haylage, and 12.5% alfalfa hay. Milk production (36.3, 37.0, 36.6, and 34.8 kg/d for diets 1 to 4) tended ($P > 0.05$) to be lower with HiLN. Milk fat percentages (3.14, 2.89, 2.72, and 3.06) were lowest ($P < 0.10$) for HiLO. Milk protein percentages (2.99, 2.98, 3.01, and 3.07) were similar ($P > 0.10$) for all diets. Dry matter intake (25.8, 23.4, 24.2, and 24.6 Kg/d for diet 1 to 4) were highest ($P < 0.08$) when cows were fed HiS diets. Milk CLA concentrations (0.75, 1.00, 1.67, and 1.07 g/100g fatty acids 4) and yields (81.6, 107.2, 164.8, and 111.5 g/d for diet 1 to 4) were highest ($P < 0.05$) with the HiLO and were the lowest with HiS. Milk CLA concentrations and yields were similar between cows fed HiO and HiLN diet. As with milk CLA, milk TVA (1.75, 2.41, 3.86, and 2.38 g/100g fatty acids 4) was highest ($P < 0.05$) with the HiLO diet and lowest with HiS diet. In summary, feeding a high linoleic acid fat source with fish oil most effectively increased concentrations and yields of milk CLA and TVA.

Key Words: conjugated linoleic acid, transvaccenic acid, milk fatty acids

1264 Investigation of exogenous fibrolytic enzyme activity on barley straw using in vitro incubation. Y. Wang^{*} and T.A. McAllister, *Agriculture and Agri-Food Canada, Lethbridge, AB.*

The effects on nutrient utilization of adding exogenous fibrolytic enzymes (EFE) to livestock diets have been inconsistent. To isolate factors that may influence the overall effectiveness of EFE treatments, native and ammoniated (5%, w/w) ground barley straw (S and AS) were each prepared six ways for use in batch culture incubation: 1) control (treated with water), 2) treated with EFE (and used directly), 3) treated with EFE and held at 39°C for 24 h prior to incubation (i.e., prehydrolyzed), 4) prehydrolyzed and washed (PW) to remove EFE and hydrolysis products, 5) PW followed by re-application of autoclaved (inactivated) EFE, and 6) PW followed by re-application of hydrolysis product (reducing sugars, RS). The 12 substrates (500 mg DM) were incubated anaerobically at 39°C in 20 mL buffered ruminal fluid, with $(^{15}\text{NH}_4)_2\text{SO}_4$ included as a microbial marker ($n = 3$). At all time points (4, 12, and 48 h), DM disappearance (DMD), gas production (GP) and incorporation of ^{15}N into particle-associated microbial N (^{15}N -PAMN) were higher ($P < 0.001$) with AS than with S. Application of EFE increased ($P < 0.001$) DMD and GP at 4 and 12 h, but not ($P > 0.05$) at 48 h. Enzyme applied onto S increased ($P < 0.01$) ^{15}N -PAMN only at 4 h ($P > 0.05$ at 12 and 48 h), but EFE on AS increased ($P < 0.001$) ^{15}N -PAMN at all time points. Prehydrolysis increased ($P < 0.01$) DMD from both S and AS at 4 and 12 h, but reduced ($P < 0.01$) ^{15}N -PAMN early in the incubation (4 h), as compared to non-prehydrolyzed samples. Comparing treatments 5 and 6 with treatment 4 isolated the effects of post-washing supplementation with autoclaved EFE or RS. Both supplements linearly increased ($P < 0.05$) DMD at all time points, and GP and ^{15}N -PAMN at 4 and 12 h, but not at 48 h. Application of EFE to barley straw prior to incubation increased bacterial colonization of the substrate, but hydrolytic action of EFE decreased it, at least initially - the RS resulting

from hydrolysis did promote colonization. Ammoniation enhanced the efficacy of enzyme action.

Key Words: Barley Straw, Ammoniation, Exogenous Fibrolytic Enzymes

1265 Calcium salts of conjugated linoleic acid were more effective than calcium salts of *trans* fatty acids in reducing milk fat of lactating cows. U. Moallem^{*}, B. Teter, L. Piperova, J. Sampugna, and R. Erdman, *University of Maryland, College Park, MD.*

The objective of this study was to determine the effects of feeding supplements containing calcium salts of *trans* fatty acids (Ca-tFA) or conjugated linoleic acid (Ca-CLA) on milk fat production in lactating dairy cows. Forty-five lactating Holstein cows (15 primiparous and 30 multiparous) were fed a basal TMR (Control), containing 51% forage and 49% concentrate (DM basis) supplemented with 400 g of Energy-II (Ca-salts of fatty acids) during 2 wk adjustment period. After the adjustment period cows were assigned to one of five treatments: Control; and 4 diets supplemented with either 100 g (Ca-CLA100), or with 100 g (Ca-tFA100), 200 g (Ca-tFA200), and 400 g of (Ca-tFA400) in a randomized block design. The Ca-tFA and Ca-CLA supplements substituted for equal parts of Energy-II in the treatment diets. The treatment period lasted 4 wk followed by a 2 wk post-treatment period when cows again were fed the Control diet. Milk production and feed intake were recorded daily. The average DMI was decreased by 2.5% ($P < 0.02$) in cows fed the Ca-tFA400 diet. Daily milk production was reduced by 6.4% ($P < 0.0001$) with the Ca-tFA200 and Ca-tFA400 treatments, while no effects of Ca-CLA100 on milk production were observed. The Ca-CLA100 diet decreased milk fat percent and milk fat yield by 26% and 24% respectively. The Ca-tFA200 and Ca-tFA400 treatments were also effective in reducing milk fat (11-16%) and yield (10-13%). Milk CLA and tFA increased with the supplementation and returned to the control values during the post-treatment period. The recovery of milk fat was faster in cows received diets supplemented with Ca-tFA than in cows fed the Ca-CLA100 diet. Isomers of tFA and CLA containing a *trans*-10 double bond have been associated with reduction of milk fat synthesis. Analysis of CLA and tFA isomers of the diet supplements, indicated that 1.5 g/d of *trans*-10, *cis*-12-18:2 provided by the Ca-CLA100 diet were more effective in reducing milk fat production than 6.5 g/d of *trans*-10-18:1 supplied with the Ca-tFA400 diet.

Items	Treatments					SEM
	Control	Ca-tFA100	Ca-tFA200	Ca-tFA400	Ca-CLA100	
DMI, kg/d	23.5 ^c	25.1 ^a	24.0 ^b	22.9 ^d	23.4 ^c	0.2
Milk yield, kg/d	38.3 ^a	37.6 ^a	36.0 ^b	35.9 ^b	38.1 ^a	0.3
Fat, %	3.39 ^a	3.30 ^a	3.04 ^b	2.98 ^b	2.54 ^c	0.06
Fat yield, kg/d	1.24 ^a	1.19 ^{ab}	1.11 ^{bd}	1.04 ^d	0.95 ^e	0.03

Means within a row without common superscripts differ ($P < 0.03$).

Key Words: Calcium salts of *trans* fatty acids, Calcium salts of conjugated linoleic acid, Milk fat yield

1266 Digestion and ruminal parameters of fresh winter oats supplemented with protected fatty acids in substitution or addition to corn grain energy. P. V. van Olphen^{*1}, F. J. Santini¹⁻², E. Pavan², G. A. Gagliostro², and J. C. Elizalde¹⁻³, ¹Facultad de Ciencias Agrarias, Universidad Nacional de Mar del Plata, ²Instituto Nacional de Tecnologia Agropecuaria, Balcarce, ³CONICET.

Six steers (BW 428 kg) fitted with ruminal, duodenal and ileal cannulas were used to evaluate the fermentation and total DM (DMD) and NDF (NDFD) digestibility of fresh winter oats (WO) supplemented by addition or substitution of ground corn grain by calcium salts of fatty acids (Ca-FA). Treatments were: C) only WO, HC) 50% WO + 50% of ground corn grain, LC) 65% WO + 35% ground corn grain, and FA) 58.5% WO + 35% corn grain + 6.5% of Ca-FA. HC and FA supplement were iso-energetic. Winter oats (22% DM, 68% IVDMD, 16.8% CP, 44.5% NDF) was cut daily and offered with the supplement three times per day. Total DMI was restricted to 90% of ad libitum. Data were analyzed under a 6 × 4 Youden square design, and treatments were compared by the following contrasts: C vs HC, HC vs FA (substitution effect) and LC vs FA (addition effect). Mean total DMI was 10 kg per day. Results are shown in the table below. It is concluded that the supplementation of winter oats with HC reduce total DMD and NDFD, but similar level

of energy may be supplied without negative effects on total DMD and NDFD by substitution of corn by Ca-FA. Although, the addition of Ca-FA as supplement depresses DM and NDF ruminal digestibility, these effects disappear in the total tract digestion.

Item	Treatments ^a					Contrasts ^b		
	C	HC	FA	LC	SEM	Cvs	LCvs	HCvs
Apparent digestion Rumen	DM	50.1	52.2	43.2	54.5	2.76	NS ^c	< .01
	NFD	60.0	56.6	58.2	68.5	3.06	NS	.02
Total tract	DM	62.4	57.8	63.1	64.4	1.32	.02	NS
	NFD	61.0	52.1	60.3	61.6	2.55	.03	NS
pH		5.99	5.63	5.87	5.82	.08	< .01	NS
Total VFA, mM		91.2	94.9	85.1	95.9	13.1	NS	.03
A:P ^d		3.32	2.56	2.95	3.05	.29	< .01	NS

^a C) only WO, HC) 50% WO + 50% of ground corn grain, LC) 65% WO + 35% ground corn grain, and FA) 58.5% WO + 35% corn grain + 6.5% of Ca-FA. ^b Contrasts effects. ^c Not significant ($P > .10$). ^d acetate : propionate ratio.

Key Words: calcium salts of fatty acids, fresh forage, corn grain

1267 Effects of feeding encapsulated and unprotected docosahexaenoic acid on feed intake, milk production, milk composition, and fatty acid profile in dairy cows. S.A. Crowder*¹, J.E. Garrett², and S.S. Donkin¹, ¹Purdue University, West Lafayette,IN, ²OmegaTech, Boulder,CO.

Milk enriched with docosahexaenoic acid (DHA) could provide consumers with alternatives for attaining adequate omega-3 fatty acids from natural sources. Enriching milk with DHA is potentially challenged by rumen metabolism. The objective of this study was to determine the effects of DHA derived from marine algae (DHA Gold, Omega Tech, Inc., Boulder, CO) on milk production, composition, and fatty acid profile when fed as a rumen unprotected DHA source or one of two rumen-protected DHA to dairy cows. Within the rumen unprotected DHA source the level of DHA feeding was examined. Forty-eight Holstein cows were assigned to six groups and supplemented for 11 weeks with 0, 50, 100, or 150 g/d of rumen unprotected DHA or 100 g/d with one of two encapsulated DHA sources (B and P). Average milk production did not differ for the treatment groups, but DHA feeding decreased milk production after 4 weeks (time x treatment, $P < 0.05$). Feed intake was decreased ($P < 0.05$) by 14% for all DHA sources and was more pronounced after 3 weeks. Feeding DHA decreased ($P < 0.05$) milkfat percent and yield regardless of DHA level or source. Milk fatty acids (g/100g) were: conjugated linoleic acid (CLA) 0.27, 0.88, 1.07, 0.97, 0.75, and 1.150.07; eicosapentaenoic acid (EPA) 0.07, 0.59, 0.28, 0.30, 0.14, and 0.590.11; DHA 0.19, 0.42, 0.64, 0.64, 0.45, and 0.590.06 for 0, 50, 100, 150 g/d unprotected DHA and encapsulates B and P respectively. Feeding DHA elevated ($P < 0.05$) milk CLA, EPA and DHA. The effects of unprotected DHA were linear and quadratic for CLA and DHA and quadratic for EPA. Feeding DHA increased ($P < 0.05$) total unsaturated fatty acids an average of 19% (23.9 and 28.5 0.77) regardless of DHA level or source but did not alter total saturated fatty acids. The data indicate DHA enrichment of milk that does not depend on protection from rumen metabolism but is responsive to level of DHA feeding.

Key Words: Omega-3 fatty acids, DHA, CLA

1268 Dry matter intake and rumen-fill from lactating cows receiving elephant grass (*Pennisetum purpureum*, Schum.) at three harvesting date. J.P.G. Soares^{1,4}, L.J.M. Aroeira*², F. Deresz², T.T. Berchielli³, R.S. Verneque², and P. Andrade³, ¹Embrapa Rondonia, Porto Velho - RO - Brasil, ²Embrapa Gado de Leite, Juiz de Fora - MG - Brasil, ³FCAVJ/UNESP, Jaboticabal - SP - Brasil, ⁴Part of Ph.D. Thesis of the 1st author at FCAVJ/UNESP, supported by FAPESP.

Dry matter intake (DMI), neutral detergent fiber intake (NDFI) and rumen fill from nine Holstein x Zebu (520kg) lactating (13.2kg), fistulated cows were evaluated in a split plot experiment. Three cows were

distributed in a Latin Square design to testing three treatments (elephant grass cut at 30, 45 and 60 days old, offered chopped *ad libitum*). The Latin Square was repeated three times. Within each treatment a split-plot design was included to test four schedules of ruminal evacuation: 0, 2, 4 and 6 hours after feeding. DMI and NDFI were measured gravimetrically in a Calan Gates system by the difference between offered and refused feed. The chemical composition, *in vitro* dry matter digestibility (IVDMD) of the grass and the ruminal content varied in relation to the forage growth stage ($P < 0.05$). Values for IVDMD were 58.7, 57.7 and 55.2% and for NDF 62.9, 65.5 and 70.1% for forage 30, 45 and 60 days old, respectively. The results showed that elephant grass 30 days old had higher IVDMD and lower NDF ($P < 0.05$) when compared to samples from forage 60 days old. Mean DMI (8.0 kg/cow/day) and NDFI (5.0 kg/cow/day) values observed from animals fed elephant grass aged 30 days were less ($P < 0.05$) than those from forage 45 days- (10.5 and 6.6 kg/cow/day) and 60 days-old (11.0 and 7.7 kg/cow/day). Mean DMI values for the last two treatments forage cut at 45 and 60 days re-growth were similar to each other ($P > 0.05$). Maximum ruminal contents were observed at 4:22, 3:55 and 3:49 hours after feeding with neutral detergent fiber fill (NDFFILL) of 7.0; 6.3 and 8.4 kg/day from elephant grass 30, 45 and 60 days old, respectively. However, no difference was found. In this trial the hypothesis that rumen fill was the limiting factor of DMI, in tropical forages was not proved.

Cut age	DMI	NDFI	NDFFILL
days	kg/day	kg/day	kg/day
30	8.0±0.41 b	5.0±0.23 c	7.0±0.21 a
45	10.5±0.41 a	6.5±0.23 b	6.3±0.21 a
60	11.0±0.41 a	7.7±0.23 a	8.4±0.21 a
Average	9.8	6.4	7.3
CV(%)	24.6	24.6	16.7

a>b ($P < 0.05$) in the column, by Newman-Keuls test

Key Words: Elephant grass, Intake, Rumen fill

1269 The effect of diet on milk production, lactation curve, composition, and processing characteristics in dairy goats. B.R. Min*¹, K.A. Soryal, S.P. Hart, S. Zeng, R. Puchala, A. Goetsch, and T. Sahlul, ¹E (Kika) dela Garza Institute for Goat Research, Langston University, OK 73050, USA.

This study investigated effects of different levels of concentrate supplementation on milk production (MP), composition, and processing characteristics (PC) with dairy goats grazing from April 2000 to September 2001. Forty-four Alpine goats (54±10 kg BW) were randomly allocated to four groups and supplemented with 0.66 (A and B), 0.33 (C), and 0 kg concentrate (D) per kg of milk over 1.5 kg/d. Mixed vegetative forages were rotationally grazed except for A (confined and fed alfalfa hay). The MP was recorded daily and milk samples were collected twice monthly and analyzed for fat (F), protein (P), lactose (L), solids-not-fat (SNF), total solids (TS), and PC (Year 2001 only). Egyptian Domiati cheese yield and organoleptic PC were analyzed fresh or after 1 or 2 mo pickling in whey solution. The lactation curve was calculated by Wood's incomplete gamma function. Average MP (kg/d) increased ($R^2=0.59$; $y=1.72x+1.51$; $P < 0.001$) with increasing level of concentrate supplementation. Average MP during both years was 3.7, 3.3, 3.3 and 2.8 kg/d for A, B, C, and D, respectively ($P < 0.01$). Initial MP and the rate of increase to the peak were similar among treatments, but the mean date of peak MP for D (29 d) was earlier ($P < 0.05$) than for A, B, and C (43, 35, and 36 d, respectively). Persistency was not affected (6.2) by treatment in 2001, but for D (5.6) was lower than for A, B and C in 2000 (6.5, 6.2 and 6.1, respectively). Milk F concentration was similar among treatments; however, milk P and L concentrations for D were lower than for A, B, and C ($P < 0.01$). Average milk concentrations of F, SNF, TS, P, and L decreased linearly ($P < 0.01$) as lactation progressed. Cheese yield was 17% higher ($P < 0.01$) for B at the beginning and end of lactation than for other groups. Greatest cheese flavor was for D during summer (June-July; $P < 0.01$). In conclusion, MP, composition, and PC, as well as the lactation curve, were affected by the feeding treatment and stage of lactation.

Key Words: goat milk, cheese.

1270 Intake preferences and nitrogen metabolism in beef steers grazing Bermudagrass, Caucasian bluestem, or Gamagrass. G.B. Huntington^{*1}, J.C. Burns², and S.A. Archibeque¹, ¹North Carolina State University, ²USDA-ARS.

Our objective was to evaluate three warm-season grasses from the perspective of forage composition, selection by grazing beef steers, and nitrogen (N) metabolism in ruminants. Paddocks of bermudagrass (*Cynodon dactylon*, BG), caucasian bluestem (*Bothriochloa caucasica*, CBS), and gamagrass (*Tripsacum dactyloides*, GG) were fertilized with 70 lb of N per acre about 60 and 30 d before sample collection. In 2000 and 2001, 12 steers (250 kg BW) were blocked on the basis of liveweight and then randomly assigned to a replicated, randomized complete block design with 2 paddocks of each forage and 2 steers per paddock. After at least 14 d adaptation, urine and blood samples were collected from each steer for determination of serum urea N (SUN, mM) and percentage of urinary N in the form of urea (PCTUREA). One steer per paddock was infused i.v. with ¹⁵N-urea for 48 h before urine was collected for 6 h to measure enrichment of urea N, urea entry rate (UER, mmol N/h), and urinary urea excretion (UUE, mmol N/h). Three other steers with esophageal fistulas were used to collect masticate samples that represent the steers' intake preferences. Forage and masticate composition data are for 2000 only. The CP (% of DM) and NPN (% DM) content were highest for BG canopy (12.0 and 3.1), followed by GG (10.9 and 1.9) and CBS (9.1 and 1.8). True protein (% DM) was similar in GG (9.0) and BG (8.9) canopy followed by CBS (7.3). However, crude protein was higher in masticate for GG (13.8) than BG (11.8) or CBS (9.8). Masticate from GG was higher in true protein (12.2) than masticate from BG (8.7) or CBS (8.1). Steers grazing CBS had lower (P < 0.05) SUN, PCTUREA, and UER (2.49, 31.5, and 177) than steers grazing BG (12.23, 69.9, and 294) or GG (10.14, 66.3, and 266). The proportion of UER excreted as UUE was lower (P < 0.10) for CBS (0.11) than for BG (0.54) or GG (0.35). Responses in SUN and PCTUREA, and UER reflect canopy or masticate crude and true protein content. However, NPN was similar in canopy and masticate for CBS and GG, but those two forages differed in SUN, PCTUREA, and UER. We conclude that compositional differences among the forage species affected proportions of nitrogen absorbed as non-protein N and affected urea production and recycling by the steers.

Key Words: Beef steers, Forages, Nitrogen metabolism

1271 Effect of feed intake on mean retention time of fibre in the rumen. M.R. Weisbjerg^{*}, P. Lund, and T. Hvelplund, Danish Institute of Agricultural Sciences, DK-8830 Tjele, Denmark.

Rumen metabolism of neutral detergent fibre (NDF) was investigated in four 4x4 Latin square experiments with rumen, duodenum and ileum fistulated Danish Holstein Friesian cows with an average weight of 616±92 kg. Eight different forages (early cut and late cut grass silage, grass-clover silage, pea whole crop silage, barley whole crop silage, corn silage, grass hay, alfalfa hay) were fed ad libitum, either as the sole feed (two experiments) or supplemented with concentrate (two experiments). Concentrate was low in fibre, and daily offer was 5 kg of wheat meal and 1.5 kg of soybean meal. Forages showed a large variation in NDF content (269 # 659 g/kg DM) and indigestible NDF (INDF) content (46 # 172 g/kg DM). Intake, intestinal flow and faecal output were measured over three days in the third week in each period, followed by a week where three rumen evacuations were performed on different days and at different times (8, 14, 20), for estimation of mean rumen pool size of INDF. INDF content of rumen digesta and faeces was determined by 21 days rumen incubation in nylon bags. Mean rumen retention time (MRT, h) of INDF was calculated as 24*[(mean rumen INDF pool (kg))/(daily faecal INDF output (kg))]. Data were analysed for a general effect of dry matter (DM) intake on MRT of INDF using PROC MIXED (SAS Institute) and with experiment and cow interaction as random effects. A total of 60 observations were used with a variation in MRT of INDF from 30 to 118 h, and in feed intake from 6.1 to 20.1 kg DM/day. The analysis showed a decreasing MRT of INDF with increasing feed intake (P=0.007). However, the variation caused by type of forage was larger (P<0.0001) with least square means for MRT of INDF from 35h (corn silage) to 82h (early cut grass silage), but there was no significant interaction between forage and DM intake on MRT of INDF. The following equation for calculation of MRT was estimated (as a mean over forages): MRT of INDF (h) = 87.0(±9.5) # 2.04(±0.7)*(daily DM intake (kg)).

Key Words: INDF, Mean rumen retention time, Rumen evacuation

1272 Effect of diet forage:concentrate ratio on odd-chain fatty acids in milk from Holstein-Friesian cows. R. J. Dewhurst¹, J. M. Moorby^{*1}, J. Danelón², and J. K. S. Tweed¹, ¹Institute of Grassland and Environmental Research, Aberystwyth, UK, ²University of Buenos Aires, Argentina.

Odd-chain fatty acids (OCFA) in milk are potential markers of microbial synthesis in the rumen. There is further interest in OCFA because recent studies showed anti-cancer effects. This experiment investigated the effect of varying diet forage-to-concentrate ratio on OCFA in milk. The companion paper gives further details and showed the substantial changes in composition of DM fermented in the rumen as concentrate feeding increased (20, 35, 50 and 65% of DMI for the 4 treatments). The experiment was a 4 x 4 Latin Square with 4-week periods. Milk samples were taken during the final week of each period and analysed for fatty acids by GC after a one-step preparation of methyl esters. Results were tested by ANOVA with orthogonal contrasts and the significance of linear effects is given. Odd-chain fatty acids were detected at low levels in the grass silage (0.11, 0.32, 0.25, 0.08, 0.09 and 0.29 % of total fatty acids as *iso*C15:0, *anteiso*C15:0, C15:0, *iso*C17:0, *anteiso*C17:0 and C17:0 respectively) and extremely low levels in concentrates (0.08 and 0.11 % of total fatty acids as C15:0 and C17:0 respectively; traces of others). There was no difference in concentrations of OCFA in morning and afternoon milk. The concentrations of some OCFA in milk (% of total fatty acids) remained the same (mean=0.44 and 0.22 for *anteiso*C17:0 and *iso*C17:0 respectively) as concentrate proportion increased. Concentrations of others decreased (*iso*C15:0: 0.32, 0.30, 0.30 and 0.26; SED=0.021; P<0.05; *anteiso*C15:0: 1.59, 1.49, 1.50 and 1.38; SED=0.104; P=0.11; C15:0: 1.85, 1.67, 1.53 and 1.35; SED=0.071; P<0.001; C17:0: 0.81, 0.74, 0.66 and 0.62; SED=0.018; P<0.001; C17:1: 0.54, 0.45, 0.38 and 0.35; SED=0.033; P<0.001). Patterns of OCFA in milk did not reflect differences in the OCFA content of diets, presumably because of differences in the pattern of microbial synthesis of OCFA. For example, increased synthesis of *anteiso*C15:0 with high-concentrate diets is consistent with earlier results showing high levels of this fatty acid in liquid-phase bacteria.

Key Words: Odd-chain fatty acids, Milk, Rumen

1273 Effect of diet forage:concentrate ratio on digesta flow and milk production in mid-lactation Holstein-Friesian cows. J. M. Moorby^{*1}, R. J. Dewhurst¹, J. Danelón², R. T. Evans¹, and M. A. Neville¹, ¹Institute of Grassland and Environmental Research, Aberystwyth, UK, ²University of Buenos Aires, Argentina.

Four Holstein-Friesian dairy cows in mid-lactation were used to investigate the effect of forage-to-concentrate ratio (FC) on digesta flow to the duodenum and milk production and composition in a 4 x 4 Latin Square changeover experiment with 4-wk periods. Four treatments, based on ad libitum access to ryegrass silage (12.2% CP and 62% NDF in the DM) and a standard dairy concentrate (comprising 31% wheat, 15% rape meal, 15% corn gluten feed, 12% linseed meal, 11% sunflower meal and 16% others; 22.8% CP, 24.8% NDF, 22.1% starch), differed in FC: 80:20, 65:35, 50:50 and 35:65 DM. Concentrate allowances were calculated from 3 d rolling averages of silage intake. Results were tested by ANOVA with polynomial contrasts. Total DM intakes increased linearly (P<0.001) with decreasing diet FC (13.2, 15.5, 18.4 and 20.7 kg DM/d; SED=0.85, for 80, 65, 50 and 35% forage), with a slight but significant (P<0.01) linear substitution effect on silage intake (10.5, 9.8, 9.3 and 8.1 kg DM/d; SED=0.63). Flows of DM, N, NDF and starch to the duodenum all increased linearly with decreasing diet FC (all P<0.001). Apparent ruminal digestion of DM (5.0, 6.2, 6.4 and 8.8 kg/d; SED=0.76; P<0.01), N (-2, 27, 3 and 105 g/d; SED= 26.1; P<0.05) and starch (0.45, 0.97, 1.71, 2.42 kg/d; SED=0.184; P<0.001) increased linearly with decreasing diet FC, while that of NDF was not different among treatments (grand mean 4.5 kg/d). Milk yields increased linearly (17.3, 18.7, 20.8, 24.8 kg/d; SED=0.98; P<0.001) as DM intakes increased. Yields of milk fat (P<0.01) and protein (P<0.001) increased linearly, but fat concentrations decreased (P<0.01) and protein concentrations increased (P<0.01) with decreasing diet FC. In conclusion, increasing the proportion of concentrates in the diet increased feed intake which increased nutrient supplies to the animal and led to increased milk and milk component yields. Effects on milk odd-chain fatty acids can be found in a companion abstract.

Key Words: Forage:Concentrate Ratio, Milk Production, Rumen Digestion

1274 Milk production and composition from Holstein cows fed a total mixed ration or grazing different types of pasture under an intensive management system. C. Benchaar¹, T. D. Whyte², R. Berthiaume¹, G. F. Tremblay³, T. Astatkie², A. H. Fredeen², R. C. Martin², and P. Y. Chouinard⁴, ¹Agriculture and Agri-Food Canada, Lennoxville, QC, ²Nova Scotia Agricultural College, NS, ³Agriculture and Agri-Food Canada, Ste-Foy, QC, ⁴Universite Laval, QC.

The objective was to compare milk production and composition in cows fed a total mixed ration (TMR) or grazing different pasture species. Thirty-two lactating Holstein cows were randomly allocated to one of four treatments: 1) TMR, 2) permanent pasture (PP) containing a mixture of grasses and legume species, 3) pasture consisting of red clover (RC), and 4) PP during the day and annual ryegrass at night (PP/ARG). All cows received a supplement mix of similar composition. From the last week of June to the end of August, milk samples were collected from four consecutive milkings at wk 0 (covariate), 2, 4, 6, and 8 of the trial. Data were analysed as repeated measures using Proc Mixed of SAS. Effects of treatments were determined by orthogonal contrasts: TMR vs all pastures, PP vs (RC+PP/ARG), and RC vs ARG/PP. Throughout the experiment, milk production was not different ($P>.10$) between grazing groups (30.5 kg/d) and cows fed TMR (28.4 kg/d). Fat and total solids contents were similar (3.5 and 12.0%, respectively, $P>.05$) between grazing cows and confined cows. Protein percentage was not different between confinement cows and pasture-fed cows at wk 2 (3.01 and 2.94%, respectively, $P=.44$), but it increased linearly and was higher ($P<.01$) for the TMR-fed group than for the grazing groups (3.23 vs 2.95%) for the rest of the season. For both groups, lactose content decreased linearly over weeks, and was higher at wk 4 and 6 with TMR than with pasture treatments (4.65 vs 4.56%, $P=.01$ and 4.56 vs 4.43%, $P=.03$, respectively). Cows performances were not different between PP and (RC+ARG/PP). Milk production was similar between cows consuming RC and those grazing ARG/PP pastures (28.8 and 31.1 kg/d, respectively). Milk composition was relatively unchanged between RC and ARG/PP treatments. Only at wk 2 of the experiment, fat percentage was higher for RC group than for cows grazing ARG/PP pastures (4.02 vs 3.53%, respectively, $P=.03$). This study showed that milk production did not differ between cows grazing different pasture species and cows fed TMR. Except for milk protein, milk composition was not affected by grazing treatments.

Key Words: Milk production, TMR, Pasture

1275 Effects of forage particle size, forage source and corn processing on ruminal pH, chewing activity and milk production in dairy cows. K. M. Krause* and D. K. Combs, University of Wisconsin-Madison.

The objective of this study was to investigate the effects of and interactions between increasing levels of ruminally fermentable carbohydrates and forage particle size on ruminal pH. Twelve ruminally cannulated Holstein cows were used in two 6 x 6 Latin squares. Diets were arranged as a 3 x 2 factorial with three levels of ruminally fermentable carbohydrates and two levels of forage particle size (coarse:5.3 and 5.7 mm, fine: 2.6 and 2.6 mm for alfalfa and corn mean particle size, respectively). Ruminally fermentable carbohydrates were increased by replacing 50% of the alfalfa silage DM with corn silage and by replacing dry cracked corn with high moisture corn. Diets were: dry corn/coarse alfalfa silage (DCCA), dry corn/coarse alfalfa plus corn silage (DC-CAC), dry corn/fine alfalfa silage (DCFA), dry corn/fine alfalfa plus corn silage (DCFAC), high moisture corn/coarse alfalfa plus corn silage (HMCCAC), and high moisture corn/fine alfalfa plus corn silage (HMC-FAC). Diets were fed as TMRs with a 60:40 concentrate to forage ratio. Alfalfa silage based diets contained 29.1% starch and 1.60 Mcal NEI/kg, alfalfa/corn silage based diets contained 37.0% starch and 1.61 Mcal NEI/kg; all diets contained 25.0% NDF (DM basis). Effects of forage particle size (fps), corn processing (C), forage source (F) and interactions were tested using preplanned contrasts. Decreasing fps had a positive effect on milk production, but decreased chewing activity. Increasing level of fermentable carbohydrates decreased fat % and yield. Ruminal pH was only affected by corn processing.

	Diet						Contrast		
	DC-CA	DCC-AC	DC-FA	DC-FAC	HMC-CAC	HMC-FAC	fps	C	F
DMI, kg	24.4	23.5	22.6	22.0	21.8	20.3	**	*	NS
Milk yield, kg	39.8	41.6	43.0	42.0	41.6	42.1	*	NS	NS
Fat, % ^a	3.32	3.19	3.38	2.89	2.72	2.43	*	***	**
Fat yield, kg ^b	1.30	1.34	1.44	1.22	1.10	1.02	NS	***	*
Protein, %	2.86	2.92	2.83	2.89	2.84	2.83	NS	*	*
Ruminal pH	5.96	5.79	5.87	5.85	5.73	5.62	NS	*	NS
Eating, min/d	273	255	224	214	242	201	***	NS	NS
Ruminating, min/d	402	451	306	346	461	373	***	NS	*

* $P<0.05$, ** $P<0.01$, *** $P<0.001$, NS $P>0.01$ ^afps x F interaction ($P=0.08$) ^bfps x F interaction ($P=0.007$)

Key Words: Ruminal pH, Forage particle size, Fermentable carbohydrates

1276 Feeding behavior of dairy cows in hot climate. I. Halachmi, E. Maltz, N. Livshin, A. Antler, D. Ben-Ghedalia, and J. Miron*, ARO, The Volcani Center, Bet Dagan, Israel.

Feeding behavior of cows in Israeli hot climate was measured and analyzed for simulation purposes. Forty cows kept in a group in an open cowshed, were divided into two feeding groups and fed individually ad libitum, one of two TMR: a TMR containing 18% forage NDF (CS), and a similar TMR containing 12% forage NDF in which the corn silage component was replaced by soybean hulls (SH). A fully automated system monitored each feeding event, of every cow in the group, as well as milk yield at every milking (06:00, 13:00, 20:00), and body weight (BW) after each milking. Food was given once a day at 10-11 AM. On average, a cow visited a feeding trough 14.3 times/d. Feeding duration and timing, and average DM intake (25.8 ± 4.2 and 25.1 ± 2.7 kg DM/d for the CS and SH groups, respectively) were not effected by the TMR, perhaps because of the similar physical density of the diets. The most intensive feeding activity was recorded at food distribution time when the cow consumed 17.4 ± 3.4 % of the daily feed within 1h, and additional 3% during the consecutive hour. The lowest food consumption (22.9 ± 1.7 % of total daily intake) was recorded between night and morning milking, compared to 38.4 ± 0.7 , and 38.7 ± 1.4 % between the two following milking intervals. This was also represented by lower BW recorded after the morning milking (601 ± 61 kg compared to 605 ± 58 and 621 ± 63 kg after the afternoon and night milking, respectively). Feeding activity and consumption correlated with food freshness rather than daily temperature, partly because milking stimulated feeding ($14.2\pm1.4\%$, $16.8\pm1.5\%$, and $8.5\pm1.8\%$ of daily feed consumption occurred during the first two h after 1st, 2nd, and 3rd milking respectively). However, during a particular hot day ($>30^{\circ}\text{C}$), food consumption during the night was elevated to 28.4%, reduced between morning and noon milking to 32.6%, and elevated again to 39.0% between noon and night milking. This indicates that above a certain heat level, cows prefer feeding in the cooler hours of the day.

Key Words: Dairy cows, Feeding behavior, Hot climate

1277 Daily energy intake influences fat and protein concentration of the milk. C.F. Borsting*, M.R. Weisbjerg, and V.F. Kristensen, Danish Institute of Agricultural Sciences, DK-8830 Tjele, Denmark.

The effect on milk composition (Danish Holstein Friesian cows) of increasing concentrate:forage ratio was examined with three types of forage. The forages were grass silage (first cut with organic matter digestibility, OMD: 0.75), whole crop barley silage (OMD: 0.70) and ammonia treated barley straw (OMD: 0.56). Each type of forage was examined in TMR diets fed ad libitum at three different concentrate:forage ratios, these ratios differing between forages aiming at equal levels of energy intake. The experiment was carried out twice with forages from the harvest of two years. Each year 7 cows were allocated to each of the 9 diets. The net energy (NE) of the diets varied between 6.6 and 8.0 MJ/kg dry matter. The daily ad libitum intake of NE varied from 118 to

209 MJ. There was an overall average increase of 0.43 g protein/kg milk for each increase of 10 MJ NE intake. For grass silage diets the increase was only 0.20 g, whereas it was 0.48 g for whole crop barley silage diets and 0.62 g for straw diets. For fat there was an overall average decrease of 0.61 g/kg milk for each increment of 10 MJ NE. Also for milk fat the changes were smaller for grass silage diets with a decrease of 0.13 g per increase of 10 MJ, compared to 0.62 g for barley silage diets and 1.08 g for straw diets. As expected also milk yield was affected by energy level, however, across the three energy concentrations there were no differences due to type of forage. Average daily milk yields were 34.1, 34.3 and 33.9 kg for grass silage, barley silage and straw diets, respectively, during week 3 to 15 post partum. The increase in milk yield was higher (0.9 kg) for silage diets (grass and whole crop barley) than for straw diets with an increase of 0.2 kg per additional 10 MJ NE. However, the effects of increasing energy level on the concentrations of protein and fat in milk increased from grass silage over whole-crop silage to straw. These different effects may be explained by a decreasing difference between proportions of concentrate between forages, from grass over whole crop to straw diets, when the overall level of concentrate (energy level) increased.

Key Words: Dairy cows, Milk protein, Milk fat

1278 Increasing feed availability for dairy cows. T. J. DeVries^{*1}, M. A. G. von Keyserlingk¹, J. A. Shelford¹, D. M. Weary¹, and K. A. Beauchemin², ¹The University of British Columbia, Vancouver, Canada, ²Agriculture and Agri-Food Canada, Lethbridge Research Centre, Canada.

When cows are fed from a feed alley, they will consume, push away, and sort the feed in the time between feedings. To improve feed availability and quality, some producers push feed closer to the cows in the period between feedings. The objectives of this study were to monitor the effects of increasing the number of times feed is pushed up to cows on feed availability, feed quality, and feeding behaviour. We used 11 primiparous and 13 multiparous cows housed in a free-stall barn and fed a TMR twice daily. These cows were fitted with transponders that allowed us to automatically monitor the location and duration of each visit to the feed bunk, using a computerized monitoring system. Cows were subjected to two different feed push-up schedules. In the baseline schedule, cows were fed at 0600h and 01500 h, and feed was pushed closer to the cows at 1100h and 2130h. In the alternative schedule, feed was also pushed up to the cows at 0030h and 0330h. We found that the higher pushing up frequency resulted in an increased amount of feed available for the cows ($P < 0.05$). We also found that the amount of short fibre material (as determined by the Penn State Particle Size Separator) decreased with time after feeding ($P < 0.05$). However, this decline was reduced when feed push-up frequency was increased ($P < 0.05$). Interestingly, we did not find any difference in feeding frequency or duration between the two treatment conditions ($P > 0.05$). This data indicates that increasing the number of push-ups improves feed availability and quality, but may have little effect on feeding behaviour.

Key Words: Feeding Management, Feeding Behaviour, Feed Quality

1279 The effect of non-nutritional factors on Milk Urea Nitrogen levels in Ayrshire dairy cows. P. Arunvipas^{*}, I. Dohoo, J. VanLeeuwen, E. Leger, and G. Keefe, *Atlantic Veterinary College, UPEI*.

This study was conducted to determine the effects of non-nutritional factors such as parity, days in milk, milk production, milk quality, and milk components on milk urea nitrogen (MUN). A total of 10 dairy farms in Prince Edward Island (PEI) containing 587 lactating Ayrshire cows participated in the research. Individual cow milk samples ($n = 4,080$) were collected monthly from July, 1999 to June, 2000 from each farm as part of the DHI milk recording system. Milk urea nitrogen levels and milk component (fat, protein, and somatic cell count (SCC)) were measured using a Fossomatic 4000 Milkoscan Analyzer at the PEI Milk Quality Laboratory. Mixed linear regression models were used to investigate the relationships between MUN and the cow and test-day factors, while controlling for the effect of clustering of MUN test dates within cow, and clustering of cows within herd, respectively. The overall average MUN was 11.17 mg/dl. Only the relationship between parity and MUN values was not significant ($P > 0.05$). The average MUN was low during the first month of lactation (10.14 mg/dl), rose to peak at

4 months of lactation (11.80 mg/dl), and decreased to the end of lactation (10.56 mg/dl). With each liter increase in milk production per cow per day, the average MUN value increased by 0.05 mg/dl. With each 0.1% increase in milk protein%, the average MUN value decreased by 0.2 mg/dl, while each unit increase in linear score decreased the average MUN value by 0.4 mg/dl. Lower MUN values occurred at low and high fat percentages. MUN values were elevated in late winter/early spring (March, April) and through the summer/fall months, with the highest average MUN values occurring in July and August (13.10 mg/dl). Results were very similar to those observed for the much larger sample of Holstein herds, except the proportion of variance at the herd level was much lower for Ayrshire herds, presumably due to more uniform feeding management.

Key Words: Milk Urea Nitrogen, Non-nutrition factors

1280 The effect of steam flaked or ground corn and supplemental phytic acid on N excretion in lactating cows and ammonia emission from manure. K. Burkholder^{*}, A. Guyton, J. McKinney, and K. Knowlton, *Virginia Polytechnic Institute and State University*.

The effect of starch source and supplemental phytic acid on N excretion and ammonia volatilization from dairy manure was evaluated with 8 lactating cows. Cows were assigned to one of four treatments in 2, 4x4 Latin squares with 18 d periods. Diets were 61% forage, 37% starch, 16.6% CP, and 31% NDF, and included dry ground corn (DG) or steam flaked corn (SF), with no supplemental P (L; 0.34%P) or supplemental purified phytic acid (PA; 0.45%P) to provide additional P from an organic source. Total collection of milk, urine, feces, feed, and orts was conducted on d 16-18 of each period. Cows fed SF had lower DMI, higher feed efficiency (milk/DMI), and reduced feces and urine excretion compared to cows fed DG (data reported elsewhere). Nitrogen intake was not affected by dietary starch source (mean = 672.6 g/d), but N excretion in feces and urine was lower in cows fed SF than in cows fed DG (248.8 and 128.8 g/d vs. 284.6 and 145.1 g/d for SF and DG). Milk N as a percent of N intake was not affected by dietary starch source (mean = 27.6%), but cows fed SF had lower MUN than those fed DG (8.65 vs. 9.65 mg/dl), indicating improved N utilization with SF. Addition of PA did not affect N intake or utilization. For measurement of ammonia emission, feces and urine were sub-sampled on d 18 of each period and feces:urine ratio was calculated for each cow. Wet feces and urine were weighed into chambers in the proportions excreted, and ammonia volatilization was measured for 32 h using acid traps. Nitrogen at time zero (A_0), rate of ammonia emission (k), and residual N (R) were calculated using the exponential decay model $A_t = A_0 e^{-kt} + R$. The interaction of starch source and PA affected rate of ammonia emission from manure (0.11, 0.13, 0.13, and 0.10 mg/h for DG-L, DG-PA, SF-L, and SF-PA). Altering source of dietary starch may provide opportunity to improve utilization of dietary N and reduce N excretion by lactating cows.

Key Words: steam flaked corn, ammonia emission, nitrogen excretion

1281 Use of cannulated pigs to model intestinal nutrient disappearance in cattle. D. Loveday¹, J.J. McKinnon¹, P. Thacker¹, and A. Mustafa², ¹University of Saskatchewan, ²McGill University.

The objective was to use the mobile bag technique to determine if cannulated pigs can be used to estimate intestinal (I) and total tract (TT) crude protein (CPD) and dry matter digestibility (DMD) of ruminal undegradable residues (RUR) of various feed samples in cattle. Feeds varying in rumen degradability were utilized including heated (145°C for 1 h) and unheated samples of canola meal, soybean meal, barley distillers' grains, and barley silage as well as alfalfa hay, dehydrated alfalfa pellets, and barley straw. Two Hereford steers (665 ± 13 kg) with ruminal and duodenal cannulas were used. RUR of each feedstuff were obtained by incubating large nylon bags (9 x 21 cm; pore size 40 mm) containing either 7 g of protein supplement or 5 g of forage sample in the rumen for 12 h. Subsequently, RUR of each feedstuff (0.52 g of protein supplement or 0.15 g of forage) were placed into 8 polyester bags (2.5 x 4.0 cm; 48 mm pore size) and inserted into the duodenum of the steers. Another 8 bags of each sample were randomly allocated to 6 Yorkshire x Lacombe gilts (50 ± 1.2 kg) and inserted into the duodenum of the pigs. All bags were recovered in the feces. Linear regression was used to relate I and TT DMD and CPD of pigs to that of steers. Intercepts

not different from zero were forced through zero to obtain a measure of bias and loss of precision resulting from forcing the zero intercept. The non-zero regression equations predicting steer estimates from those of pigs were $-3.14 + 0.95X$ ($r^2 = 0.98$ SE 0.043) and $-0.14 + 0.96X$ ($r^2 = 0.99$ SE 0.029) for I and TT DMD, respectively. Respective CPD estimates were $0.33 + 0.96X$ ($r^2 = 0.98$ SE 0.045) and $0.21 + 0.99X$ ($r^2 = 0.99$ SE 0.035). Forcing the non-zero intercept resulted in a bias of -10 and -4% with a SE of 0.03 and 0.01, respectively for I and TT DMD. Respective values for CPD were -3 and -1% for bias with a SE of 0.03 and 0.01. It is concluded that pigs can be used to model I and TT DMD and CPD of RUR in cattle.

Key Words: model, cattle, pigs, nutrient disappearance

1282 Development and evaluation of models to predict the feed intake of dairy cows in early lactation. M. A. Shah* and M. R. Murphy, *University of Illinois at Urbana- Champaign.*

The objective of the present study was to develop an accurate, robust and broadly applicable model for predicting dry matter intake, and to compare it with the current (2001) National Research Council model for dairy cows in early lactation. Among various functions, an exponential model was selected for its best fit to dry matter intake data of dairy cows in early lactation. Daily dry matter intake data ($n = 8547$) for three groups of Holstein cows (at Illinois, New Hampshire, and Pennsylvania) were used in this study. Cows at Illinois and New Hampshire were fed totally mixed diets for the first 70 d of lactation. At Pennsylvania data were for the first 63 d postpartum. Data from Illinois cows were used as the developmental data set and the other two data sets were used for model evaluation and validation. Data for body weight, milk yield, and milk composition were only available for Illinois and New Hampshire cows; therefore, only these two data sets were used for model comparisons. The exponential model, fitted to the individual cow daily dry matter intake data, explained an average of 74, 49, 67 and 64% of the total variation in daily dry matter intake for Illinois, New Hampshire, Pennsylvania, and overall, respectively. Based on all model selection criteria used in this study, the exponential model for prediction of weekly dry matter intake of individual cows was much superior to the current National Research Council equation. The exponential model explained 85% of the variation in weekly mean dry matter intake compared to 42% for the National Research Council equation. Compared to the exponential model a high relative prediction error was associated with prediction using the National Research Council equation (6 and 14%, respectively). The overall mean square prediction error value for individual cows was fivefold higher for the National Research Council equation than the exponential model (10.4 vs. 2.0 kg^2/d^2). The consistently accurate and robust prediction of dry matter intake by the exponential model for all data sets suggested that it could safely be used for predicting dry matter intake in many circumstances.

Key Words: intake, model, lactation

1283 Effect of stage of lactation on visceral tissue mass and intestinal proliferation. R. L. Baldwin*¹, K. R. McLeod¹, and A. V. Capuco¹, *¹USDA, ARS, Beltsville, MD 20705.*

Twenty multiparous, nonpregnant, lactating dairy cows were used to assess the impact of stage of lactation on visceral tissue mass and small intestinal cell proliferation. Cows were housed in tie stalls with 12 h of light/dark and were milked twice daily at 0700 and 1800 h. Cows had ad libitum access to water and were fed a common corn silage based total mixed ration. Four to six cows were slaughtered at each of four stages of lactation: 14 d ($n = 4$), 90 d ($n = 5$), 120 d ($n = 6$) and 240 d ($n = 5$) of lactation. Following exsanguination, visceral organs were separated and weighed. Additionally, intestinal lengths were determined and tissue sections were sampled for composition analysis. Duodenal mucosa (100 mg wet wt.) was obtained by scraping with a glass slide and incubated for 1 h in the presence of tritiated-thymidine to assess proliferative activity. Dry matter intake increased with stage of lactation through 120 d with intake at 90 d and 240 d being similar ($P < 0.05$). Conversely, empty body wt. (EBW) declined with stage of lactation through 120 d ($P < 0.05$) and by 240 d was not different ($P > 0.1$) from 14 d cows. As a percentage of EBW, hepatic, ruminal and small intestinal weights were increased with increasing stage of lactation through 120 d ($P < 0.05$), and then either declined (liver) or remained the same through 240 d. However, stage of lactation did not have a measurable affect on Reticular, Omasal, Abomasal, or large intestinal

weights as a percentage of EBW ($P > 0.1$). Visceral adipose tissue mass as a percentage of EBW declined with stage of lactation to a minimum at 120 d and was not different from 90 d by 240 d ($P < 0.05$). Duodenal incorporation of tritiated-thymidine was greatest at 90 and 120 d of lactation with rates of incorporation being similar 14 and 240 d of lactation ($P > 0.1$). These data demonstrate that dairy cattle visceral tissues increase in mass, as a percentage of EBW, in order to meet the energetic demands of lactation.

Key Words: viscera, lactation, proliferation

1284 Effects of duodenal amino acid and starch infusion on milk production and nitrogen balance in dairy cows. H. Volden and O. M. Harstad, *Agricultural University of Norway.*

A 6x6 Latin square designed experiment was conducted with 6 ruminally and duodenally cannulated dairy cows to evaluate the response of duodenal infusion of histidine, a mixture of histidine, methionine and lysine, wheat starch, and a combination of starch and present amino acids. Cows averaged 567 22 kg BW and 119 9 d postpartum, and were fed a basal diet consisting of grass silage (50 % of diet DM, 14.2 % CP) and a barley/oat based concentrate mixture (15.3 % CP). Infusion treatments (g/d) were water (Control), 4.1 g histidine (H), 4.0 g histidine + 5.4 g methionine + 14.3 g lysine (HML), 536 g starch (S), 4.1 g histidine + 532 g starch (HS), and 4.1 g histidine + 5.6 g methionine + 14.9 g lysine + 532 g starch (HMLS). Each period was divided into 7 d of water infusion and 14 d of treatment infusion. Treatments showed no effect on DM intake, which averaged 17.8 0.22 kg/d. As compared with the control, infusion of histidine alone or in combination with methionine and lysine resulted in higher milk protein production. Infusion of starch, (Control vs.S) increased milk protein production, whereas a combination of starch and amino acids showed no further increase. All starch treatments reduced milk urea, and reduced the proportion of dietary N excreted in the urine. From this study it is concluded that histidine is more limiting than methionine and lysine on grass silage based diets, and that post-ruminal starch supply increased N balance due to increased milk and tissue N retention.

	Control	H	HML	S	HS	HMLS	SEM
Milk, kg/d	22.7	24.1	24.7	24.4	24.1	24.4	0.4
Protein, g/kg	33.0	32.8	33.2	32.7	32.8	32.9	0.4
Protein, g/d	743 ^a	787 ^b	816 ^b	794 ^b	789 ^b	801 ^b	14
Fat, g/kg	38.7	37.5	37.8	37.0	36.7	36.6	0.7
Fat, g/d	876	910	931	902	885	893	16
Milk urea, mM	4.68 ^a	4.75 ^a	4.85 ^a	4.28 ^b	4.32 ^b	4.33 ^b	0.13
Milk N, % of N intake	25 ^a	27 ^b	27 ^b	28 ^b	28 ^b	28 ^b	0.7
Fecal N, % of N intake	31	31	32	33	33	33	0.8
Urine N, % of N intake	36 ^a	37 ^a	35 ^a	28 ^c	31 ^b	30 ^b	1.2

^{a,b,c} Means in rows with different superscripts differ ($P < 0.05$)

Key Words: Histidine, Starch, Nitrogen utilization

1285 Live weights and carcass traits of steers from heifer calving ease selection and control lines. G. L. Bennett*, USDA, ARS, US Meat Animal Research Center, Clay Center, NE.

Intense selection since 1992 for reduced heifer calving difficulty score EPD and average yearling weight EPD in seven experimental populations of cattle has resulted in improved heifer calving ease, lighter birth weight, and similar yearling weight EPD compared to control lines. Control lines were selected for average birth weight and yearling weight EPD. This apparent genetic change in growth pattern might alter carcass composition. Females born in 1996 and 1997 were randomly retained within the two lines of each population. They were mated to sires from their own lines and produced calves as 2- and 3-yr-old cows in 1998 and 1999. Random (stratified by sire and dam) male calves from select (N = 204) and control (N = 91) lines were fed as steers and measured for live weights and carcass traits. The 295 calves were from 157 sires and 279 dams. Birth weights were 4.5 kg (11.3%) lighter in the select lines ($P < 0.001$). Weight differences (select - control) were small and not significant at weaning (1.4 kg) and at subsequent average ages of 261 d (2.3 kg), 368 d (1.1 kg), and 436 d (-1.7 kg). Carcass weight was also similar (824 vs 825 kg). Adjusted fat thickness was greater ($P < 0.01$) in select lines (0.91 vs 0.78 cm) and marbling score was slightly higher ($P < 0.10$). Differences in ribeye area and KPH% were small and not significant. Results show that selection for calving ease and average yearling weight produced calves that were lighter at birth but had weights similar to control calves from weaning to 14.5 mo of age. Select animals following this genetically determined growth pattern may be slightly fatter.

Key Words: Cattle, Growth, Selection

1286 Year, season, dam age and sex effect on weaning performance of Hungarian Simmental beef calves. F. Szabo¹, Z. Lengyel¹, Zs. Wagenhoffer¹, I. Komlosi², J. P. Polgar¹, and L. Nagy¹, ¹University of Veszprem, Georgikon Faculty of Agricultural Sciences, ²Debrecen University, Centre for Agricultural Sciences.

Weaning performance of 1,393 purebred Hungarian Simmental beef calves (695 male and 698 female) born from 520 cows mated with 15 sires were analyzed. Heritability of weaning weight (WW), preweaning daily gain (PDG), and 205-day weight (CWW), and the genetic, phenotypic and environmental correlations between WW and PDG were calculated. Factors that influence weaning performance (year of birth, season of birth, sex, dam age) were also analyzed. Multiplicative correction factors were computed to correct for the effects of season and dam age. The sire model of Harvey's (1990) Least Square Maximum Likelihood Computer Program and an animal model that included maternal effects in the MTDFREML program were used to compare the breeding values obtained by the two methods. The overall mean value and standard error of WW, PDG and CWW were 226.3 ± 2.74 kg, 1200.8 ± 16.68 g/day and 249.7 ± 3.58 kg, respectively. The average age of the analyzed calves was 190 days. Heritabilities of the traits were between 0.10 and 0.20. The genetic, phenotypic and environmental correlations between WW and PDG were strong and positive. The factor with the largest effect was sex, and the factor with the smallest effect was sire ($P < 0.01$). Only the first born calves had significantly lower WW than the average; therefore, the correction factor was only computed for the first calving. The spring born calves had the best results for both traits. The estimated breeding values and rank order of sires differed when using the sire model vs the animal model.

Key Words: Weaning weight, Hungarian Simmental, Environmental effects

1287 Genetic parameter estimates for yearling traits of N'Dama cattle in humid tropics of Nigeria. O.T.F. Abanikannda*, O. Olutogun², and A.O. Leigh¹, ¹Department of Zoology, Lagos State University, Nigeria, ²Department of Animal Science, University of Ibadan, Nigeria.

N'Dama cattle are a trypanotolerant breed in the West and Central part of Africa and are well adapted to the inimical environmental conditions of Southern Nigeria. Its good beef conformation, ability to withstand high ambient temperature, and the scourge of Trypanosomiasis prevalent in the sub-region has endeared this breed to animal breeders. The

aim of this study was to investigate the various factors that may affect the yearling traits of this breed. A total of 419 records comprising calf birth weight (CBW), average daily gain (ADG), and adjusted yearling weight (AYW) were used in the study. Factors studied included sex of calf and season of birth as fixed factors, sire as a random factor, and age of dam as a covariate. General Linear Model for analysis of variance and variance components of Harvey's LSMLMW procedure was used to analyze the data. The mean CBW was 19.41 ± 0.13 kg, while AYW was 117.52 ± 0.79 kg; ADG was 0.359 ± 0.003 kg. With the exception of age of dam on CBW, all other factors studied exerted significant influence on all of the traits. The heritability estimates for the traits were 0.23 ± 0.12 , 0.22 ± 0.11 , and 0.26 ± 0.06 for AYW, ADG, and CBW, respectively. With the exception of ADG and AYW, whose genetic, phenotypic and environmental correlations were very high, correlations among the other traits were very low. The very low heritability estimates provide an indication that selecting from within the stock may not yield appreciable response within a short time interval.

Source	Degrees of Freedom	AYW Mean Square	ADG Mean Square	CBW Mean Square
Sex of Calf	1	1718.350**	0.01399*	82.482**
Season of Birth	3	1605.430**	0.02470**	25.664*
Sire	13	567.972**	0.00728**	18.441*
Age of Dam	1	857.950**	0.01499*	17.900 ^{ns}
Error	400	233.205	0.00300	6.951

* = $P < 0.05$, ** = $P < 0.01$, ns = not significant

Key Words: Genetic parameter, N'Dama, Yearling traits

1288 Effect of sire on rate and extent of postmortem increase in myofibrillar fragmentation indices of Brahman longissimus steaks. D. G. Riley*, C. C. Chase, Jr.¹, T. D. Pringle², R. L. West³, D. D. Johnson³, A. C. Hammond⁴, T. A. Olson³, and S. W. Coleman¹, ¹USDA, ARS, Subtropical Agricultural Research Station, Brooksville, FL, ²University of Georgia, Athens, ³University of Florida, Gainesville, ⁴USDA, ARS, SAA, Athens, GA.

The objective of this study was to assess sire effects on postmortem tenderization associated with aging of Brahman longissimus. Brahman steers and heifers (n = 87) sired by 9 bulls were born in 1995 and 1996, and were weaned at approximately 7 mo of age. After weaning, they were sorted by weight and sex into feedlot pens and adjusted to a final diet of 72.5% corn. When each pen had a median backfat of 10 mm as measured by ultrasound, the entire pen was slaughtered. Longissimus steaks were obtained from strip loins of each carcass and myofibrillar fragmentation indices (MFI) were determined after 1, 7, 14, and 21 days of aging. Models were built using main effects (sex, year, slaughter group, and adjusted 12th rib backfat thickness as a linear covariate) and interactions ($P < 0.15$). These models were used to evaluate MFI for each aging period. Residuals from these models were fitted, using nonlinear regression, to an exponential curve: $MFI = \kappa_0 + \kappa_1 \exp\{\kappa_2 t\} + \epsilon$, where t represents aging in days, κ_0 is asymptotic MFI, κ_1 is the difference between initial and ultimate MFI, κ_2 is the rate of increase in MFI, and ϵ is error. When all data were fitted the κ_0 , κ_1 , and κ_2 estimates were 67.8 ± 1.8 , 31.4 ± 1.9 , and 0.15 ± 0.03 , respectively. Data from individual sires were fitted separately and κ_0 estimates ranged from 56.9 ± 4.1 to 73.5 ± 9.3 . Estimates for κ_1 of individual sires ranged from 37.8 ± 12.4 to 20.2 ± 4.7 ; κ_2 values ranged from 0.22 ± 0.1 to 0.1 ± 0.09 . The progeny of sires with low κ_0 (ultimate MFI) would be expected to benefit the least from aging. Among sires with higher κ_0 values, the κ_1 (potential increase in tenderness) and κ_2 (rate of tenderization) values could be used to sort progeny carcasses into different aging periods in order to achieve maximum tenderness. Asymptotic correlations of parameter estimates (all sires) were 0.87 (κ_0 with κ_1), 0.56 (κ_0 with κ_2), and 0.24 (κ_1 with κ_2), and indicated interdependencies among the parameters estimated. Results suggest that genetic differences exist in the rate and extent of tenderization of Brahman longissimus steaks.

Key Words: Brahman, Postmortem changes, Tenderness

1289 Sire differences for growth, carcass, and tenderness traits of Brahman steers. J. D. Domingue^{*1}, T. Smith¹, T. D. Bidner¹, J. C. Paschal², G. Whipple³, and D. E. Franke¹, ¹Louisiana State University Agricultural Center, Baton Rouge, ²Texas A&M University, Corpus Christi, ³University of Nebraska, Lincoln.

Brahman bull calves (n=440) were purchased at weaning from private breeders in Louisiana (1996 through 2000) to evaluate sire variation (n=68) for growth, carcass and tenderness traits. Bull calves were castrated, dehorned, dewormed, vaccinated and backgrounded. Steers were grazed on ryegrass an average of 120 d and shipped to South Texas for feeding. Each year steers were harvested in two groups when about half the pen reached an average of 500 to 575 kg body weight and 7 to 10 mm fat thickness. Carcasses were electrically stimulated and chilled for 24 hr. A 15-g 24-hr longissimus muscle sample was taken for calpastatin assay. A primal rib was purchased and two 2.54-cm-thick steaks cut for 7- and 14-d aging. Steaks were cooked to an internal temperature of 70°C. Tenderness was measured by averaging the force required to cut each of six 1.27-cm cores taken parallel to the muscle fibers and sheared once each on an Instron Universal Testing Machine with a Warner-Bratzler shear attachment. Sire differences were evaluated with PROC GLM. REML estimates of sire variances and sire solutions were obtained with PROC MIXED. Overall means \pm sd were 1.5 \pm .2 kg/d for ADG, 337 \pm 37 kg for carcass weight, 86 \pm 9 cm² for longissimus area, 8.8 \pm .4 mm for fat thickness, 391 \pm 62 for marbling score (Slight plus), 4.6 \pm 1.2 kg for 7-d shear force, 3.8 \pm .9 kg for 14-d shear force, and 4.5 \pm 1.2 for calpastatin. Sire differences were significant for all traits. The ranges from low to high sire EPDs were .26 kg for ADG, 57 kg for carcass weight, 12.4 cm² for longissimus area, 3.3 mm for fat thickness, 50 units for marbling score, .64 kg for 7-d shear force, .59 kg for 14-d shear force, and 1.69 for calpastatin. Genetic variances were within mid to high ranges of reported estimates.

Key Words: Brahman, Carcass composition, Tenderness

1290 Use of computer image analysis to evaluate heart-shaped ribeyes in Wagyu cattle. K Kuchida^{*1}, A Kikuchi¹, K Kato², M Suzuki¹, and S Miyoshi¹, ¹Obihiro Univ. of AVM, Obihiro-shi Japan, ²Livestock Improv. Assoc. Makubetsu-cho Japan.

A depression formed by intermuscular fat ingrowing into the upper side of the M. longissimus dorsi (i.e., heart-shaped ribeye) causes decreased carcass value in Japan. The purpose of this research was to propose a new method to evaluate the level of the heart-shaped ribeye by computer image analysis and to investigate the influence of sire on the appearance of the heart-shaped ribeye in Wagyu cattle. Digital images of the M. longissimus dorsi (ribeye) between the 6th and 7th ribs were taken by equipment developed by the authors. The resolution of the image was 1800 \times 1200 pixels with a file size of 800 to 900 KB in JPEG format. A five times dilation and thinning process was performed to smooth the contour line of the ribeye, which was semi-automatically detected from the binary image using computer software developed by the authors. The area, maximum length, and pattern width were measured in an area structured with a convex polygon and the contour line of the upper side over the major axis of the ribeye. The level of the heart-shaped ribeye was assigned to one of four levels (None, Small, Middle, Large). Multiple regression equations with an average heart-shaped ribeye level as assigned by researchers as the dependent variable used the stepwise method with 18 covariates associated with image analysis traits. The number of depression pixels, depth of depression and interaction between the depth and length of depression were selected for the multiple regression equation ($R^2 = 0.84$). These results indicated that the level of heart-shaped ribeye could be automatically and subjectively estimated by the image analysis method. The percentage difference between the level assigned by the researchers and by multiple regression within \pm 0 was 89.5%. The level of heart-shaped ribeye was progeny tested with 237 (32 sires) Japanese Black steers using image analysis. Heart-shaped ribeyes were confirmed in 37 cattle. The effect of the sire on level of heart-shaped ribeye was highly significant ($P < 0.01$). A trend towards high frequency of heart-shaped ribeyes in progeny from several sires was found. Heart-shaped ribeyes were recognized in all six steers from one sire.

Key Words: Wagyu, Image analysis, Heart-shaped ribeye

1291 Pedigree analysis using the Python programming language. J. B. Cole^{*} and D. E. Franke, Louisiana State University, Baton Rouge, LA.

The utility of the programming language Python as a tool for rapid application development is demonstrated with PyPedal, a package for pedigree analysis. Python is an interpreted, object-oriented programming language. It is a full-featured language which supports modern design paradigms, is available free of charge, and is ideally suited to rapid application development. Animal breeding applications are typically complex and computationally demanding. For the sake of efficiency such applications are usually written in a compiled language such as Fortran 90. The gain in efficiency from such languages is accompanied by complex syntax and primitive libraries for tasks such as I/O. This often makes the implementation of new algorithms non-trivial and results in long development cycles. While Python is not well-suited for applications such as the quarterly USDA dairy cattle genetic evaluations, it is ideal for exploring new methodologies or writing tools to perform common tasks. PyPedal is capable of many operations on pedigrees, including error-checking, construction of A and A⁻¹, calculation of average coefficients of inbreeding and relationship, and calculation of effective founder number using direct and approximate methods. Diagnostic and error messages are written to the standard output device. Output is stored in text files. A pedigree containing records for 304 Brahman cattle was used to demonstrate PyPedal. A and its inverse were calculated and stored using one direct and two indirect methods. A was very sparse and contained 92,416 elements. Population average coefficients of inbreeding and relationship were 0.001 and 0.004, respectively. There were 152 actual founders in the pedigree. The effective number of founders was 95.86 and 132.57 by the direct and indirect methods, respectively. The difference in effective founder numbers is accounted for by the lack of precise generation information needed for accurate results from the approximate algorithm. The lack of useful generation information prevented the estimation of effective ancestor number. Total processing time was 68s on a 450 MHz Pentium II computer with 128 MB of RAM. PyPedal is available upon request from jcole@lsu.edu.

Key Words: Pedigree analysis, Programming languages

1292 A population study of milk urea nitrogen. J. E. Vallimont¹, J. Hyman¹, G. W. Rogers^{*2}, L. A. Holden¹, M. L. O'Connor¹, C. D. Dechow², and J. B. Cooper², ¹Penn State University, University Park, PA, ²University of Tennessee, Knoxville, TN.

Successful population studies require a large database of valid and accurate data that has been carefully edited. Test day and lactation data for over 625,000 cow lactations with milk urea nitrogen (MUN) values were obtained from Dairy Records Management Systems, Raleigh, NC, to study the heritability of MUN and the impact of MUN on reproduction and metabolic disease in Holstein cattle. Data were included from October 1998 through February 2001, after national changes in MUN calibration standards occurred. Herds were excluded if their milk testing lab could not be identified. Cows purchased in the middle of a lactation were excluded; however, subsequent lactations were included. Edits were imposed to ensure accurate family relationships and randomness of data: herds must have at least 20 cows with sire identification and 75% or more of cows must have been tested for MUN on a test day to include that test day. Test day records were edited for 6-305 DIM, and milk fat and protein percentages must be >0 . Although the standard deviation of the MUN mean increased as milk fat percentage increased, the standard deviation of the MUN mean of the entire dataset did not change whether the maximum fat percentage was set to 6.0% or 9.9%. Values for MUN >39 were excluded. Reproductive analyses were limited to outcomes of first services within 30 d of a MUN measurement. The final dataset contained almost 150,000 cow lactation records. Significant predictors of MUN resulting from preliminary analyses of the final dataset included lactation number (1 or 2+), season of calving (winter: October through March and summer: April through September), method of MUN measurement (infrared or wet chemistry), and stage of lactation. Judicious data editing is crucial to obtaining results that are useful.

Key Words: milk urea nitrogen, data editing

1293 Analysis of calving interval, age at first calving, and herd life in Japanese Holstein cows. C Fujita^{*1}, M Suzuki¹, and S Matsumoto², ¹*Obihiro University of A&VM*, ²*Livestock Improvement Association of Japan*.

The objective of this study was to investigate the relationships among calving interval, age at first calving, herd life, and production traits by year of birth in Holstein cows. Data used in this study were provided by the Livestock Improvement Association of Japan and consisted of calving interval records for 1,671,476, 1,321,611, and 951,411 cows in first, second, and third lactation, respectively. Production traits were milk, fat, protein, and SNF yields from test-day records. All cows were milked twice per day. Pedigree information consisted of three generations. The average herd life decreased from 2,363 d in 1975 to 2,012 d in 1995. Calving interval for the first three lactations decreased until 1990 and lengthened in recent years. The phenotypic correlations between herd life and age at first calving by birth year were low, ranging from 0.064 to 0.185. The phenotypic correlations by birth year between calving interval and protein, calving interval and fat, and calving interval and SNF were low and negative. Also, the phenotypic correlations between calving interval and herd life by birth year were low, ranging from 0.02 to 0.12. The average calving intervals by birth year were 403 to 424 d, 402 to 421 d, and 404 to 421 d on first, second, and third lactation, respectively. The modes were about 360 d and 25 mo for calving interval and age at first calving, respectively. The average ages at first calving by birth year were between 27.5 and 27.6 mo.

Key Words: Holstein, Calving interval, Herd life

1294 Factors affecting fertility traits of Holsteins and Jerseys. R. H. Miller^{*1}, H. D. Norman¹, and J. S. Clay², ¹*Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD*, ²*North Carolina State University, Raleigh, NC*.

Dairy Herd Improvement data from 3,604,990 Holstein and 264,775 Jersey lactations were used to assess variation in 70-d nonreturn to first service, days from calving to first service, days from calving to last reported service, calving interval, and number of services. Data were restricted to artificial inseminations from 1995 through 2000. Mean nonreturn rate was calculated by herd-year, and herd-years with nonreturn rates of <10% or >90% were excluded. Nonreturn rate was not examined for cows that left the herd within 70 d or if first service was after September 15, 2000. Mean nonreturn rate was 55.0% for Holsteins and 57.3% for Jerseys; mean calving interval was 410 d and 397 d, respectively. Factors evaluated were lactation stage at first service, parity, and partial regressions on peak yields for milk, fat, and protein and on age within parity. Lactation stage was evaluated only for nonreturn rate and number of services. The least-squares model absorbed herd-year-month of first service. Nonreturn rate was lowest for services before 50 d for both breeds and highest for services after 139 d for Holsteins and between 120 and 129 d for Jerseys. For both breeds, fertility for all five traits was highest for third parity. Fertility was lowest for both breeds for parities after fifth as measured by nonreturn rate and number of services and for first parity as measured by days to first service and calving interval. Days to last breeding were greatest for first parity for Holsteins and for parities after fifth for Jerseys. Partial regressions of fertility on peak yield were generally significant ($P < 0.01$) for all breed-trait combinations. Fertility generally declined as peak milk and fat yields increased but increased with peak protein yield when peak milk and fat yields were held constant. Fertility was markedly lower for breedings <50 d after calving for Jerseys and <90 d after calving for Holsteins. For Jerseys, first service occurred significantly later in first parity than in subsequent parities. All the examined effects influenced fertility and should be considered in genetic evaluation of reproductive traits.

Key Words: Fertility, Nonreturn rate, Reproduction

1295 Heritabilities and correlation among body condition scores, dairy form, stature, strength and final score. C. D. Dechow^{*1}, G. W. Rogers¹, L. Klei², and T. J. Lawlor², ¹*The University of Tennessee, Knoxville, TN*, ²*Holstein Association USA, Inc., Brattleboro, VT*.

The objectives of this study were to estimate the heritability of body condition score (BCS) and the genetic relationships among BCS, dairy form (DF), stature (STAT), strength (STR) and final score (FS).

Records were obtained from the Holstein Association USA Inc. Body condition scores are assigned on a scale of 1 (thin) to 50 (obese). Because BCS is a new trait for Holstein classifiers, distribution patterns and scoring accuracy for some classifiers were not normal. Therefore, edits were made to retain BCS that would represent data likely to be used to estimate genetic evaluations for BCS in the future. Additional edits included: a minimum of 20 daughters per sire, a minimum of 10 cows per herd-classification date (HD-CL), 0 to 305 days in milk (DIM), 20 to 60 months of age at calving and a single observation per cow. After edits, 207,149 records were used in the analyses. Heritabilities and correlations were estimated with ASREML and using multiple trait sire models that included: age at calving nested within lactation, 5th order polynomials for DIM, fixed HD-CL, and random sire and error. Genetic correlation estimates between data edited for classifiers and unedited data were generated to determine the effect of classifier edits on BCS variation. The genetic correlation estimate between BCS in edited and unedited data sets was 0.9954, but genetic variation was 28% higher and heritability 4% higher for the edited data. Heritability estimates were 0.22 for BCS, 0.24 for DF, 0.37 for STAT, 0.27 for STR and 0.25 for FS. Genetic correlation estimates of BCS with DF, STAT, STR, and FS were -0.72, 0.27, 0.69 and 0.08, respectively. Genetic correlation estimates of FS with DF, STAT, and STR were 0.34, 0.56 and 0.42, respectively. Sires with daughters that have high BCS have daughters that are less dairy and stronger. Body condition scores were not genetically correlated with final score as strongly as DF, STAT, or STR.

Key Words: Body condition score, Holstein, Type traits

1296 Estimation of genetic and phenotypic correlations between type traits and milk yield in Holstein dairy cows in Iran. Ali Toosi^{*}, Ferdowsi University, College of Agriculture.

Type scores and milk yield records of 302 grade Holstein cows from two herds were used to estimate genetic and phenotypic correlations between type traits and milk production. The type information included first classification scores for 12 traits on a 50 point linear scale, 4 score card traits (including General appearance, Dairy character, Body capacity, and Mammary system) and final score. Milk yield was 2x, 305-day mature equivalent yield. Data were analysed by method of least squares analysis of variance with unequal subclass numbers. Sire and residual variance components were estimated by method 3 of Henderson. Most of the phenotypic correlations were low and nonsignificant ($P > 0.05$). Udder depth and rear udder width had the highest significant phenotypic correlations with milk yield (-0.18 and 0.20, respectively; $P < 0.05$). These correlations indicate that cows with higher milk production also tend to have deeper udders with wider rear attachments. Genetic correlations between type traits and milk yield were higher than their corresponding phenotypic correlations in absolute values. The highest estimated desirable genetic correlations were found between rear udder height (0.59), rear udder width (0.56), dairy character (0.41), and angularity (0.34) in one side, and milk yield on the other side. Udder depth (-0.86) and fore udder attachment (-0.77) had the highest undesirable estimated genetic correlations with milk yield. These results suggest that continued selection for milk yield would result in serious weaknesses of udder attachments. Results also showed that the relative genetic progress in milk production, if selection is on final score, is expected to be 17 percent of that which can be obtained by selecting on the basis of milk production alone.

Key Words: Genetic correlations, Type traits, Milk yield

1297 Genetic and environmental factors affecting some linear type traits in Holstein dairy cows in Iran. Ali Toosi^{*} and Fereidoon Eftekhari, Ferdowsi University.

Records on 550 Holstein cows classified for 28 linear type traits were analysed by method of least squares to determine the effects of herd, month, age, and stage of lactation at classification on variability of these traits. Heritabilities of and genetic and phenotypic correlations among type traits were estimated from paternal half sisters analyses. (Co)variance components were estimated by Henderson's method 3. Herd, month, and age at classification were important sources of variation for most of the traits. Phenotypic correlations among type traits were in the range of -0.23 (between udder depth and rear udder width) to 0.89 (between strength and body capacity). Genetic correlations were in the range of 0.75 (between fore udder attachment and udder support) to 0.98 (between dairy character and final score). High genetic

correlations among most of the type traits and final score suggest that continued selection on the latter is an effective means for improving the former. Heritabilities of the linear type traits were in most cases lower than those reported by others, ranging from zero for back and fore udder length to 0.31 for stature. Results of this study suggest that phenotypic selection on most of the type traits will yield low to moderate genetic improvement in the next generation.

Key Words: Type traits, Genetic correlations, Heritabilities

1298 Comparison of occurrence and yields of daughters of progeny-test and proven bulls in artificial insemination and natural-service bulls. H. D. Norman*, R. L. Powell, and J. R. Wright, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

Extent of artificial-insemination (AI) use was determined for Ayrshire, Brown Swiss, Guernsey, Holstein, and Jersey breedings since 1959. Yield deviations for milk, fat, and protein of daughters of progeny-test (PT) bulls were compared with those of daughters of AI-proven bulls and natural-service (NS) bulls available contemporaneously. Bulls were categorized as 1) PT through a major AI organization, 2) PT through a minor AI organization, 3) proven through a major AI organization, 4) proven through a minor AI organization, 5) marketed through AI based on an NS evaluation, or 6) used through NS. Only Holstein results are reported. Percentages of daughters that first calved in 1998 with lactation records used in USDA genetic evaluations were 15, 2, 63, 12, 2 and 6% for bulls in categories 1 through 6, respectively. Percentage of daughters sired by PT bulls increased from 8% in 1984 to 17% in 1998, while percentage sired by bulls brought into AI based on NS daughters decreased from 19 to 2% and percentage of NS daughters dropped from 12 to 6%. Percentage of daughters of AI-proven bulls from major AI organizations changed little (from 61 to 63%), but percentage from minor AI organizations increased from 0 to 12%. Those changes were caused by a large reduction in the number of bulls entering AI based on an NS evaluation, plus a moderate increase in percentage of AI use and herds participating in PT programs. From 1984 to 1998, Holstein daughters of AI-proven bulls annually produced 107 to 199 kg more milk and 2 to 5 kg more fat and protein than PT daughters and 366 to 443 kg more milk, 10 to 14 kg more fat, and 9 to 11 kg more protein than NS daughters based on mean yield deviations. Those mean yield differences supported PTA differences (not shown). Use of AI in place of NS would increase annual income of producers by approximately \$96 per cow.

Key Words: Artificial insemination, Natural service, Progeny test

1299 Genetic correlations between semen production and economic traits of swine. S. H. Oh*¹, M. T. See¹, T. E. Long², and J. M. Galvin², ¹*North Carolina State University, Raleigh, NC*, ²*NPD USA, Roanoke Rapids.*

Currently boars selected for commercial use as AI sires are usually evaluated on grow-finish performance and carcass characteristics. If AI sires were also evaluated and selected on semen production, it might be possible to reduce the number of boars required to service sows, thereby improving the productivity and profitability of the boar stud. The objective of this study was to estimate genetic correlations of semen production with average daily gain (ADG), backfat thickness (BF) and muscle

depth (MD). The semen collection records and performance data for 599 boars and two generations of pedigree data were provided by NPD USA. Semen production was defined as the mean of repeated measurements of number of doses per ejaculate (1 dose = 3.05 billion sperm cells per 500 ml). Backfat thickness and MD were estimated by real-time ultrasound. Genetic parameters were estimated from a four-trait animal model using MTDFREML. Breed and contemporary group were included as fixed effects, and were highly significant ($P < .0001$) for all four traits. Heritability estimates were .46 for semen production, .46 for ADG, .47 for BF and .33 for MD. The genetic correlations between semen production and ADG, semen production and BF, and semen production and MD were .21, -.01 and -.01, respectively. Genetic correlations between ADG and BF, ADG and MD, and BF and MD were .55, .54 and .39, respectively. Semen production showed a positive genetic correlation with ADG, but was not genetically correlated with BF and MD. Therefore, current AI boar selection practices should not have a detrimental effect on semen production.

Key Words: Genetic correlation, Semen, Pigs

1300 Relationship of body length to number of teats and litter size for four breeds of swine. Z.B. Johnson*¹ and R.A. Nugent, III², ¹*University of Arkansas, Fayetteville*, ²*The Pork Group, Rogers, AR.*

The objective of this study was to estimate relationship of body length to number of teats and number of pigs born alive in first parity pigs from Landrace, Yorkshire, Duroc, and Hampshire breeds of swine. Data consisted of performance test records collected in a commercial swine operation from 1992 to 1999. Boars from 60% of the litters were culled at weaning based on a combination of maternal and performance indexes which differed by breed. Remaining boars and all females were weighed at 100 d of age (WT100) and selected for performance testing based on recalculated indexes. For three years (1992 to 1995), the number of teats (NT) was counted on both sexes at 100 d of age ($n = 4,162$ for Landrace, 18,986 for Yorkshire, 3,814 for Duroc, and 2,932 for Hampshire). For all years body length (LEN) was measured at the end of the 77-d performance test, and number born alive (NBA) at the first parity was recorded. Number of records for WT100 was 8,611, 38,979, 7,046, and 4,878 for Landrace, Yorkshire, Duroc, and Hampshire, respectively. Of these 825 Landrace, 3,140 Yorkshire, 4,237 Duroc, and 441 Hampshire had records for NBA. For each breed, genetic parameters were estimated using an animal model with litter effects and multiple-trait DFREML procedures. Three-trait models including WT100, LEN, and either NT or NBA were examined. Fixed effects included contemporary group and the appropriate age as a covariate for WT100 and LEN. Heritability estimates for NBA were 0.02 for Landrace, 0.15 for Yorkshire, 0.05 for Duroc, and 0.14 for Hampshire. Estimates of heritability for NT were 0.06, 0.29, 0.04, and 0.08 for Landrace, Yorkshire, Duroc and Hampshire, respectively. Genetic correlations between body length and NBA were 0.22, -0.02, -0.07, and 0.72 and between LEN and NT were -0.17, 0.04, 0.41, and -0.27 for Landrace, Yorkshire, Duroc, and Hampshire, respectively. Estimates of heritability of NBA and NT were low, and no consistent relationship with body length was observed in these data.

Key Words: Body length, Litter size, Number of teats

Dairy Foods Micro

1301 Efficacy of spices alone or in combined with bifidobacteria to control *Escherichia coli* O157:H7. S.A. Ibrahim*, S.R.K. Dharmavaram, G. Shahbazi, and C.W. Seo, *North Carolina Agricultural and Technical State University, Greensboro, NC.*

Escherichia coli O157:H7 is one of the leading causes of bacterial food-borne disease outbreaks in the United States. An estimated 73,000 cases of infection and 61 deaths occur each year. Many of these outbreaks are associated with the consumption of meat and meat products such as ground beef and ground beef patties. Spices are usually added to meat products to improve the quality and shelf life. Our research hypothesis is that manganese (Mn^{2+}), a common element in many spices, could stimulate the production of organic acids and antimicrobial compound by lactic acid bacteria. Therefore, combinations of starter cultures and

spices would enhance the biosafety of these consumable products. The objective of this research was to determine the effectiveness of combinations of bifidobacteria and spices on inactivation of *E. coli* O157:H7 in ground beef. Ground Beef (93% lean meat) was inoculated with *E. coli* O157:H7 (380-94) to make the initial inoculum level of 2.0 log cfu/ml. Inoculated ground beef was mixed with different spices (garlic, ginger, jalapeno pepper and commercial spice, served as antioxidant) at the level of 2% (W/V). Bifidobacteria was then added to a final level of 5.00 log cfu/ml. Beef samples were held at 37 C for 48hr. Changes in the populations of *E. coli* in meat samples were followed on EMB agar plates. The results showed that ground beef treated with commercial spice had the highest inhibitory effect against *E. coli* ($P < 0.05$), followed by jalapeno pepper and garlic. Ginger had little effect on the

growth of *E. coli* in ground beef. The synergistic effect of spices and bifidobacteria on *E. coli* O157:H7 was higher than the effect of single spice alone ($P < 0.05$). Knowledge gained from this research project will be valuable in developing new strategies to eliminate *E. coli* O157:H7 in many meat products and ultimately improve the biosafety of these consumable products.

Key Words: *E. coli* O157:H7, bifidobacteria, meat products

1302 Production of conjugated linoleic acid by *Lactobacillus acidophilus* and *Lactobacillus casei* of human intestinal origin. L. Alonso, P. Cuesta Alonso*, and S. Gilliland, *Oklahoma State University, Stillwater, Oklahoma, USA.*

Conjugated linoleic acids (CLA) are a mixture of positional and geometrical linoleic acid isomers, the predominant ones are (c9t11) and 18:2 (t10c12) (t9t11). At each position the double bond can be either in the cis- or the trans- configuration. However, it is the cis-9, trans-11-octadecadienoic acid (18:2 c9t11) that is considered to be the most biologically active isomer. It is a naturally occurring fatty acid, present mainly in foodstuffs from animal sources. CLA is produced from polyunsaturated fatty acids by rumen microorganisms during biohydrogenation. The objective of this study was to determine the ability of different cultures of lactobacilli isolated from human intestinal sources to produce CLA. Four different cultures, two strains each of *Lactobacillus acidophilus* and *Lactobacillus casei* were tested for their ability to produce CLA from free linoleic acid. Different concentrations of linoleic acid (0, 0.05, 0.1, 0.2, 0.5 mg/ml) were added to MRS broth and sterilized skim milk inoculated with the cultures of the lactobacilli, and incubated at 37° C. Samples were taken at 0, 24, 48 and 72h. For each sample the amounts of individual isomers of CLAs (c9t11, t10c12, t9t11) and total CLA (conjugated linoleic acid) were quantitated by gas liquid chromatography. Growth in media containing 0.2% linoleic acid for 24h was most effective in CLA production. All the cultures were able to convert linoleic acid in conjugated linoleic acid in broth media and milk with a concentration range of (90.74-165.37 µg/ml) and (79.54-143.73 µg/ml) respectively. Conjugated linoleic acids have been reported to induce beneficial physiological effects including anticarcinogenic, inhibition of arteriosclerosis and enhancement of immunological function in different species. The use of lactic acid bacteria able to deconjugate linoleic acid might enrich dairy products with CLA contributing to these beneficial effects. Probiotic bacteria, such as the ones in this study, also might produce CLA in the intestinal tract following their ingestion.

Key Words: Conjugated linoleic acid, Lactobacillus, Probiotic

1303 Colonization Property of *Lactobacillus reuteri* and Its Antagonistic Activity in Mice Infected With *Salmonella enterica* serovar Typhimurium DT104. S. H. Kim¹, N. H. Kwon^{*1}, J. Y. Kim¹, J. Y. Lim¹, H. J. Kang², D. S. Lee², I. B. Kwon², B. W. Yoo³, and Y. H. Park¹, ¹College of Veterinary Medicine and School of Agricultural Biotechnology, Seoul National University, ²Lotte R&D Center, ³Agribands Purina Korea, Inc.

The aim of this study was to compare the colonization properties of three probiotic strains, *Lactobacillus reuteri*, *L. bulgaricus* and *L. casei*, and their antagonistic activities against *Salmonella enterica* serovar Typhimurium DT104 infection in mice. Mice were fed with one of three probiotic strains (10^9 cfu/mouse) for 7 days and fecal samples were collected daily from day 8 to 11. Mice fed with *L. reuteri* continued to be present at high lactobacilli population in feces even 4 days after stopping feeding it, compared with the others. To investigate the antagonistic activity, mice were challenged with *S. enterica* serovar Typhimurium DT104 (3.7×10^8 cfu/mouse), after prefeeding with one of the above three probiotic strains for 7 days. The fecal shedding of *S. enterica* serovar Typhimurium DT104 and serum IgG and intestinal IgA against the organism were examined. The fecal shedding was dramatically decreased and *S. enterica* serovar Typhimurium DT104 was not detected in feces and intestines 3 days after challenge in mice fed with *L. reuteri*. Antibody responses of the intestinal IgA were significantly increased and relatively strong responses were also observed for serum IgG in mice fed with *L. reuteri*. These findings suggest that *L. reuteri* can survive better in the gastrointestinal tract and has superior antagonistic activity against *S. enterica* serovar Typhimurium DT104 compared with the others. Also, administration of *L. reuteri* might enhance the mucosal and systemic immune responses against *S. enterica*

serovar Typhimurium DT104. Further study will be followed to define the mechanism of immunomodulatory effects of *L. reuteri*.

Key Words: *Lactobacillus reuteri*, antimicrobial activity, immunomodulatory effect

1304 Antimicrobial activity of *Lactobacillus reuteri* SD 2112 against bovine pathogens and *Escherichia coli* O157:H7. N. H. Kwon¹, S. H. Kim^{*1}, J. Y. Kim¹, J. Y. Lim¹, J. S. Ahn², B. W. Yoo³, H. J. Kang⁴, D. S. Lee⁴, I. B. Kwon⁴, and Y. H. Park¹, ¹College of Veterinary Medicine and School of Agricultural Biotechnology, Seoul National University, ²National Veterinary Research and Quarantine Service, ³Agribands Purina Korea, Inc., ⁴Lotte R&D Center.

The purpose of this study was to determine antimicrobial activity of *Lactobacillus reuteri* SD 2112 and to compare it with other lactic acid bacteria such as *L. acidophilus*, *L. bulgaricus*, *L. casei* and *Bifidobacterium longum*. Tested bovine pathogens were *Salmonella dublin* isolate, *S. enteritidis* ATCC 13076, *S. enteritica* serovar Typhimurium DT104, *Staphylococcus aureus* MNEV, FRI 913, *Listeria monocytogenes* ATCC 11285 and *Bacillus anthracis* Sterne 34F₂. *Escherichia coli* O157:H7 ATCC 43890 and ATCC 43894 were also included in as food-borne pathogens derived from cows. Five probiotics were incubated in 3 different growth conditions (MRS without glycerol, MRS with 0.5 M glycerol and 0.25 M glycerol solution) to obtain supernatants. Nine pathogens were inoculated on Mueller Hinton Agar containing supernatant of each 5 probiotics. Data were analyzed with Friedman two-way ANOVA by ranks in Statistical Analysis System Institute version 8. Though antimicrobial activity of *L. reuteri* in the first two conditions was not better than the others', the activity was significantly higher than those of the others in 0.25 M glycerol solution. This prominent effect might be attributable to reuterin, produced by *L. reuteri* using glycerol. We could detect the presence of reuterin in the supernatant of 0.25 M glycerol solution with Nuclear Magnetic Resonance at 500 MHz. The result of minimum bactericidal concentration has revealed that reuterin had pan-bactericidal effects against above pathogens. To examine any changes of antimicrobial activities of the probiotics, each supernatant was treated with different pH conditions, pepsin and trypsin digestion. Antimicrobial activity of reuterin was not entirely affected by any of these treatments, while the activities of the other probiotics were significantly decreased. This study has indicated that *L. reuteri* could be a good aid of bovine and other animal health when used as feed additives because of its antimicrobial activity and unchangeable characteristic even in gut environments. Also, *L. reuteri*, as feed additives, could be helpful to human by preventing *E. coli* O157:H7 being transferred from cows to human.

Key Words: *Lactobacillus reuteri*, Antimicrobial activity, Probiotics

1305 Autoaggregation behavior of bifidobacteria as influence by media composition and incubation temperatures. V. Rada¹, J. Medkova¹, S. A. Ibrahim^{*2}, O.A. Hassan², G. Shahbazi², and Y. Murad³, ¹Czech University of Agriculture Prague, Prague, Czech Republic, ²North Carolina Agricultural and Technical State University, Greensboro, NC., ³Rush-Presbyterian-St. Luke's Medical Center, Chicago, IL.

Bifidobacteria are of increasing interest to the dairy industry. The incorporation of such culture into the human diet corresponds to the emergence of a new generation of dairy products, which use the beneficial effect of bacteria to improve intestinal metabolism. However, if the use of bifidobacteria as a dairy product supplement is to be justified, these cultures must possess certain characteristics, one of which is the ability to autoaggregate in the human intestinal tract. Therefore, the objective of this research was to determine the autoaggregation behavior of bifidobacteria as influence by media composition and incubation temperatures. Eight strains obtained from commercial culture collection and six strains isolated in our laboratory were tested for their autoaggregation ability. These strains were grown in different media (MRS, TPY, and Wilkins-Chalgren) and incubated at different incubation temperatures (30, 37 and 42 C). The autoaggregation ability of these strains was determined at different time intervals during the incubation period. Results showed that Tween 20 and Tween 80 reduced autoaggregation behavior. TPY broth, increased the autoaggregation behavior of the tested strains, where as Wilkins-Chalgren and MRS reduced autoaggregation behavior. This could be due to the reduced growth in these media. The

autoaggregation behavior significantly differed among tested samples. Higher incubation temperature, (42 °C) compared to lower incubation temperature (30 °C), increased the ability of strains to autoaggregate. Our data suggest that autoaggregation is an important trait that contributes to the ability of bacteria to colonize in the intestinal tract. Our results also suggest that this ability should be used as a preliminary step to determine a potentially suitable culture for specific dairy food applications. Further studies are required to determine the molecular mechanism of autoaggregation.

Key Words: autoaggregation, bifidobacteria

1306 Bacteriological quality of bulk tank milk in Pennsylvania. B. M. Jayarao*, S. R. Pillai, D. R. Wolfgang, C. M. Burns, and L. J. Hutchinson, *The Pennsylvania State University, University Park, PA, USA.*

Studies conducted over the last two decades have shown that examination of bulk tank milk (BTM) is useful for diagnosing multiple problems (current and potential) that might exist in a dairy herd related to milk quality and mastitis pathogens. An extension and research program was conducted in Pennsylvania from April 2000 through March 2001 focused on BTM analysis. The research project involved surveying BTM quality in Pennsylvania. A total of 126 dairy producers from 14 counties in Pennsylvania participated in the study. Four BTM samples were collected at interval of 15 days from each of the participating dairy herds. The BTM samples were examined for somatic cell count (BTSCC) and differential bacterial counts including; 1) Standard plate count (SPC), 2) Preliminary incubation count (PIC), 3) Laboratory pasteurization count (LPC), 4) *Staphylococcus aureus* (SA) count, 5) Coagulase negative staphylococcal (CNS) count, 6) Streptococci and streptococci-like organisms (SSLO) count, 7) Coliform count (CC) and 8) Gram-negative non-coliform (NC) bacteria. The findings of the study are summarized in Table 1. BTSCC are expressed as cells/ml while bacterial counts are expressed as cfu/ml.

Table 1. Somatic cell and bacterial counts in bulk tank milk

Test	Mean	Median	Mode	Std.error
BTSCC	363,214	347,500	9520-737,500	142830.39
SPC	7672	4193	180-62,825	796.48
PIC	22,913	12,250	500-139,750	2452.82
LPC	388	133	5-6400	66.65
SA	45	34	0-275	4.07
CNS	1246	693	60-15,175	173.86
SSLO	1390	890	15-11,402	152.62
CC	159	60	5-4130	41.81
NC	838	226	0-15,475	203.43

Key Words: bulk tank milk, milk quality, mastitis

1307 Production of exopolysaccharides by *Lactobacillus rhamnosus* RW-9595M: influence of carbon source and ratio carbon / nitrogen. M. I. Cote*, D. Roy¹, and J. C. Vuilleumard², ¹*Food Research and Development Centre, Dairy Research Centre STELA.*

Lactic acid bacteria (LAB) produce exopolysaccharides (EPS) which have a beneficial effect on organoleptic properties of fermented dairy products. EPS from LAB may enhance the immune system. Furthermore, EPS from *Lactobacillus rhamnosus* RW-9595M stimulate the production of cytokines (IL-6 and IL-12 as well as TNF and IFN- γ). It seems to be a potential in these EPS to help a immune response which would favour both anti-infection and anti-allergy reactions. The aim of this work was to study the influence of carbon source and the ratio carbon/nitrogen on growth and EPS production by *L. rhamnosus* RW-9595M. Batch fermentations were carried in BMM (basal minimum medium) at 37°C, with a pH maintained at 6.0 and a constant agitation at 100 rpm. Optical density at 600nm, cell counts (CFU mL⁻¹), carbon consumption (g.L⁻¹) and EPS production expressed as total sugar (mg.L⁻¹) were measured. It has been observed that the nature and the concentration of carbon source influenced growth and EPS production by *L. rhamnosus* RW-9595M. EPS biosynthesis increased steadily when cells entered in stationary growth phase. The BMM supplemented with glucose or fructose+glucose (1:1) at a concentration of 40 g.L⁻¹ reached an EPS production of respectively 1457.3 \pm 386.9 mg.L⁻¹ and 1205.4 \pm 121.3 mg.L⁻¹ after 72 hours of fermentation. However, after 24 hours of fermentation, the EPS production rate was higher with

fructose+glucose (1:1) 901 \pm 177.2 mg.L⁻¹ as compared to 405 \pm 31.6 mg.L⁻¹ for glucose. The ratio carbon/nitrogen was modified to enhance the EPS production by adding different concentrations of casamino acids or tryptone to BMM medium containing either glucose, fructose+glucose (1:1) or isoglucose (high fructose syrup) at 40 g.L⁻¹. Values of 1747.5 \pm 192.7 mg.L⁻¹, 1913.1 \pm 309 mg.L⁻¹ and 2184.7 \pm 172.5 mg.L⁻¹ were obtained in term of EPS production after 72 hours of fermentation, by combining 2.0 g.L⁻¹ of tryptone to fructose+glucose (1:1), isoglucose and glucose respectively. After 24 hours of fermentation an EPS production of 1816.6 \pm 95.9 mg.L⁻¹ was reached with isoglucose and tryptone, compared to 1662.1 \pm 135.8 mg.L⁻¹ with fructose+glucose (1:1) and tryptone and 1067.9 \pm 275.4 mg.L⁻¹ with glucose and tryptone. These results confirm that *L. rhamnosus* RW-9595M is a highly EPS-producing strain.

Key Words: exopolysaccharides, *Lactobacillus rhamnosus*, fermentation

1308 Utilization of dot blots to screen probiotic *Lactobacilli* for mucin binding. J. Newman* and R. Jimenez-Flores, *California Polytechnic State University, San Luis Obispo, CA.*

Probiotics are live microbial food ingredients that benefit the host's health, specifically, the gastrointestinal tract (GI). Mucin, a highly glycosylated protein, is a major constituent of mucus and therefore is present in the GI tract. Mucin is also present in the milk fat globule membrane. To be effective, probiotic organisms must adhere to intestinal cells to successfully colonize the intestine. Adherence to intestinal cells involves the ability to bind to mucin. The objective of this project was to develop a method to explore the mucin binding ability of probiotic *Lactobacillus* species. Bovine sub maxillary mucin, porcine stomach mucin and various milk fractions were diluted in series, in concentrations that ranged from 1-5% to 0.001-0.005%. A serial dilution was tested for each purified protein or buttermilk fraction. The proteins were immobilized on PVDF membrane using a dot blotter and then the membrane was blocked with gelatin. The different bacterial strains under study were biotinylated using EZ-LinkTM Sulfo-NHS-LC-Biotin. These labeled cells were used to wash the membranes containing the immobilized proteins. Streptavidin-horseradish peroxidase conjugate was used to develop the blot with o-phenylenediamine dihydrochloride substrate. Results demonstrate the ability of NCFM cells to bind to bovine mucin. Our work suggests this is an effective method to screen probiotic *Lactobacillus* species for mucin-binding ability.

Key Words: Probiotics, Mucin, *Lactobacillus*

1309 The use of a *Lactobacillus* cell extract in growth media designed for lactic cultures. H. Gaudreau*, C.P. Champagne¹, and P. Jelen², ¹*Food Research and Development Center, Alberta University, Edmonton, Canada.*

Some probiotic bacteria grow poorly in milk. However, the addition of ruptured yoghurt cells to milk could potentially stimulate the growth of probiotic cultures in milk through hydrolysis of lactose into glucose and galactose, by hydrolysis of casein into peptides and amino acids and by the presence of growth factors contained in cell lysates. A crude cellular extract (CCE) of *Lactobacillus delbrueckii* subsp. *bulgaricus* was produced using a high pressure homogenizer. Lactase and proteolytic capacity of this extract and its ability to promote growth of probiotic strains was evaluated. After two passes through the homogenizer (17 000 psi), 85% of initial cells were ruptured and lactase activity of the extract was maximum. With a 2g/L CCE supplementation of 6% sterile skim milk, 85% of initial lactose was transformed into glucose and galactose over a 12 h incubation period at 37°C. An automated spectrophotometric method was used to evaluate the growth-promoting properties of non-heated CCE and heated-CCE (121°C/5min) in MRS-type media, in comparison with yeast extracts and tryptones on the growth of 3 strains of *Lactobacillus acidophilus* and 2 *Lactobacillus rhamnosus* cultures. In heated-CCE, enzymes were inactivated. The growth of one strain of *Lactobacillus acidophilus* was non significantly different in media containing yeast extracts or heated-CCE but for all other cultures the growth-promoting properties of heated or non-heated CCE was poor. However, heated-CCE had better growth-promoting properties than non-heated CCE. Thus, thermolabile inhibitory compounds were found in non-heated CCE when MRS-type media were used. In pH-controlled fermentations of *Lactobacillus rhamnosus* R011 in 6% (w/w) sterile skim milk with or without 2 g/L non-heated CCE, biomass obtained in the two media was almost the same. However, time required

to obtain maximal biomass (fermentation time) was much shorter in the CCE-enriched milk. Moreover, 2 times more lactic acid was produced in supplemented milk than in native milk.

Key Words: Starters, Media, Lactobacillus

1310 Development and validation of immunological approaches for the evaluation of probiotic adhesion to Caco-2 cells. Gwenaëlle Le Blay*, Melanie Gagnon, Christophe Lacroix, and Ismail Fliss, *Dairy research centre (STELA), Laval university.*

Probiotics are widely recognised as beneficial for human health. Amongst the different criteria for selecting them, attachment to the intestinal mucosa remains one of the most important. Indeed, this ability is regarded as essential for probiotics to exert their beneficial effects, such as the exclusion of entero-pathogenic bacteria or immunomodulation of the host. Due to the difficulties of assessing adherence of probiotics strains *in vivo*, *in vitro* adherence assays have been developed. *In vitro* adhesion to Caco-2 cells has been extensively used to select for adhesive properties. Different methods have been developed for detecting highly adherent probiotic strains. The principal ones are Gram staining and radiolabelling. These methods successfully detect probiotic adherence, however, they present several limitations. The Gram staining can not differentiate bacteria with the same Gram staining and the extensive washing steps may influence the determination of the adherence potential. As for the radiolabelling assay, which is more accurate but more time consuming, it can not either distinguish between different bacterial strains in competition studies. In this study, we propose to use an Enzyme Linked Immunosorbent Assay (ELISA) and the histo-immunostaining assay to quantitatively and qualitatively study the adhesion of different strains of probiotic bacteria and pathogens to Caco-2 cells. Different antibodies were then produced in order to specifically detect target bacterial strains. These specific antibodies were labelled with different molecules including enzymes and fluorochromes, and used for the simultaneous and specific detection of different bacterial species attached to Caco-2 cells. Results were compared to those obtained by the traditional microbiological method using specific selective media. Both immunological techniques were shown to be very effective. They were safe, economic, and have the high advantage to allow the manipulation and comparison of different bacterial species simultaneously.

Key Words: Probiotic, Adhesion, Immunological approaches

1311 Development of endospore-specific primers for the TRFP analysis of microbial populations in milk powder. M. M. Arendts*, A. J. Rife, and R. Jimenez-Flores, *California Polytechnic State University, San Luis Obispo CA.*

A comprehensive risk assessment of the microbial quality of milk powder should include information of endospores as well as viable bacteria. Current methods for detection for endospore contamination in milk and dairy products are labor intensive and time consuming. Molecular methods offer a unique and sensitive tool for rapid microbial detection over traditional methods. Previous work in our laboratory has focused on the study of viable bacterial populations using 16s rDNA primers that can be detected via Terminal Restriction Fragment Patterns (TRFP). The overall objective of this work is to study microbial populations, including a specific focus on exclusively endospore forming bacteria, by utilizing a combination of primers in the TRFP. One set of primers, specific for 16s RNA, has been successfully used in several experiments to assess microbial ecology of milk powder. The second set, designed for the exclusive detection of endospore formers, is the specific objective of this work. Two genes of endospore forming bacteria were potential targets for primer development, SpoIIA and GerC3. SpoIIA shows lower exclusivity since it does not distinguish between endospore formers other bacteria present in milk samples. The GerC3 primer set is specific for the germination gene in *Bacillus subtilis*, and was shown to amplify 70% of the endospore forming strains of the Dairy Products Technology Center (DPTC) library. However, the designed degeneracy of these primers represent a problem for positive identification of TRF patterns. Because this gene has not been sequenced in the most common endospore forming bacteria found in milk powder we undertook the task of sequencing fragments for re-design of these GerC3 primers.

Key Words: Endospore, Milk Powder, Terminal Restriction Fragment Patterns

1312 Survival of a five strain cocktail of *E. coli* O157:H7 during thermalization and the 60 days aging period of hard cheese made from unpasteurized milk. J. Schlessner*, J. Dunn², K. Madsen², and R. Gerdes², ¹*Food and Drug Administration, NCFST, Summit-Argo, IL*, ²*Illinois Institute of Technology, NCFST, Summit-Argo, IL.*

The purpose of this study was to investigate the adequacy of the 60-day minimum aging to eliminate the foodborne pathogens in hard cheese made from unpasteurized milk. Hard cheese was made from unpasteurized milk inoculated with 10^3 cells/ml of a five-strain cocktail of acid-tolerant *E. coli* O157:H7 (Strain Numbers: 43895, SEA 13B88, 932, C7927, and ENT 9490). Samples of unpasteurized milk, curd and whey were collected during the cheese manufacturing process. After pressing, the blocks of hard cheese were packaged into plastic bags, and sealed with a vacuum-packaging machine, and aged at 7 ° C. After 1 week, the cheese blocks were cut into smaller uniform-sized pieces, and vacuum sealed in clear plastic pouches for ease of sampling at the various aging intervals. Samples were plated and enumerated for *E. coli* O157:H7 using BCM# for *E. coli* O157:H7 (-) Plating Medium. Populations increased to 10^4 in the drained curd and to 10^5 at milling and pressing. Populations of *E. coli* in cheese aged for 60 and 180 days at 7 ° C decreased by less than 1 log and 3 logs, respectively. Low levels of *E. coli* O157:H7 could still be detected at 360 days of aging. Cheese runs conducted with unpasteurized milk inoculated with *E. coli* O157:H7 at the 10^1 level showed similar results. These studies appear to confirm prior reports in the literature that suggest 60-day aging may be inadequate to eliminate *E. coli* O157:H7 during cheesemaking. Thermalization, a sub-pasteurization heat treatment, was evaluated as a method to improve the safety of hard cheeses made from unpasteurized milk. Thermalization runs at 148 ° F (64.4 ° C) for 16 seconds were conducted on unpasteurized milk inoculated with *E. coli* O157:H7 at 10^5 CFU/ml. A 5-D *E. coli* O157:H7 reduction by thermalization was shown. After pre-enrichment and enrichment of the 25-ml thermalized milk sample, growth of *E. coli* O157:H7 was observed suggesting very low levels of survivors or recovery of cells injured by the heat treatment. Thermalization appears to be a process that would improve the safety of hard cheeses made from unpasteurized milk.

Key Words: raw milk cheese, thermalization, *E. coli* O157:H7

1313 Microbiological analysis of processor obtained milk samples: Experimental determination of shelf-life. Todd Pritchard*, and Emmanuelle Monteith², ¹*Northeast Dairy Foods Research Center, Burlington, VT*, ²*Dept. Nutrition and Food Sciences, University of Vermont, Burlington, VT.*

Grade A fluid milk is subject to the regulations put forth in the Pasteurized Milk Ordinance (PMO). The PMO includes a microbiological standard of less than 20,000 CFU/ml. This standard is based on quality, not safety, related issues. The goal of our research was to determine what percentage of milk samples maintained at ideal temperature conditions were still within the PMO code for microbiological quality at the carton encoded sell by date. A total of 204 milk samples were directly obtained from 12 of 13 fluid milk processors in the Maine-New Hampshire-Vermont region of New England during the period of April 2001 through December 2001. The milk was maintained below 41F at all times during collection and evaluation. Analysis of the samples included a preliminary coliform evaluation and a total plate count evaluation over the time period from collection until the carton encoded sell by date. Coliform and total plate counts were determined utilizing 3M CC petrifilm and 3M AC petrifilm respectively. Fifty-one percent (104/204) of the samples were still within PMO code at the carton encoded sell by date. The number of samples meeting PMO code varied by plant with a low of 19% to a high of 83.3% passing. An evaluation of the samples meeting PMO code also revealed that there was variation from state to state. An evaluation of the samples which failed to meet PMO code indicated that 60 of the samples were still within PMO code at least 7 days post processing and that among these samples, 14 were still within PMO code at least 10 days post processing. The overall percentage of samples within PMO code at least 7 days post production was calculated to be 80.4% and 57.8% of the samples were still within PMO at least 10 days post production. Our results indicate that some processors may wish to re-evaluate the shelf life of their products. Furthermore,

consumers may wish to utilize milk as close to the day of purchase as possible to ensure they are consuming the highest quality milk available.

Key Words: milk, quality, shelf-life

1314 Characterization of the novel lactococcal food-grade vector pRAF800 based on melibiose fermentation. I. Boucher*, C. Vadeboncoeur, and S. Moineau, *Université Laval, Québec, Canada.*

A food-grade plasmid vector named pRAF800 was developed for the genetic engineering of industrial *Lactococcus lactis* strains using: 1) the melibiose fermentation phenotype conferred by the *Lactococcus raffinolactis* *aga* gene encoding an alpha-galactosidase; 2) the minimal replicon of *L. lactis* plasmid pSRQ800 to ensure plasmid maintenance. pRAF800 is therefore constituted of two divergently oriented genes separated by non-coding regions, each of them containing a unique cloning site. The expression profile of pRAF800 was monitored by RT/PCR in *L. lactis* MG1363. Results indicated that the *aga* gene would be expressed from the putative promoter located immediately upstream (TTGACA-N17-TATAAT) and would terminate at non-specific sites located in the *repB* gene encoding the replication initiator. Similarly, the *repB* transcript is likely to initiate at a promoter located upstream, in the replication origin, and would encompass *aga* to end at a transcriptional terminator identified upstream of the *aga* promoter. This particular transcription profile suggests multiple avenues for the exploitation of pRAF800. One of the two proposed cloning sites offers the opportunity to express cloned genes from the plasmid promoters while the other site might be adapted for the expression of genes from their own promoter. Expression of *aga* from pRAF800 was also examined in the *L. lactis* industrial strain SMQ-741 by enzymatic activity measurement. Alpha-galactosidase activity was induced by galactose and melibiose but not by glucose or lactose, indicating that a gene regulation is present. Consequently, the introduction of pRAF800 into an industrial *L. lactis* strain should not cause a metabolic burden to the cells during the manufacture of the starter culture as well as during the milk fermentation where lactose is the principal energy source.

Key Words: *Lactococcus lactis*, Food-grade cloning vector, Alpha-galactosidase

1315 Bifidobacteria protection study using whey protein matrix. Viel Louise-Marie*¹⁻², Fliss Ismail¹, and Subirade Muriel¹⁻², ¹Centre de recherche STELA (Université Laval) Québec, Canada, ²Functional Food and Nutraceutical Institute (INAF) (Université Laval) Québec, Canada.

Bifidobacterias are probiotics which, when ingested in sufficient dose, are likely to provide many beneficial effects to the health. Numerous studies were performed on these bacterias and showed that at least 10E6 to 10E8 bacterias/g must reach the colon alive to have a significant effect. However, bifidobacterias are particularly vulnerable to acidic pH of the stomach which inhibits their biological effect. Different strategies were developed to encounter this problem and maximise cell viability. A simple one is to higher the amount of ingested bacterias for a maximum resistance to the acidic pH of the stomach to reach the colon alive. A better solution is to protect the cells by means of encapsulation. Many matrices were elaborated based on natural polymers. Despite being non-toxic and low cost, many of those matrices are reversible in phosphate buffers and most of them use organic solvents and high temperatures when they are made. Factors very deadfull for the incorporated cells. Recently, a new method based on emulsification and cold gelation process of whey proteins was elaborated in our research group (patent in press). The objective of the present project is to determine the impact of process parameters on the viability of bacterial cells incorporated in this matrix. *Bifidobacterium longum* ATCC 15707 cells were grown in modified MRS broth (0,05% L-cysteine HCl) and added in the matrix at the beginning of the matrix formation process. The pour plate method was used to follow cells viability and compared to non-encapsulated cells. Optimal process conditions were then determined with the lowest death rate. Data were analyzed using a 4 x 4 x 3 replications completely randomized factorial design. An analysis of variance was conducted. The predetermined acceptable level of probability was 5% ($P \leq 0,05$) for all comparisons. In the following presentation, results of the impact of

process parameters on viability of probiotic bacterias (*Bifidobacterium longum*) will be exposed.

Key Words: bifidobacteria, protection, whey protein

1316 Factors influencing cell count of a probiotic *Lactobacillus crispatus* strain. Kevin Bourzac*, Ann Bernard, Dr. M. E. Sanders, and Dr. Rafael Jimenez-Flores, *California Polytechnic State University, San Luis Obispo, CA.*

The probiotic bacteria *Lactobacillus crispatus* strain HP101 was derived from a fermented dairy product in eastern Europe. Commercialization of this strain has been a challenge due to its poor growth characteristics in standard *Lactobacillus* media. The objective of this work was to analyze factors influencing growth and cell count in different media to improve the commercialization potential of this strain. Compared to the successful industrial *Lactobacillus acidophilus* strain NCFM, HP101 exhibits 2-3 log cycle fewer CFU/ml in MRS media although optical density measurements are equivalent. HP101 cells were also observed to have different morphology than NCFM when grown in MRS. NCFM cells were short, compact rods where HP101 were long and spindly (often associated with unhealthy cells). A live/dead staining procedure also indicated that a high percentage of HP101 cells were damaged or dead when grown on MRS for 24hrs. Growth in milk completely reversed the negative HP101 growth parameters. Cell morphology, cell health (as determined by the live/dead stain), and final cell count became equivalent to that of NCFM. However, since cells are not easily recovered from milk media, it is unsuitable for industry use. Therefore, applicable media adjustments which mimicked results from growth in milk were determined. Our experimental methods included growth curve analysis, colony counts, live/dead stain analysis, peptide analysis of media and 2-D gel electrophoresis. Milk permeate supplemented with ≥ 0.3 % casein resulted in CFU and cell morphology that mimicked milk-grown cells.

Key Words: Probiotics, Permeate, Lactobacillus

1317 Production of lactic acid and antimicrobial compounds from cheese whey. A. Shahbazi* and S.A. Ibrahim, *North Carolina Agricultural and Technical State University, Greensboro, NC.*

Whey is an important by-product from the cheese manufacturing industry. Typically, 100 pounds of milk yield 10 pounds of cheese and 90 pounds of liquid whey. Disposal of liquid whey is costly due to its high BOD content. Whey is a rich source of nutrients. Many different value added products such as lactic acid, vitamins, proteins and functional ingredients can be produced from cheese whey. Developing these processes will help to reduce the waste treatment cost and add to the profitability of the dairy industry. The purpose of this project was to determine the ability of spiral-sheet membrane to immobilize bifidobacteria and to determine the performance of a spiral-sheet immobilized bacterial reactor for the production of organic acids (lactic and acetic acids) and antimicrobial compounds using cheese whey. *Bifidobacterium bifidum* (NCFB 1454) obtained in freeze-dried form was propagated by weekly transfers (2% vol/vol) in trypticase-peptone-yeast extract (TPY). A 10-liter culture was prepared and immobilized into a spiral sheet membrane in a 10-liter cylindrical bioreactor. Immobilization was achieved at room temperature (23 C) within 24 hrs. Fermentation experiments were conducted with 4.8% lactose and 4% TPY broth. When no pH control was used, the pH dropped from 6.5 to 3.8, which inhibited the bacterial activity in the bioreactor. As a result, during the subsequent experiments the pH was controlled, and it was adjusted to 6.5 by neutralizing the acid with 5N ammonium hydroxide. Samples were collected every 6 hours and were analyzed for lactic acid using HPLC, and for the production of antimicrobial compounds using the bioassay. Under the controlled temperature and pH conditions, the bioreactor effectiveness was measured as 37% conversion of lactose to lactic acid within the first 24 hours and 67% conversion rate within 48 hrs. We expect a higher conversion rate under a longer fermentation time. Our results indicate that immobilization of bifidobacteria on a spiral-sheet reactor could be used for the continuous production of lactic acid and antimicrobial compounds.

Key Words: Bifidobacteria, Immobilization, Spiral-sheet reactor

1318 Inhibition of *Lactococcus lactis* ssp *lactis* ml3 and c2 bacteriophage proliferation by chelation of Ca^{2+} with monosodium glutamate. C. L. Hicks* and I Surjawan, *University of Kentucky, Lexington, KY 40546-0215.*

Calcium (Ca^{2+}) is required for the replication of many lactococcal phages and for efficient adsorption of the phage to the host cells. Monosodium glutamate (MSG)(2.0%) chelated Ca^{2+} in the medium (M17) to inhibited c2 phage (10^5 pfu/ml) attachment and proliferation on host *Lactococcus lactis* ssp. *lactis* C2 (10^8 cfu/ml). The effect of MSG on ml3 phage attachment was similar. Phage inhibition tests were conducted by growing *L. lactis* ssp *lactis* C2 in M17 medium (10mM Ca^{2+}) with or without 2% MSG, and infecting the culture with various ml3 phage titers (10^4 , 10^6 , and 10^8 pfu/ml) after 15 min incubation. Culture growths was monitored by recording the absorbance (λ_{600nm}) every 10 min. At the highest ml3 phage infection level (10^8 pfu/ml), lysis of host cells occurred quickly after 2 h of incubation. When MSG (2.0 %) was added to M17 medium, cell lysis was delayed for 30 min. MSG, had a greater inhibition on cell lysis when phage titers were reduced. Cell lysis was delayed for 50 min at a phage titer of 10^6 pfu/ml and no lysis occurred when the phage titer was reduced to 10^4 pfu/ml. Inhibition of ml3 and c2 phage proliferation were compared with and without MSG present in the medium. When *L. lactis* ssp *lactis* C2 was grown in M17 (10mM Ca^{2+}) with and without 2% MSG and infected (after 15 min) with either ml3 or c2 phage (10^5 pfu/ml) both ml3 and c2 phage proliferation were inhibited equally. Lysis of host cells grown in the medium without MSG occurred after 190 min incubation. When C2 was grown in the M17 containing 2% MSG and infected (either ml3 or c2) with 10^5 pfu/ml the culture was able to reach the stationary phase and no lysis was observed. Addition of additional calcium (40 mM) restored c2 ability to lysis the host culture. These experiments suggested that 2% MSG bound most of the Ca^{2+} in M17 medium and was responsible for the inhibition of ml3 and c2 phage proliferation.

Key Words: Lactococcal phage, MSG, Inhibition

1319 Study of the attachment of Hepatitis A virus (HAV) to stainless steel, copper, polyethylene and PVC surfaces. Irena Kukavica-Ibrulj*¹, Andre Darveau², and Ismail Fliss¹, ¹Dairy Research Centre STELA, Laval University, ²Biochemistry department, Laval University.

Hepatitis A virus (HAV) is a frequent cause of food-borne infections world-wide. Many outbreaks have been commonly associated HAV with waste water or food which are served raw or only lightly cooked, such as shellfish, fruits and vegetables. A great number of reports have suggested that infected human food handlers and/or use of contaminated water may play an important role in food and surface contamination. There is no clear evidence in the literature that enteric viruses are capable to attach on solid surfaces. This study was designed to investigate the ability of HAV to attach to various food contact surfaces. An immunofluorescent method using confocal microscopy was developed for detection of HAV attached. The attachment ability of HAV was studied as a function of the type of solid surfaces (stainless steel, polyethylene, PVC and copper), temperature (4 and 20°C) and contact time (2 and 4 hours). HAV was shown to attach to all four surfaces tested. This attachment level depends on the initial viral concentration and the incubation temperature. The highest attachment was obtained at 4°C after a short contact time. Mechanisms implicated in this attachment phenomenon was studied by determining the surface energy values of the studied materials. The total surface energy, the Lifshitz-Van der Waals (LW) and the short range (SR) hydrogen bonding components of surface energy have been derived from contact angle determinations with help of an extended Young equation. The calculation of these parameters indicated an attractive nature of the interaction potential of the HAV attachment. In conclusion, this study confirms the attachment capabilities of HAV to different surfaces currently used in food industry. The comprehension of the HAV attachment mechanisms will permit to establish the solid base necessary to put in place better disinfection programme and consequently, reduce viral food intoxication incidence.

Key Words: Hepatitis A Virus, Attachment, Surface Energy

1320 Molecular characterisation of lactic acid bacteria of Ragusano cheese. L. Corallo¹, R. Gelsomino¹, P.S. Cocconcelli², P. Campo¹, S. Carpino*¹, and G. Licitra³, ¹Consorzio Ricerca Filiera Lattiero-Casearia, Ragusa, Italy, ²Ist. di Microbiologia e Centro Ricerche Biot., Università Cattolica, Piacenza e Cremona, Italy, ³D.A.C.P.A., Catania University, 95100 Catania, Italy.

The purpose of this work was to study the natural bacterial community involved in Ragusano cheese production and the evaluation of thermal treatment as selective steps which allow selection from environmental microbiota of lactic acid bacteria responsible for Ragusano fermentation. To perform this study molecular techniques were applied to analyse bacterial population dynamics during the fermentation process of Ragusano. The analysed cheese was produced at farm level in three cheese factories from raw milk during the spring pasture of the Hyblean region of Sicily. Samples of curd, curd after first and second scalding steps, curd after 24 h of ripening and curd after stretching were immediately analysed by serially diluting in peptonate water and plating on agar media. In order to understand the effect of technology on bacterial population dynamics, 1257 selected colonies of Gram positive were isolated from M17 and MRS plates, 400 from curd samples, 224 isolates from the second cooking step, 345 from 24 h ripened curd and 288 after the stretching process. The application of RAPD methodology made it possible to follow the growth kinetics of dominant strains composing the bacterial community of Ragusano and to allow the identification of 40 different bacterial populations in the three studied production processes. The taxonomical position of all the 40 biotypes was achieved by means of sequence analysis of at least 400 bp of the 5' region of the 16S rDNA gene. In curd after first scalding, *Lactococcus lactis* subsp. *lactis* and strains from *Enterococcus faecium* and *Enterococcus durans* were the isolated species. The community of curd after the second cooking step was modified and *Streptococcus suis* was found to be the most represented species. After the 24 hours of ripening, when the pH of curd dropped to 5.5, a modification in the bacterial community was observed and *E. faecium* and heterofermentative lactobacilli belonging to the *L. reuteri* species were identified by means of 16S rDNA sequencing. After the stretching, variations in the natural bacterial association occurred and the most strains present were identified as *Strep. macedonicus*, *E. faecium*, *E. durans*, *L. paracasei* and *L. Reuteri*.

Key Words: Molecular characterisation, lactic bacteria, Ragusano cheese

1321 Cloning of heterologous *pedA1* in different microbial systems. L. Beaulieu*^{1,2}, J-F. Jette², L. Laramée², C. Miguez², D. Groleau², and M. Subirade¹, ¹STELA Dairy Research Centre, ²Biotechnology Research Institute.

Antimicrobial cationic peptides are important components of the innate defense mechanism of all life species. Many organisms, including fungi, insects, amphibians and humans, produce hydrophobic and amphipathic peptides which exhibit antibiotic, fungicidal, hemolytic, virucidal and tumoricidal activities by interaction with the membranes of living cells and, on this basis, many are being developed for use as a novel class of antimicrobial agents. For example, bacteriocins produced by lactic acid bacteria are presently being investigated for their potential utilisation as food preservatives. Although the bacteriocins produced by many lactic acid bacteria have an important role as future food biopreservatives, there are limitations to their practical use, such as a narrow antimicrobial spectrum, low level/unstable production, or the inability of some producing strains to grow in certain foods. Because natural producing strains tend to produce low bacteriocin quantities and because chemical peptide synthesis is expensive, industrial or therapeutical applications of bacteriocins are limited. Nevertheless, the rapid growth in our understanding of the genetics of many of these bacteriocins has provided us with the tools for considering over expression of natural bacteriocin genes, or that of engineered variants of these genes, to obtain improved bacteriocins, using unnatural producing strains capable of high protein production. Such heterologous bacteriocin production might, therefore, be used to greatly increase the usefulness of these antibacterial compounds and at the same time provide us with an interesting tool for better understanding the mechanism of bacteriocin activity and structure-function relationships. The pediocin PA-1 (*pedA1*) has been inserted in expression vectors (pCM110, pPICZαA) and cloned in *Escherichia coli*, *Methylobacterium extorquens* and *Pichia pastoris*. Expression levels are being tested using anti *pedA1* polyclonal antibodies.

Key Words: Bacteriocin, Cloning, Protein expression

1322 *In vitro* and *in vivo* inhibition of vaginal Group B *Streptococcus* (GBS) by bifidobacterial strain of human origin. Josee Beaulieu^{*1}, Naceur Naimi², Denis Richard², Yvan Boutin³, and Ismail Fliss¹, ¹Dairy Research Centre STELA, Université Laval, Quebec, Canada, ²Centre for Research on Energy Metabolism, School of Medicine, Université Laval, Quebec, Canada, ³Transbiotech, Cegep de Lévis-Lauzon, Lévis, Canada.

Group B *Streptococcus* (GBS), *Streptococcus agalactiae*, is considered to be problematic in countries all over the world. In fact, 2 or 3 out of every thousand newborns are infected with this bacterium and in 15 to 20% the infection leads to death due to severe meningitis. GBS is mostly found in the genital tracts of pregnant women and can be transmitted to newborns during labour.

In this work, the inhibition of GBS by strains of bifidobacteria was investigated *in vitro* as well as *in vivo* in an animal model. Different strains of bifidobacteria of human origin were screened for their potential to inhibit GBS. An exopolysaccharide-producing isolate (UL-2), exhibiting a high inhibitory effect against GBS and showing a good adherence to HeLa cells was selected. At pH 5.0, this isolate adhered to HeLa cells 25-fold higher than at pH 7.4. This adherence capacity was 1,6 and 3,8 times higher than that of GBS at pH 7.4 and 5.0 respectively. When UL-2 was added at a concentration of 1×10^7 CFU/mL, GBS adhesion to HeLa cells was inhibited by 61% and 69,5% at pH 5.0 and pH 7.4 respectively. However, a complete inhibition was obtained when UL-2 was added at a concentration of 1×10^9 CFU/mL. Finally, the *in vitro* inhibition of GBS by UL-2 was validated *in vivo* by using an animal model simulating GBS vaginal infection. The efficiency of UL-2 was evaluated by microbiological, immunological, histological and metabolic analysis.

Key Words: Human bifidobacterial strain, Group B *Streptococcus* inhibition, Animal model

1323 Effectiveness of cleaning and sanitizing agents against a biofilm of lactobacilli isolated from slit-defected Cheddar cheese. Cecilia Golinazarian^{*} and Catherine Donnelly, University of Vermont, Burlington, VT.

Slit-defect in long-hold Cheddar cheese results in loss of salable product. Strains of lactobacilli with the ability to slit cheese have been identified and characterized for the purpose of developing a procedure for the elimination of this problem. The objectives of this research were to study the ability of the strains to form biofilm on stainless steel, and determine if commonly used cleaning and sanitizing agents would eliminate the biofilm.

Selected lactobacillus strains were inoculated, as a cocktail and individually, into containers of sterile milk with stainless steel coupons in each, then held at 31°C for 20 days. The containers were drained, and sterile

milk was added on day 5, 10 and 15. On day 20, the coupons were rinsed, cleaned and/or sanitized as follows: 1) rinsed with vortexing five times in sterile phosphate buffered saline (PBS); 2) rinsed then washed in cleaning agent using agitation; 3) rinsed, cleaned, then soaked in 25°C sanitizer; 4) rinsed, cleaned, then soaked in 72°C sanitizer. Treatments were followed by three rinses in buffer, and a fourth rinse with agitation in Lactobacillus MRS broth. The final rinse was plated for bacterial counts and the tubes incubated for 24 hours. One coupon from each treatment was examined by scanning electron microscopy.

Growth plates for treatment one were too numerous to count (TNTC). Bacterial counts for treatments two averaged between 1.50 ± 2.25 log CFU/ml, depending on agents applied. Bacterial counts for treatment 3 and 4 were <100 CFU est/ml. However, the final rinses in MRS (used to inoculate the growth plates) were turbid with growth within 24 hours. The scanning electron micrographs illustrated the presence of biofilm, as well as an apparent injury effect of cleaning and sanitizing agents on the formation of the films. Although none of the tested agents were able to eliminate the presence of the biofilm, there were noticeable differences in their effect.

Key Words: lactobacilli, Cheddar cheese, biofilm

1324 Incidence of *B. cereus* spore in raw milk by membrane filtration. Yoosung Shin^{*} and Heidi Schraft, ¹University of Guelph.

In order to determine the incidence of *B. cereus* spore in raw milk, a total of 78 raw milk samples from various sampling sites, 12 environmental swabs and finished pasteurized milk were collected.

Spores of *B. cereus* in bulk tank milk of dairy farms were enumerated to be 1-37/60 ml. The incidence of *B. cereus* spores was varied with 1-222 spores and 6-263 spores/60 ml for raw milk of delivery truck and silo tank, respectively. By enrichment of heat-treated milk, *B. cereus* spores were enumerated to be 1.0×10^1 - 7.4×10^7 ml⁻¹ for bulk tank milk samples, 1.1×10^2 - 2.1×10^7 ml⁻¹ for truck samples, and 1.0×10^1 - 4.6×10^7 ml⁻¹ for silo samples, respectively. Finished pasteurized milks were contaminated with *B. cereus* by numbers of 0.5×10^1 - 6.3×10^4 , 1.0×10^4 - 3.2×10^7 , and 1.9×10^6 - 3.4×10^7 cfu ml⁻¹ for enrichment at 7°C for 14 days, 10°C for 7 days, and 40°C for 2 days, respectively. Environmental swab samples contained *B. cereus* with range 0.5×10^1 - 8.2×10^8 cfu ml⁻¹ by up to 24 hours enrichment at 30°C.

Overall, the incidence of *B. cereus* spore was found to be higher in silo and delivery truck than bulk tank in dairy farms. There is a tendency to find higher numbers of psychrotrophic *B. cereus* in raw milks of delivery truck and silo than in bulk tank on the farms. The result suggests the possibility of *B. cereus* residue on the surface of raw milk handling equipment after C.I.P.

Key Words: *B. cereus*, Raw milk, Membrane filtration

Forages and Pastures Grasses and Legumes

1325 Effects of camphene, myrcene, caryophyllene oxide, and β -pinene on consumption of alfalfa pellets by sheep. R. E. Estell^{*1}, E. L. Fredrickson¹, D. M. Anderson¹, K. M. Havstad¹, and M. D. Remmenga², ¹USDA/ARS Jornada Experimental Range, ²New Mexico State University Statistics Center.

Four experiments were conducted to examine effects of individual terpenes on alfalfa pellet intake by lambs. Forty-five lambs (9 lambs/treatment) were individually fed alfalfa pellets sprayed with either camphene, myrcene, caryophyllene oxide, or β -pinene at one of five concentrations in an ethanol carrier. Treatments (0, .5, 1, 2, and 10X) were multiples of the concentration (X) of a specific terpene on the leaf surface of *Flourensia cernua*. Terpenes were applied to alfalfa pellets (.64 kg.lamb⁻¹.d⁻¹, DM basis), and consumption was measured during a 20-min interval for 5 d. Lambs were adapted to handling and individual pen feeding for 10 d and were maintained and fed alfalfa pellets in one group (except during 20-min tests) at a mean total daily intake of 4.7% of BW (DM basis). Camphene and caryophyllene oxide tended to decrease intake (linear contrasts were $P = .0651$ and $P = .0504$, respectively), while myrcene and β -pinene exerted no effect on consumption of alfalfa pellets by lambs during the 20-min interval. Camphene and

caryophyllene oxide may be involved in the differential herbivory of individual tarbush plants by livestock.

Key Words: Herbivory, Intake, Terpenes

1326 Influence of sward height, daily timing of concentrate supplementation and grazing time management on intake, digestibility and grazing efficiency of lactating beef cows. O.J. Gekara^{*}, E. C. Prigge, W. B. Bryan, E. L. Nestor, and W. V. Thayne, West Virginia University, Morgantown, WV.

Thirty-two crossbred lactating beef cows were randomly assigned to two Kentucky bluegrass/white clover sward height (SH) treatments, either 4 to 8 cm or 10 to 12 cm, replicated four times. They were fed a concentrate supplement (T) (4.1 kg DM animal⁻¹.d⁻¹) at 0700 (AM) or 1800 (PM), and either restricted (R) to 12 hrd⁻¹ (0700 to 1900) grazing or allowed (U) to graze 24 hrd⁻¹ (MGT). The experiment was repeated over three 15-d periods in May, July and August 2000. Mean SH of continuously stocked pasture throughout the experiment was 6.0 and 9.9 cm for low and high SH, respectively. The high SH treatment herbage was higher ($P < 0.05$) in fiber components and lower in CP compared to low SH pasture. An interaction, T x MGT ($P < 0.05$), on forage DM

intake (FDMI) was evident. For R cows, supplementing in the AM as opposed to PM resulted in greater FDMI (8.6 vs 8.2 kgd⁻¹). The U cows had greater FDMI (8.4 vs 8.1 kgd⁻¹) when supplemented in the PM as opposed to AM. An interaction between SH and T ($P < 0.05$) on herbage DMD was apparent. Supplementing in the PM as opposed to AM resulted in greater herbage DMD (67.7 vs 65.4%) for cows on high SH while cows on low SH had greater herbage DMD (66.3 vs 64.5%) when supplemented in the AM. An interaction, T x MGT ($P < 0.10$) on grazing time (GT) was apparent. Supplementing in the PM as opposed to AM increased the actual time spent grazing more for R than U cows. An interaction, T x MGT ($P < 0.01$), on grazing efficiency (forage intake/hr of GT) was evident. Supplementing in the AM as opposed to PM increased grazing efficiency of R cows (1.3 vs 1.2 kg DM/hr). When forage intake is restricted as a result of either a limitation in GT or forage availability, supplementing in the AM may result in higher animal performance. When forage or GT is not limiting, feeding concentrate supplements in the PM can result in increased performance.

Key Words: Sward Height, Supplementation, Cows, Intake, Digestibility

1327 Assessment of gamagrass based diets without and with corn supplementation on ruminal fermentation in continuous cultures. J-S. Eun^{*1}, V. Fellner¹, J. C. Burns², and M. L. Gumpertz¹, ¹North Carolina State University, Raleigh, NC, USA, ²USDA-ARS, Raleigh, NC, USA.

This study was designed to determine the effects of gamagrass diets similar to those fed in a previous lactating cow trial on microbial metabolism in rumen cultures. Artificial fermentors were incubated with filtered ruminal contents and allowed to adapt for 4 days to diets followed by 3 days of sample collection. Five dietary treatments were tested: gamagrass hay (GH), gamagrass silage (GS), gamagrass silage + low corn (GSLC), gamagrass silage + medium corn (GSMC), and gamagrass silage + high corn (GSHC). A concentrate mix consisting of soybean meal and mineral and vitamin premix was added to all diets to keep CP levels similar across treatments. Daily feed offered, on a DM basis, was 13.9 g for all diets. Data were analyzed as repeated measures according to a randomized block design using the proc mixed procedure of SAS. Feeding GS resulted in a higher ruminal pH compared to GH. Increasing the level of corn supplementation in GS linearly decreased culture pH ($P < 0.04$). Concentration of NH₃-N was similar across treatments (27.9 mg/100 ml) and tended to decrease with increasing levels of corn. All diets resulted in similar methane production with the exception of GSMC which lowered methane output ($P < 0.04$). Total VFA concentrations were not affected by diet. Molar proportions of acetate were higher with GH compared to GS. Corn supplementation at the medium and high level resulted in the lowest proportion of ruminal acetate ($P < 0.01$). In contrast, molar proportion of propionate was reduced in the GSLC diet and remained similar across all other diets. Butyrate was higher in GS compared with GH. Corn supplementation increased molar proportions of butyrate which were highest in cultures receiving the high level of corn. Including corn at the high level with gamagrass silage did not have a detrimental effect on ruminal fermentation. There were no major effects of dietary treatments on microbial fermentation, but gamagrass silage resulted in higher ruminal pH when compared to gamagrass hay. Parameters to determine microbial growth are currently being analyzed.

Key Words: Gamagrass, Continuous culture, Fermentors

1328 Effect of variety and maturity stage on chemical composition and energy content of alfalfa and Timothy hay. P. Yu^{*1}, D.A. Christensen¹, J.J. McKinnon¹, H. Soita¹, and J. Markert¹, ¹Department of Animal and Poultry Science, University of Saskatchewan.

The objective of this study was to investigate changes in chemical composition and energy content of two alfalfa varieties (*Medicago sativa* L. cv. Pioneer, Beaver) and two timothy varieties (*Phleum pratense* L. cv. Climax, Joliette) grown at 3 locations (N=3), and cut at 3 stages of growth. The forages were harvested at the following growth stages: 1=early bud for alfalfa; joint for timothy; 2=late bud for alfalfa; pre-bloom head for timothy; 3=early bloom for alfalfa; full head for timothy. Comparing alfalfa and timothy means, alfalfa contained higher ($P < 0.05$) levels of EE (3.1 vs. 2.5 % DM), CP (18.9 vs. 9.7 % DM), SCP (53.6 vs. 40.1 % CP), NPN (86.0 vs. 40.9 % SCP), ADIP (8.6 vs. 5.2 % CP), NDIP (35.8 vs. 24.5 % CP), NSC (25.7 vs. 13.0 % DM), ADL (10.0 vs. 5.5 % DM), but lower ($P < 0.05$) levels of TP (46.3 vs. 78.3 % CP), CHO

(68.2 vs. 81.1 % DM), NDF (49.4 vs. 70.7 % DM), ADF (31.0 vs. 39.7 % DM) and GE (4.3795 vs. 4.4397 Mcal/kg DM). There were no differences between the 2 forage types in estimated energy values (TDN_{1x}: 55.2 vs. 56.4% DM; DE_{1x}: 2.5531 vs. 2.4886; DE_p: 2.3447 vs. 2.2855; ME_p: 1.9193 vs. 1.8584; NE_{Lp}: 1.1602 vs. 1.1165; ME^{beef96}: 2.0936 vs. 2.0407; NE_m^{beef96}: 1.2390 vs. 1.1900; NE_g^{beef96}: 0.6712 vs. 0.6264 Mcal/kg DM). Within a forage species, variety had little effect on chemical composition. With advancing maturity, CP was decreased ($P < 0.05$) (alfalfa: 20.2 to 17; timothy: 11.1 to 7.9 % DM). ADF and NDF were not affected in the alfalfa, but increased ($P < 0.05$) in timothy (ADF: 38.0 to 40.7% DM; NDF: 68.7 to 72.8% DM). Lignin was not affected by maturity in either species, but ADIP was increased ($P < 0.05$) in alfalfa (3.5 to 17.1% CP). NDIP was not affected by stage of growth. The highest energy values for both forages were found at stage 2 (TDN_{1x}, DE_{1x}, DE_p, ME_p, NE_{Lp}: 58.0%, 2.5615, 2.4592, 2.0363, 1.2438 Mcal/kg DM for alfalfa varieties; 57.1%, 2.5273, 2.3210, 1.8943, 1.1418 Mcal/kg DM for timothy varieties). The results indicate that within each species, stage of maturity rather than variety has the greatest impact on chemical composition and energy content of the forage.

Key Words: Forage Quality, Variety and Maturity Stage, Chemical Composition and Energy Value

1329 Effect of variety and maturity stage on *in vitro* rumen degradability of alfalfa and Timothy hay. P. Yu^{*1}, D.A. Christensen¹, J.J. McKinnon¹, and J. Markert¹, ¹Department of Animal and Poultry Science, University of Saskatchewan.

The objective of this study was to determine the effects of variety and stage of growth on *in vitro* rumen degradability (IVRD) of alfalfa (*Medicago sativa* L. cv. Pioneer and Beaver) and timothy (*Phleum pratense* L. cv. Climax and Joliette) hay grown at three locations (N=3) and cut at three stages of growth: 1=early bud for alfalfa and joint for timothy; 2=late bud for alfalfa and pre-bloom head for timothy; 3=early bloom for alfalfa and full head for timothy. The results showed that IVRD of alfalfa was higher ($P < 0.05$) than that of timothy for DM (IVRDDM) and NDF (IVRDNDF) after 24 and 48 h of incubation (IVRDDM24: 40.9 vs. 25.2%; IVRDDM48: 48.9 vs. 35.7%; IVRDNDF24: 38.5 vs. 20.3%; IVRDNDF48: 40.9 vs. 34.8%). Species differences decreased markedly with increasing rumen incubation time. There was no effect of alfalfa variety on IVRDDM (averaging 40.9 and 49.0% for 24 and 48 h, respectively). IVRDNDF24 for Pioneer tended to be higher ($P < 0.1$) than that of Beaver (41.2 vs. 36.4%) but not after 48 h of incubation. Similar results were seen for the timothy varieties (IVRDDM24 26.4 vs. 23.9% $P < 0.1$; IVRDDM48 36.9 vs. 34.5%, $P < 0.05$; for Climax vs. Joliette, respectively) with no effect of timothy variety on IVRDNDF24 and IVRDNDF48, averaging 20.4 and 33.9%, respectively. No differences were seen in alfalfa in IVRDDM and IVRDNDF between the early and late bud stages. However, as maturity advanced from stage 2 to 3, IVRDDM and IVRDNDF were reduced ($P < 0.05$) (IVRDDM24: 43.4 to 38.1%; IVRDDM48: 50.5 to 46.0%; IVRDNDF24: 43.9 to 34.4%; IVRDNDF48: 42.8 to 38.4%). In contrast, there was no effect of maturity on timothy. These results indicate IVRD is influenced by factors such as forage variety and maturity, however the magnitude of the impact will be influenced by forage species.

Key Words: In vitro Rumen Degradability, Forage Quality, Variety and Maturity

1330 Yield and composition of milk from cattle grazing various binary mixtures of grass and Kura clover. R. F. Gregoret^{*}, K. A. Albrecht, and D. K. Combs, University of Wisconsin-Madison.

Binary mixtures of kura clover (*Trifolium ambiguum* M. Bieb., cv. Endura) with low alkaloid reed canarygrass (*Phalaris arundinacea* L., cv. Palaton), endophyte free tall fescue (*Festuca arundinacea* Schreb., cv. Select), or Kentucky bluegrass (*Poa pratensis* L., cv. Park), were established at the Arlington Agricultural Research Station in spring, 1999. The pastures (each 1.5 ha) have been grazed by dairy cattle since that time and now contained approximately 37% clover in the reed canarygrass (RCK), 45% clover in the tall fescue (TFK) and 75% clover in the Kentucky bluegrass (KBK) pastures. The three pastures had similar available herbage (2795 363, 2839 464 and 3239 657, kg/ha, for RCK, TFK and KBK, respectively) but differed in height and sward density (14.36 cm, 1.89 kg/m³; 13.65 cm, 2.04 kg/m³; and 13.25 cm, 2.58 kg/m³, respectively). They also differed in NDF and ADF (41.9%,

23.7%; 40.5%, 23.9%; and 33.1%, 21.2%, respectively). Thirty multiparous Holstein cows, managed under an intensive rotational grazing management system were used to compare milk production and milk composition across pastures. Cattle were randomly assigned to one of 10-3 x 3 Latin squares. There were 3 cows and 3 treatments per square. Each period was 14 d. Cows grazed the paddocks 19 h/d and were offered 175% of their calculated maximum forage intake by adjusting paddock size daily. All cows were offered 7.8 kg/d corn-soybean meal supplement after the morning and evening milking. Milk yield, milk protein and MUN were highest ($P < 0.05$) for cattle grazing the KBK pasture. Higher production could be due to higher forage quality because of the higher proportion of legume and/or the greater sward density in the KBK pasture.

	RCK	TFK	KBK
Milk yield, kg/d	27.01 ^b	27.21 ^b	29.07 ^a
Fat, %	3.45	3.49	3.44
Protein, %	2.70 ^b	2.73 ^b	2.77 ^a
SNF, %	8.10 ^b	8.20 ^a	8.26 ^a
MUN, mg/dl	17.73 ^{ab}	17.00 ^b	18.37 ^a
Fat yield, g/d	1132	1147	1131
Protein yield, g/d	827 ^b	819 ^b	839 ^a
SNF yield, g/d	2091 ^b	2116 ^a	2132 ^a
Concentrate intake, kg/d	5.22 ^b	5.22 ^b	3.92 ^a

^{a, b} Least square means with different superscripts differ $P < 0.05$

Key Words: Kura clover, Grazing, Milk

1331 Mineral concentrations in four tropical forages as affected by increasing daylength. D. Arizmendi-Maldonado¹, L.R. McDowell^{*1}, T.R. Sinclair², P. Mislevy², F.G. Martin³, and N.S. Wilkinson¹, ¹University of Florida, Departments of Animal Sciences, ²Agronomy, ³Statistics.

Pure stands of the following four grasses Florakirk and Tifton-85 bermudagrass (*Cynodon dactylon*), Florona stargrass (*Cynodon nlemfuensis* Vanderyst) and Pensacola bahiagrass (*Paspalum notatum* Fluegge) were established in central Florida. Individual grass plots contained an artificial light, which extended the daylength. There were two daylength treatments, extended (artificial light used to maintain daylength at 15 h) and normal daylength conducted over a two-year period. Samples were taken at distances of 4.0 m #behind# the light and 1.0 m #in front# of the light. Samples were collected and analyzed for mineral concentrations at six sample dates from the late fall to early spring for two consecutive years. There was no difference ($P > 0.05$) between normal and extended daylength for P, Mg, K, Na, Fe, Zn, and Mn. Forage Ca decreased with extended daylength for Florakirk bermudagrass and Pensacola bahiagrass (from 0.40 to 0.36% and from 0.32 to 0.27%, respectively). Florakirk bermudagrass was highest ($P < 0.05$) in P (0.38%), while Florona stargrass was highest ($P < 0.05$) in Ca (0.44%). Pensacola bahiagrass was highest ($P < 0.05$) in Na (0.027%), while Tifton-85 bermudagrass was highest ($P < 0.05$) in Mg (0.21%). Forage Cu increased ($P < 0.05$) with extended daylength for Florona stargrass from 20.3 to 23.1 ppm. Florona stargrass was highest in Zn (90.7 ppm) with normal daylength and had the highest Fe and Cu concentrations (130.0 and 32.1 ppm, respectively) with extended daylength. Pensacola bahiagrass was highest ($P < 0.05$) in Mn (250.8 ppm) with normal daylength. Forage Se increased ($P < 0.05$) with extended daylength from 0.033 to 0.042 ppm. Forage Se had the greatest increase with extended daylength for Tifton-85 bermudagrass from 0.028 to 0.049 ppm. For the 10 minerals analyzed in the four forages, only Se and Na were severely deficient in relation to cattle requirements. In general, extended daylight did not have a practical effect on forage mineral concentrations.

Key Words: minerals, forages, daylength

1332 Steer performance and clover persistence in Georgia-5 tall fescue pastures. J.A. Parish^{*1}, R.H. Watson¹, M.A. McCann², C.S. Hoveland¹, and J.H. Bouton¹, ¹The University of Georgia, Athens, ²Virginia Polytechnic Institute and State University.

White clover is often overseeded into wild-type endophyte-infected (E+) tall fescue in an attempt to dilute the toxic effects of endophyte-derived ergot alkaloids on grazing livestock. However, clover persistence in tall

fescue stands may not be adequate for alleviating tall fescue toxicosis long-term. To address this problem, GA211-59, a white clover with enhanced stolon production and virus resistance, was developed. The objectives of this study were to determine steer growth performance and assess clover persistence in the following pasture treatments: GA211-59 white clover overseeded into GA-5 E+ tall fescue (GA211-59TF), Regal white clover overseeded into GA-5 E+ tall fescue (RWCTF), and a monoculture of GA-5 E+ tall fescue (TF). Replicated ($n=2$) .809-ha paddocks were established at the Northwest Georgia Branch Station near Calhoun, GA in October 1999. Cattle were stocked on the paddocks using put-and-take grazing management during four periods from Spring 2000 - Autumn 2001 that averaged 100 d during spring and 69.5 d during autumn. Mean stocking rate averaged 4.7 steers/ha. Mean available forage during grazing was approximately 1870 kg DM/ha. Clover available forage was higher ($P < .01$) in the GA211-59TF pastures than in the RWCTF pastures, 687 kg/ha vs 436 kg/ha ($SE=19$), respectively. Forage stand clover percentage was higher ($P < .01$) in the GA211-59TF pastures than in the RWCTF pastures, 38.8% vs 25.38% ($SE=1.0$), respectively. Mean serum prolactin was higher ($P < .05$) in steers grazing GA211-59TF pastures than in steers grazing TF pastures. Steer ADG and gain/ha were higher ($P < .01$) on the GA211-59TF and RWCTF pastures than on the TF pastures. These results suggest that overseeding E+ tall fescue with white clover is an effective alternative for combating fescue toxicosis in stocker cattle. In addition, GA211-59 white clover may exhibit better stand persistence than Regal white clover in competition with tall fescue and may subsequently comprise a greater proportion of the available DM in the pasture.

Key Words: tall fescue, white clover, stocker cattle

1333 Nutrient cycling in cool season grasses. T.W. Downing^{*1} and T.T. Leonnig², ¹Oregon State University, ²Oregon Dairy Farmers Association.

Forage grass production is a major component to profitable dairying along the Oregon coast. Grazing with both milk cows and heifers continues to be a common practice. Increased intensity of grazing management and waste management practices have lead to a renewed interest in the nutrient uptake potential in grass systems. A two-year study was conducted to identify the nutrient demands and uptake potential of cool season forages. Seventeen varieties were planted in randomized field plots measuring 6 square meters and each replicated three times. These included several different varieties of perennial ryegrass (*Lolium perenne*), hybrid ryegrass (*Lolium perenne* x *multiflorum*) and orchard grass (*Dactylis glomerata*). The plot area was sprayed, tilled and planted in the fall of 1999. During the next two consecutive growing seasons the plots were mechanically harvested, weighed, and samples were taken for analysis. All samples were tested for dry matter, nitrogen and phosphorus content. Harvesting occurred eight times each season and nutrient uptake per cutting calculated. Fresh scraped manure was applied using a honey wagon. The manure was applied at a rate of approximately 561 kg of nitrogen per hectare annually, with a total of five applications each year. The first year dry matter yields ranged from 14719 to 16897 kg/he and averaged 15801 ± 820 . Nitrogen removal ranged from 611 to 759 kg nitrogen per hectare averaging 690 ± 45.8 . Phosphorus removal ranged from 44 to 60 kg/he averaging 53.3 ± 4.8 kg of phosphorus removed. In year two, dry matter yields ranged from 15433 to 21550 kg/he averaging 18194 ± 1665 . Nitrogen removal rates ranged from 578 to 842 kg/he averaging 725 ± 73 . Phosphorus removal ranged from 53 to 78 kg/he averaging 64 ± 6.9 in the second year. The percent of nutrients removed per cutting was determined. Approximately 65 percent of the total nutrients removed occurred in the first half of the season. These data suggest the timing of manure nutrient applications may be real important in determining annual utilization. These data also indicate dry matter yields and nutrient uptake potential of modern forage grasses can be 50 to 100% higher than previously reported having significant implications on nutrient management strategies.

Key Words: Nutrient cycling, Cool season grasses, Nutrient Management

1334 Forage quality management of Kura clover in binary mixtures with selected cool-season grasses. B. W. Kim^{*1} and K. A. Albrecht², ¹Kangwon National University, Korea, ²University of Wisconsin-Madison, USA.

Kura clover (*Trifolium ambiguum* M. Bieb.) is a potentially useful perennial legume because of its excellent nutritive value and persistence under environmental extremes. However kura clover has not been evaluated in mixtures with grass species used widely in the North-Central USA. Objectives of this research were to determine forage nutritional value of kura clover-grass mixtures under varying harvest frequency and cutting height regimes. 'Rhizo' kura clover was grown alone and in binary mixtures with #Park# Kentucky bluegrass (*Poa pratensis* L.), #Comet# orchardgrass (*Dactylis glomerata* L.), and #Badger# smooth brome grass (*Bromus inermis* Leyss.) at the Arlington Agricultural Research Station located near Madison, WI. Three harvest frequencies (3 X, 4 X, or 5 X annually) and two cutting heights (4 or 10 cm) were imposed on each binary mixture and solo kura clover. Averaged over 3 years and all harvest frequency and cutting height treatments, the nutritive value of the Kentucky bluegrass and smooth brome grass mixtures was superior to that of the orchardgrass mixture (410 g kg⁻¹ NDF and 194 g kg⁻¹ CP in the Kentucky bluegrass mixture; 405 g kg⁻¹ NDF and 188 g kg⁻¹ CP in the smooth brome grass mixture; 435 g kg⁻¹ NDF and 175 g kg⁻¹ CP in the orchardgrass mixture). Higher nutritive value was observed in the binary mixtures from more frequent harvest frequencies and lower cutting height. All of the mixtures evaluated in this study produced forage with quality equivalent to grade one alfalfa hay and suitable for high producing livestock.

Key Words: KURA CLOVER

1335 Digestion and fermentation of fresh alfalfa as affected by season and level of intake in steers fed indoors. P. Pavan^{*1}, F.S. Santini^{1,2}, and J.C. Elizalde^{2,3}, ¹Instituto Naciopnal de Tecnología Agropecuaria (INTA), ²Facultad de Ciencias Agrarias, UNMDP, ³Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET).

We studied the effect of two seasons (S, spring and F, fall) and three levels of intake (AL= ad libitum, 1.8 and 1% of BW) on dry matter intake (DMI) and in vivo OM (OMD) and NDF (NDFD) digestibility of fresh alfalfa fed indoors. Six Holstein steers fitted with ruminal and duodenal cannulas (379 ± 60 kg) were used in a factorial design with a Latin Square arrangement of the treatments. Alfalfa was cut daily and offered in three meals. Chromic oxide (Cr₂O₅) was used as external marker for digesta flow estimation. The S alfalfa had more % DM (23.0 vs 19.6), non starch carbohydrates (6.9 vs 5.8) than F, less CP and soluble CP (21.2 and 8.1, and 29.4 and 10.8% for S and F, respectively) and similar OM, in vitro OMD and NDF (89.2, 63.5, AND 54.5 %DM, respectively). Total DMI (kg) between seasons tend to be higher (P=.06) in S than in F for AL (8.61 and 7.76 kg, respectively), but for 1 and 1.8% total DMI was not affected (P>.05) by season (3.5 and 6.3 kg for 1 and 1.8%, respectively). When expressed as % of BW, AL DMI was higher (P<.05) in S than F (2.5 vs 2.0 for S and F respectively). Ruminal NH₃-N, total VFA concentrations, and pH, were affected (P<.05) by levels of intake (NH₃: 24.1, 28.8 and 27.7 mg/dl, VFA: 88, 100 and 117 mM; pH: 6.6, 6.4 and 6.4 for 1, 1.8 and AL, respectively) and by the season (NH₃: 31.1 vs 22.6 mg/dl; pH: 6.35 vs 6.56; VFA: 111 vs 98 mM for F and S respectively). For pH and total VFA concentration interaction effect was significant (p<0.05). Neither intake level nor season affected the OMD (63.1%). Although NDFD was not affected by intake level or season (p>.10), NDFD increased (P<.02) as intake increased in F (45.4, 50.6 and 54.2%, respectively) but not in S (48%). It is concluded that higher intakes of high quality fresh forage did not decrease OMD or NDFD. Because there was no season effect on OMD, other factors would depress intake of fresh alfalfa in F respect to S. High VFA and NH₃-N concentration would indicate higher rumen fermentation in S compared to F.

Key Words: Digestibility, Intake, Alfalfa

1336 Prediction of the energy content of Canadian grown forages for growing cattle. B. Gosselin¹, J.F. Bernier¹, G. Allard¹, H. Lapierre², and D. Pellerin^{*1}, ¹Université Laval, QC, Canada, ²AAC, Lennoxville, Qc, Canada.

Climatic conditions influence the chemical composition and digestibility of forages. Equations developed with Canadian forages could improve the prediction of their energy content. A data set of 46 diets from 11 Canadian experiments published over the last 10 years in growing cattle was used to compare four equations predicting their forage DE content (Mcal/kg DM). Two equations were determined using in vivo forage digestibility trials conducted with sheep and cattle over the last 20 years in Canada: Laval_ADF, DE=3.245+0.035xCP%-0.024xADF%-0.003LEGUME% (R²=0.52;n=202); Laval_ADL, DE=4.139+0.025xCP%-0.02xADF%-0.870xLOG10(ADL%/ADF%x100) (R²=0.57;n=202). The other two models were developed in the 1980's and are currently used in Eastern Canada: McQueen, DE(grasses)=4,681-0.0573xADF% (R²=0.68;n=69); DE(legumes)=4.079-0.0428xADF% (R²=0.83;n=20); Seoane, DE=4.96-0.0585xADF% (R²=0.83;n=20). Average BW, BW gain, DM intake and the forage proportion in diets were used to estimate NE_M and NE_G concentrations of the diet and the forage based on the requirements published in the NRC (1996) beef cattle model. Table values (NRC, 1996) of NE_M and NE_G were used for concentrates and corn silage. NE_M and NE_G in diets as well as BW gain were predicted using the four different equations and the results were plotted against their respective estimated NE_M and NE_G from the NRC model or the observed values for BW gain. Energy predicted from the four equations were lower than estimated values. Determination coefficients (R²) for the regression of forage NE_M and NE_G were low (ranging from 0.14 to 0.24), but increased when whole diets were considered (ranging from 0.29 to 0.55). Higher R² were obtained for BW gain (R² = 0.73, Laval ADF; R² = 0.74, Laval ADL; R² = 0.70; McQueen; R² = 0.63, Seoane). For the present data set, the energy value of Canadian forages was poorly predicted by the four equations. However, prediction of BW gain was adequate. Such a discrepancy could be related to concentrate-rich diets in some experiments.

Key Words: Digestible Energy, Forage, Equations

1337 Effect of sainfoin incorporated into alfalfa pasture on ruminal fluid characteristics and development of bloat in grazing steers. Y. Wang^{*1}, T.A. McAllister¹, L.R. Barbieri¹, and B.P. Berg², ¹Agriculture and Agri-Food Canada, Lethbridge, AB, ²Alberta Agriculture, Food and Rural Development, Lethbridge, AB.

Ruminal fluid characteristics and development of bloat were assessed in five grazing periods over 2 yr, in a study involving 12 ruminally cannulated Jersey steers and three alfalfa pastures containing 0 (control) to 36% (w/w) sainfoin. The steers (n = 4) were allowed to graze fresh paddocks (without access to water) each day from 0830 to 1430, then were penned without feed (but with water) until 0830 the next day. Grazing behavior and bloat status were recorded hourly while the steers were grazing. Ruminal fluid was collected immediately upon removal of the steers from pasture and analyzed for volatile fatty acids (VFA), ammonia, protozoa, reducing sugars (RS), soluble protein, proteolytic activity, polysaccharide-degrading enzymes (PDE) activity and viscosity. In both years, bloat rates were reduced markedly (by up to 88%, P < 0.05) by sainfoin present at levels as low as 11% (DM basis). However, when sainfoin fell below 5% of pasture DM, its efficacy for bloat prevention dropped substantially, especially when the pasture was in the vegetative stage of growth. Ruminal NH₃ was reduced (P < 0.05) when steers grazed pastures in which sainfoin contributed condensed tannins (CT) at 4.0 to 8.5 g/kg forage DM. This was consistent with observed reductions in intracellular and extracellular proteolytic activity, which likely arose from the effects of the CT on both plant protein and rumen microbes. Sainfoin in the alfalfa pastures increased (P < 0.05) ruminal extracellular PDE activity and tended (P < 0.10) to reduce acetate:propionate ratios, but did not affect protozoal numbers, viscosity, total VFA or RS concentrations. Sainfoin in alfalfa pastures in quantities sufficient to provide 2 to 10 g CT/kg forage DM reduced but did not eliminate pasture bloat; CT at 5 to 10 g/kg DM improved protein metabolism by steers grazing pasture at or beyond full bud maturity.

Key Words: Rumen Metabolism, Condensed Tannins, Bloat

1338 Ca and P endogenous losses and true absorption of alfalfa and fescue diets when fed to dairy cows. M. F. Weiss*, F. A. Martz, R. L. Belyea, and A. T. Belo, *University of Missouri, Columbia MO.*

Eight holstein cows of high milk potential were paired by production and parity, then assigned to a fescue(F) or an alfalfa(A) diet in order to study dietary Ca and P use. Dry cow diets were 50% forage, plus corn silage with 0.91% Ca and 0.42% P for A and 0.50% Ca and 0.27% P for F. Diets fed during lactation were 24% forage, plus corn silage and grain mix resulting in 0.55 and 0.57% Ca, while 0.37 and 0.45% P for A and F respectively. Endogenous fecal loss(EFL) and diet true absorption(TA) were measured using isotope dilution of 45-Ca and 32-P single injection tracers iv. Plasma and fecal specific activity(SA) of both tracers were measured over 7d during the dry(D) period, early(EL) and post-peak(PP) lactation. Data were analyzed as a split-plot in time. The ratio of integrals of the fecal SA curve to the plasma SA curve is theoretically justified as the first step for precursor-product single injection tracer studies (to find fractional EFL). Alternatively simple fecal SA/plasma SA equilibrium ratios with various time delays are often used for convenience. Calculated EFL and TA varied with the method used, and values from different methods changed rank dependent upon stage of lactation and mineral. For Ca EFL, the differences among methods were greatest for EL period effect, with the integral method value 9.4g/d intermediate to the equilibrium ratio methods with 24 and 48h delays, 11.3 and 6.5 g/d respectively($P<.01$). Values for TA reflect this same pattern for EL, with the integral solution value 40% being likewise intermediate. The Ca EFL for main effect of D was 6.7g/d(diff. from EL, $P<.05$) comparing integral values. Main effects for diet were not significant. For P EFL, the differences among methods were also greatest for EL period effect, with the integral method(Pi based) value 22.4g/d, being greater than the equilibrium ratio methods with 24 and 48h delays, 15.5 and 12.9g/d respectively($P<.01$). Corresponding TA values were 70, 62, and 59% respectively. The P EFL for main effect of D was 12.2g/d(diff. from EL, $P<.05$) comparing integral values. Main effects for diet were not significant($P<.05$) for P EFL.

Key Words: Dairy, True absorption, Phosphorus

1339 Continuous vs 8-paddock rotational stocking of rye-ryegrass pastures at three stocking rates. F.M. Rouquette, *Texas Agricultural Experiment Station.*

During two successive years, Simmental crossbreed steers and heifers, and Angus X Brahm (F-1) steers (total $n=272$) grazed Maton rye and TAM-90 annual ryegrass pastures under grazing methods of either continuous (CNT) or rotational (RTN) stocking, and each at three (LO, ME, HI) stocking rates (SR). All pastures were stocked without interruption each year from early-December to mid-May for 159 d in Year 1 and 156 d in Year 2. A fixed SR for both CNT and RTN were the same within a year for LO, ME, and HI, respectively, and for Year 1 was 4.2, 5.7, and 7.2 hd/ha, and for Year 2 was 3.7, 5.2, and 6.7 hd/ha. At initiation of grazing in December, stocker cattle averaged 275 kg and were weighed at 28-d intervals. Pastures were sampled for nutritive value and DM at about 14-d intervals from both CNT and the 8-paddock RTN pastures. Residence time in each paddock of RTN stocked pastures averaged 2 days with about a 14-day rest period. The overall statistical analyses showed differences for ADG between years ($P=.0001$), grazing

method ($P=.03$), stocking rates ($P=.0001$), and sex ($P=.0001$), but no difference for breeds ($P=.25$). In Year 1, ADG was similar for grazing methods, CNT vs RTN; different for all three SR with 1.25 kg/d (LO), 1.06 kg/d (ME), and 0.69 kg/d (HI); and different for steers (1.06 kg/d) vs heifers (0.86 kg/d). In Year 2, ADG was highly significant for grazing method, stocking rate, breed, and sex. A significant interaction showed ADG from RTN to be greater than from CNT and was attributable principally to HI ($P=.0008$) SR (0.39 vs 0.20 kg/d) rather than to ME ($P=.09$) (0.74 vs 0.65 kg/d) or LO ($P=.55$) (1.06 vs 1.02 kg/d). The rest period in RTN paddocks enhanced forage DM production in all SR; however, only at HI SR was ADG increased. When forage DM limits intake and SR can not be reduced, then a RTN grazing method will likely increase gains per animal and per ha via increased forage production. Selection of CNT vs RTN for cool-season annual grass pastures was not as important as selection of SR for expected animal performance. "

Key Words: Grazing, Stocking Rate, Ryegrass

1340 Use of dosed and endogenous herbage alkanes as markers for estimating intake of alfalfa and alfalfa:sainfoin pastures by grazing steers. Y. Wang*¹, T.A. McAllister¹, L.R. Barbieri¹, B.P. Berg², and D.M. Veira³, ¹*Agriculture and Agri-Food Canada, Lethbridge, AB*, ²*Alberta Agriculture, Food and Rural Development, Lethbridge, AB*, ³*Agriculture and Agri-Food Canada, Kamloops, BC.*

Externally dosed (C_{32}) and naturally occurring (C_{31}) alkanes were used to estimate intake of three alfalfa:sainfoin pastures (0 to 36% sainfoin) by 12 ruminally cannulated steers ($n = 4$) to determine the effects of sainfoin in the pasture on intake. The study comprised three 12-d periods during which the steers grazed continuously for 6 h/d (0830 to 1430 h). Samples of pasture herbage and pure swards of component species were collected every 48 h for alkane analysis by gas chromatography. The majority (95%) of the alkanes in herbage were odd-numbered from C_{25} to C_{33} , predominantly C_{29} and C_{31} , and these findings were consistent between pastures and between grazing periods. Alkane composition profiles of pure alfalfa and sainfoin were also similar. Each day, the steers were dosed intraruminally with 10 g of ground, extracted alfalfa hay coated with 1 g exogenous alkane (dotriacontane, $C_{32}H_{66}$) immediately prior to entering the pastures. Fecal samples were collected by rectal grab on d 8 to d 12, immediately prior to and following grazing. Intake was estimated as excretion of marker/indigestibility of forage. Average intake of organic matter (OMI) by steers, as estimated by the combination of C_{31} and C_{32} methods, was 4 to 5 kg per 6-h grazing bout. Within periods, OMI did not differ ($P > 0.05$) among pastures; further, OMI estimates were numerically similar in each of the three periods. In all pastures and all periods, estimates of OMI derived from afternoon fecal samples were numerically higher than those derived from samples collected in the morning; this was closely associated with the lower fecal concentration of external marker alkane (C_{32}) in the afternoon as compared to morning samples. It is concluded that sainfoin incorporated into alfalfa pastures at up to 36% (DM basis) did not affect feed intake of grazing beef cattle.

Key Words: *n*-Alkanes, Grazing, Feed Intake

1341 Withdrawn. . .

Growth and Development Dairy Calf and Heifer Growth

1342 Development of a repeatable procedure for rumen tissue sampling. K. E. Lesmeister*, A. J. Heinrichs, and P. R. Tozer, *The Pennsylvania State University, University Park, Pennsylvania.*

To aid the understanding of rumen development and papillae growth in young calves and to increase repeatability in rumen tissue sampling techniques, a procedure for rumen sampling and measuring was developed. An extensive statistical analysis of the procedure's results was conducted to determine its efficacy. With the reticulo-rumen lying upon its left side, the esophageal groove facing away, an incision was made around the circumference of the organ in line with the esophageal groove. A 6 cm section of the caudal portion of the caudal ventral blind sac was

maintained intact. The rumen pillars were incised in line with the initial incision, and the muscles forming the rumen pillars separated. The reticulo-rumen was then opened and laid flat, creating a right and left side separated by the portion of the rumen maintained intact. The rumen pillars separate the rumen into distinct sampling areas: the caudal portion of the caudal ventral blind sac (CaV), the caudal dorsal blind sac (CaD), the cranial dorsal sac (CrD), the cranial ventral sac (CrV), and the ventral portion of the CaV. Right and left sides of the rumen were sampled. A 1-cm² section was removed from the four corners and center of each area and measured for papillae length ($n=20$) and width ($n=20$), rumen wall thickness ($n=5$), and number of papillae per cm² ($n=5$). Rumens utilized in the development of this procedure were obtained from 12 calves that were assigned to 1 of 3 treatments. Means

and standard errors were obtained for each area and a power analysis conducted to determine necessary sample size with a power of .80. The power analysis suggests areas CrV, CrD, and CaD for papillae length determination and area CrV to determine differences for papillae width. Samples should be taken from the CaD and CrD to find differences for rumen wall thickness, and from the CrD, CaD, and CaV to find differences for papillae per cm². However, additional differences between treatments may result from different analysis of variance procedures.

Key Words: Procedures, Rumen Sampling, Power Analysis

1343 Absorption of IgG from maternal colostrum or fractions of bovine or porcine plasma proteins. J. D. Quigley* and T. A. Wolfe, APC, Inc.

Absorption of an adequate mass of IgG from maternal colostrum is required to minimize the risk of morbidity and mortality in neonatal calves. Colostrum supplements (CS) or replacers (CR) have been developed to allow producers to manage maternal colostrum (MC) programs. However, formulation of CS and CR have not been optimized and the potential use of porcine serum in CS has not been determined. Our objective was to compare IgG concentrations in calves fed MC, CR or CS containing bovine (BS) or porcine (PS) serum as the IgG source. Both CS were formulated to contain approximately 50 g of IgG/feeding and CR was formulated to contain approximately 100 g of IgG/feeding. Holstein and Jersey calves (n = 44) were collected immediately after birth and fed 1.9 L of MC or reconstituted CR, BS, or PS at 1.1 and 8.1 h of age. Jugular blood was collected at 0 and 24 h for measurement of hematocrit, total protein and IgG. Data were analyzed as a completely randomized design with treatment, sex of calf and breed in the model. Mass of IgG consumed by calves was 168, 100, 81, and 253 g for calves fed MC, BS, PS and CR, respectively. Plasma IgG was not measurable in samples taken at 0 h of age. Mean plasma IgG concentrations at 24 h of age were 13.8, 10.6, 6.7, and 13.9 g/L, respectively. Least squares means of total protein at 24 h were 5.73, 5.42, 5.08, and 5.45 g/dl, respectively. Least squares means of hematocrit at 24 h of age were 34.4, 29.7, 30.6, and 34.2%, respectively. Proportion of calves with FPT (<10 g of IgG/L of plasma at 24 h) for calves fed MC and CR were 40 and 14%, respectively. More calves had FPT when fed PS compared to BS. Apparent efficiency of IgG absorption did not differ among treatments, suggesting that differences in plasma IgG were due to differences in IgG intake. Relationship between total protein and plasma IgG concentrations at 24 h of age varied among treatments, suggesting that use of the refractometer to predict IgG concentrations in neonatal calves may be inappropriate when CS or CR are fed. Production of PS containing large amounts of IgG was difficult and resulted in CS with reduced IgG concentration.

Key Words: Calves, Immunoglobulin, Colostrum

1344 Colostrum intake in the newborn calves. R. Skrzypek*¹, D. Hofmansk², and S. Osiegłowski³, ¹Agricultural University, Poznan, Poland, ²Kombinat 2000, Smigiel, Poland, ³National Research Institute of Animal Production, Balice, Poland.

The study was carried out on 61 single-born Holstein x Black-and-White calves of both sexes (33 heifers, 28 bulls). Within the first 5 days after birth, the calves were fed twice a day with fresh mother's colostrum, using a bucket with nipple. The first feeding was practiced within the first hour of birth. For the first 3 days of life, the colostrum was offered ad libitum, and for the next 2 days the amount of colostrum fed was limited to 4L per feeding. Daily colostrum intake increased from 4.86L on day 1 to 7.41L on day 5 after birth. This trait was associated significantly with the share of Holstein genes in calves (range from 50.0 to 96.9%) and with their birth weight (39.5±5.9 kg). The share of Holsteins genes was associated with colostrum intake in the first day of life only (R²=0.16; P<0.01), whereas birth weight was correlated with colostrum intake from day 2 (r=0.50; P<0.01) to day 5 of life (r=0.32; P<0.01). In the first day of life, colostrum intake ranged from 4.2 to 6.1L in calves carrying 96.9% and 50.0% Holstein genes, respectively. This corresponds with earlier results of Skrzypek (2000), who found nearly 3-fold lower colostral immunity in first- and second generation sucking Holstein x Black-and-White crosses, as compared to the purebred native calves. Within the days 3 through 5 after birth, colostrum intake was correlated significantly with daily body weight gains (r from

0.25; P<0.05 to 0.43; P<0.01, respectively), while at the younger age the correlation was insignificant (r from -0.02 to 0.22).

Key Words: Calves, Colostrum intake

1345 Feeding liquid whey to newborn Holstein dairy calves. R. Valizadeh*, M. Jamchi, and A. Naserian, Ferdowsi University, Agriculture college, Animal Sci. Dep., Mashhad, Khorasan, Iran.

A study was conducted to evaluate the effects of sweat liquid whey on feed intake and daily gain of newborn Holstein dairy calves using a completely randomized design with factorial arrangement of 2×4. Sixteen male calves with mean body weight of 43±4 Kg and 16 female calves with mean body weight of 40±4 Kg fed individually from birth to weaning time (65 days post-partum) by the following regimes: A; (control), fresh milk (10% of body weight) + starter (ad libitum) + tap water, B; fresh milk (8% of body weight) + liquid whey (6% of body weight) + starter (ad lib.) + tap water, C; fresh milk (6% of body weight) + starter (ad lib.) + liquid whey (12% of body weight) + starter (ad lib.) + tap water, D; fresh milk (10% of body weight) + starter (ad lib.) + liquid whey (ad lib.). ME and CP contents of the starter component were 2.86 MCal/Kg and 15.5% respectively. Average daily gain of male calves was higher than females (499 vs. 405 g/d). Mean daily intakes of male male calves for treatments A, B, C and D was 2.05, 2.43, 2.19 and 2.12 Kg. These figures for female calves were 1.91, 2.10, 2.30 and 2.21 Kg respectively. Although, a large amount of liquid whey was consumed by the calves in treatments C (3.8 Kg/d), D (3.4 Kg/d) and B (2.01 kg/d) no significant difference was observed between the daily gain of experimental calves. This finding has an important economical and practical application. In Iranian dairy industry liquid whey is produced in large amount and is mostly discarded in the environment, which can be a big source of pollution. In this situation this cheap unconventional feed resource can be fed to suckling or young calves without any adverse effects. The minimum and maximum figures for rumen pH in this study were 6.07 and 6.70. These are in the normal range for a healthy and functional stomach. The blood glucose and BUN contents for the calves were into the normal ranges. It was concluded that utilization of liquid whey in feeding of suckling and growing calves could be an economical and practical recommendation for Iranian dairy farms.

Key Words: Liquid whey, Dairy calves, Gain

1346 Analysis of body composition of Jersey bull calves fed varying levels of fat and protein with dual energy X-ray absorptiometry. S. S. Bascom*, C. S. Huffard, S. M. Nickols-Richardson, E. P. Hovingh, R. E. James, and M. L. McGilliard, Virginia Polytechnic Institute and State University.

Week-old Jersey bull calves (n=20) were fed one of four diets for four weeks to determine differences in body composition. In addition, two calves were slaughtered at 7 days of age to establish baseline body composition. Calves assigned to diet MM (n=5) were fed 21% fat:21% protein milk replacer (MR) at 15% of body weight. Calves on diets HH, HL, and JM were fed 180g of CP per day. Calves assigned to diet HH (n=5) received a 27% CP:33% fat MR. Calves assigned to HL (n=5) received a 29% CP:16% fat MR. Calves assigned to diet JM (n=3) received whole milk (4.7% fat:3.2% true protein). Calves were fed three times daily; MRs were reconstituted to 12.5% dm. Calves were sacrificed and liver, organs (including empty GI tract), and right half of the carcass were used to estimate body composition. Tissue fat content was determined by dual energy X-ray absorptiometry (DXA; Hologic 4500A, Bedford, MA) using the Whole Body Analysis (version 8.25a) software. Differences in fat% in liver and organs were not significant. Carcass half fat% were 20.85±1.37, 12.79±0.81, 13.93±0.81, 12.80±0.86, 15.83±1.15, respectively for baseline, and diets MM, HH, HL, and JM. When compared to the baseline body composition all calves fed MR had lower carcass fat%. The carcass fat% of JM calves was not different from baseline. Calves fed MR lost carcass fat from 1 week of age to 5 weeks of age but calves fed JM maintained baseline body composition.

Key Words: Calves, Milk Replacer, DXA

1347 Growth hormone influences growth performance, but does not affect gluconeogenesis from lactate or propionate in 60-d old veal calves. H.M. Hammon^{*1} and S.S. Donkin², ¹University of Berne, Berne, Switzerland, ²Purdue University, West Lafayette, IN.

The somatotrophic axis becomes the main endocrine growth regulatory system after birth and growth hormone (GH) enhances glucose supply for bone and muscle growth. The objective was to investigate the influence of GH on growth performance, plasma glucose concentrations, and hepatic gluconeogenesis in veal calves. Thirteen male calves were randomly assigned to one of two treatment groups starting at d 3 of age. Calves received colostrum on first d of life followed by milk replacer at a rate of 2% of body weight (BW) on a dry matter basis. Calves (GrGH, n = 6) were treated with 500 mg GH as Posilac (Monsanto, St. Louis, MO) on d 3, 17, 31, 45, and 59 of age and control calves (GrC, n = 7) received 0.9% saline. BW was measured weekly and blood samples were obtained on d 3, 7, 14, 28, 42, and 60 of age. On d 60 liver biopsy samples were obtained, and liver slices were prepared to determine incorporation of [U-¹⁴C]lactate and [2-¹⁴C]propionate into glucose and CO₂ (nmol of substrate converted to product/mg tissue/h). BW increased with age (P < 0.001) and ADG tended to be higher (P = 0.06) for GrGH (0.87 ± 0.01 kg/d) compared with GrC (0.80 ± 0.03 kg/d) calves. Plasma glucose concentrations decreased in both groups to d 28. Plasma glucose concentrations were higher (P < 0.05) on d 7, and tended to be higher (P = 0.07) during the whole experimental period for GrGH compared with GrC calves. Conversion of 2.5 mM [2-¹⁴C]propionate and 2 mM [U-¹⁴C]lactate into glucose was 1.9 ± 0.2 and 0.42 ± 0.05, respectively. Metabolism of 2.5 mM [2-¹⁴C]propionate and 2 mM [U-¹⁴C]lactate into CO₂ was 3.7 ± 0.3 and 0.31 ± 0.04, respectively. Gluconeogenesis and CO₂ production did not differ between groups. The data indicates effects of GH to accelerate growth performance in veal calves and to alter plasma glucose concentrations, but no effect of GH on hepatic gluconeogenesis.

Key Words: Veal Calves, Growth Hormone, Gluconeogenesis

1348 Effect of feed intake and genetic potential for milk yield on somatotropin (ST) response to growth hormone releasing factor (GRF) in Holstein heifers. W. J. Weber^{*}, S. H. Wu, H. Chester-Jones, L. B. Hansen, and B. A. Crooker, Department of Animal Science, University of Minnesota.

Heifers (123 ± 5 d of age) from control (CL, n=6) and select (SL, n=7) lines were used to determine effects of selection on ST response to GRF. Milk yield of CL and SL cows in 1999 were 6,200 and 11,100 kg/305 d. Successive GRF challenges (C1, C2) were conducted when heifers were fed 150% (FF), 50% (HF) and 150% (RF) of maintenance during a 37 d study. Each heifer received 4 µg/100 kg BW of human GRF (1-29) analog (Hoffman-LaRoche, Ro23-7863) at 0 and 120 min. Blood samples were obtained at -30, -20, -10, -5, 0, 2.5, 5, 7.5, 10, 15, 20, 30, 45, 60, and 90 min relative to GRF challenge. Plasma ST was determined by RIA. Mean pre-challenge ST concentrations (PCST) were determined during the 30 min interval prior to C1 and C2 and transformed to natural logarithms. Area under the ST response curve was quantified (0 to 60 min post-dosing, AUC) by trapezoidal summation after subtracting baseline ST. Effects of line, intake, challenge and their interactions were assessed using GLM of SAS. Means differed when P < 0.05. PCST was greater for C2 than C1 suggesting potential carryover effects, thus only C1 data were used to evaluate PCST. There was a line by intake interaction with a reduced PCST during HF for CL (log_e: 1.49^a, 0.85^b, 1.44^a ± 0.11 ng/ml) but not for SL (log_e: 1.58^a, 1.40^a, 1.51^a ± 0.11 ng/ml). Plasma ST at time 0 was similar for C1 and C2 (log_e: 1.40, 1.49 ± 0.05 ng/ml and used for AUC baselines. AUC was greater for C1 than C2 (1896, 1404 ± 138 ng·min·ml⁻¹), less at HF than FF or RF (1895^a, 889^b, 2164^a ± 168 ng·min·ml⁻¹) and did not differ between CL and SL (1501, 1798 ± 140 ng·min·ml⁻¹). Feed deprivation caused a reduction in PCST for CL but not SL heifers and reduced AUC in both CL and SL. Selection for milk yield had no effect on AUC. Results suggest mechanisms in the growing heifer that regulate adaptation of the somatotrophic axis to feed deprivation may be affected by genetic potential for subsequent milk yield.

Key Words: Selection, GRF, GH

1349 Effect of feed intake, bST administration, and genetic potential for milk yield on hepatic IGF-I and growth hormone receptor mRNA in growing Holstein heifers. S. H. Wu^{*}, W. J. Weber, H. Chester-Jones, L. B. Hansen, and B. A. Crooker, Department of Animal Science, University of Minnesota.

Heifers from an unselected (since 1964) stable milk yield line (Control, CL) and a contemporary line (Select, SL) were used to assess effects of selection for milk yield, bST, and energy and nutrient supply on components of the somatotrophic axis. During the 37 d study, heifers (CL: n = 6, 120 ± 5 d old, 116 ± 10 kg BW; SL: n = 7, 124 ± 7 d old, 157 ± 12 kg BW) were fed 150% (d 1 to 18), 100% (d 19), 75% (d 20 to 21), 50% (d 22 to 26), 75% (d 27), 100% (d 28) and 150% (d 29 to 37) of their maintenance energy needs. Heifers received 30 µg bST/kg BW (IM) prior to the a.m. feeding on d 4 to 10. Blood samples were obtained prior to feeding and analyzed for IGF-I. Liver biopsies were collected on d 1, 8, 23, 26, 30, 33, and 36 and analyzed for IGF-I and growth hormone receptor (GHR) mRNA by RPA (reported as pixel densities relative to 18S RNA). Results were analyzed as a repeated measures analyses. Means differed when P < 0.05. Plasma IGF-I was greater in SL than CL heifers (170, 145 ± 4 ng/ml). Effects of bST, feed restriction, and refeeding were similar (223, 202; 65, 40; and 186, 175 ± 7 ng/ml) for each line. Relative to d 1, hepatic IGF-I mRNA decreased during feed restriction and increased with refeeding. There was a strong trend (P = 0.07 for line x day) for a more rapid recovery of IGF-I mRNA in SL heifers. Magnitude of the decrease in IGF-I mRNA (25% of d 1) was similar in CL and SL on d 23 but decreased in CL and increased in SL (13, 54% of d 1) on d 26. On d 30, IGF-I mRNA increased in CL and SL (80, 160% of d 1) and continued to increase through d 36 (160, 200% of d 1). Although not significant (P = 0.14), a similar line x day interaction occurred for liver specific GHR-1A mRNA. GHR-1A but not IGF-I mRNA was decreased by bST. Results suggest mechanisms in the growing heifer that regulate adaptation of the somatotrophic axis to feed deprivation may be affected by genetic potential for subsequent milk yield.

Key Words: Selection, Liver, Somatotrophic axis

1350 Comparison between measurement of parenchymal development of heifer mammary glands by computed tomography and traditional dissection techniques. J. M. Smith^{*1}, S. S. Block¹, N. L. Dykes², D. E. Bauman¹, and M. E. Van Amburgh¹, ¹Cornell University, Ithaca, NY, ²College of Veterinary Medicine, Cornell University, Ithaca, NY.

In conjunction with a study of the effects of feeding diets containing specific fatty acids prior to puberty on mammary development in Holstein heifers, mammary glands were removed and imaged by computed tomography prior to traditional dissection. Pubertal heifers had been fed a ration containing calcium salts of saturated and unsaturated fatty acids at 2.6% DM for an average of 221 d and were, on average, 361 d of age at slaughter. Half-glands from three prepubertal (pre-treatment) and three pubertal heifers were scanned in transverse 2 mm sections, 8 mm apart, by computed tomography (Picker, PQS, Cleveland, OH). Digital images were analyzed using an image analysis program (QuantIm, Zedec Technologies Inc., Durham, NC). Several levels of contrast were selected as criteria for calculating parenchymal area using the program. Areas were converted to volumes by assuming constant area over the distance between scans. Correlations between the mass of dissected parenchyma and the calculated parenchymal volumes were 0.94 and 0.91 when contrast criteria 80 and 90 were used, respectively. Table 1. Age, body weight, days on treatment, parenchymal mass, and parenchymal volume^a of mammary gland halves from six heifers.

	Time	ID	Age, d	BW, kg	D on Trt	Mass, g	Vol 80	Vol 90
PreTrt		B2	134	131.5	0	72	42	39
		B3	132	131.1	0	70	29	27
		B7	153	107.0	0	33	6	5
Post		C3	356	340.6	203	637	452	285
		C6	396	342.0	287	630	636	433
		C10	332	298.5	174	554	717	516

^aVolume in cubic cm calculated with contrast criteria set at value indicated.

Key Words: Dairy heifer, Mammary development, Computed tomography

1351 Effect of feeding a calcium salt of conjugated linoleic acid (CLA) prior to puberty on body composition and mammary development in Holstein heifers. J. M. Smith*, S. S. Block, D. E. Bauman, and M. E. Van Amburgh, *Cornell University, Ithaca, NY.*

Our objective was to determine whether feeding mixed isomers of CLA to Holstein heifers between weaning and puberty would affect body composition and mammary development measured at puberty. Twenty-eight purchased heifers between 3 and 5 mo of age were enrolled. Eight were slaughtered at 134 ± 7 d of age (119.2 ± 4.1 kg BW) for baseline data. The remaining 20 were assigned to either the control diet (CTRL) containing a commercial fat supplement at 2.6% DM or to the diet containing calcium salts of CLA (CLA) at 2.7% DM (total isomers at 1% DM). The diets were formulated to provide 1.01 kg/d ME- and 1.07 kg/d MP-allowable gain (CNCPS v. 4). Heifers were slaughtered during their third estrus cycle. One heifer on CTRL was lost from the study. Days on treatment were 251 and 259 d, respectively, for CTRL and CLA. Age at puberty, BW, body condition, body and mammary composition were analyzed by GLM (SAS System for Windows, v. 8). Significance required $P < 0.05$. Puberty was reached at 347 and 334 d, respectively, for CTRL and CLA ($P > 0.05$). Body weights at puberty (319.4 ± 13.7 kg) and slaughter (357.2 ± 13.1 kg) and body condition (3.16 ± 0.07) were not different. Two body components from CLA were lost. Body and mammary composition were not different between treatments. Fatty acids were extracted and methylated from samples of subcutaneous and mammary fat from all heifers. Component fatty acid profiles were analyzed by gas chromatography (Hewlett Packard, Wilmington, DE). Total CLA isomers were detectable only in samples from CLA. Table 1. Body and mammary composition of heifers slaughtered after puberty.

Component	CTRL	CLA
Total body fat, % dry EBW	57.4 ± 1.2	55.2 ± 0.9
Total body CP, % dry EBW	40.4 ± 1.9	41.9 ± 1.3
Total body ash, % dry EBW	7.9 ± 1.0	8.2 ± 0.3
Mammary half-gland wt, g	1354 ± 206.0	1229 ± 122.9
Parenchyma (half-gland), g	711 ± 82.1	609 ± 55.6
Parenchymal fat, % DM	89.0 ± 0.8	89.2 ± 0.7
Parenchymal CP, % DM	8.8 ± 0.9	9.1 ± 0.8
Parenchymal ash, % DM	0.5 ± 0.07	0.5 ± 0.06

1352 Leptin reduces proliferation of a bovine mammary epithelial cell line (MAC-T). L.F.P. Silva*, M.J. VandeHaar, M.S. Weber Nielsen, and B.E. Etchebarne, *Michigan State University, East Lansing MI.*

High-energy diets promoting body growth rates above 1 kg/d before puberty impairs mammary development. These rapid-growth regimens enable earlier calving but also lead to reduced milk production and increased volume of adipocytes in mammary parenchyma. We hypothesized that leptin, a protein produced by adipocytes, mediates the inhibitory effect of energy on mammary development. Our objective was to determine the effect of leptin on mammary epithelial cell proliferation. MAC-T cells, a bovine mammary epithelial cell line, were seeded onto 24-well plates coated with collagen-I, at a density of 5x10³ cells per well. Initial medium was composed of Dulbecco's Modified Eagle Media/F12 (DMEM/F12) supplemented with 10% fetal bovine serum (FBS). Cells were allowed to attach for 24h. Cells were then washed with Dulbecco's phosphate buffered saline and cultured in serum-free medium (SFM) for 48 h, after which the treatments were added. SFM consisted of DMEM/F12 containing bovine serum albumin (5µg/ml), insulin (1ng/ml), glutathione (1µg/ml), sodium selenite (1ng/ml), and transferrin (5µg/ml). The treatments consisted of increasing doses (0 to 160 ng/ml) of either ovine (oLeptin) or bovine leptin (bLeptin) together with 5 ng/ml IGF-I; or increasing doses of oLeptin (0 to 1,000 ng/ml) together with 1% FBS. Cells were grown in treatment media for three days with [³H]-thymidine present (0.5 µCi/well) during the last day of incubation to measure rate of DNA synthesis. Excess of [³H]-thymidine was removed, cells were lysed, and radioactivity measured in a liquid scintillation counter. Addition of recombinant ovine leptin (oLeptin) to media containing 5 ng/ml of IGF-I decreased cell proliferation linearly. The minimum dose of oLeptin that decreased ($P < 0.05$) cell proliferation was 64 ng/ml (13% decrease). The highest dose of oLeptin (160 ng/ml) decreased IGF-I stimulated cell proliferation by 20% ($P < 0.001$). Similar pattern was obtained using bLeptin. When MAC-T cells were stimulated to grow with 1% FBS, addition of oLeptin at 100 or 1,000

ng/ml decreased ($P < 0.001$) cell proliferation by 27%. We conclude that leptin reduces IGF-I- or FBS-stimulated proliferation of MAC-T cells. We suggest that leptin may mediate the inhibitory effect of high-energy diets on mammary development.

Key Words: Prepubertal, Heifer, Mammary gland

1353 Effect of dietary energy and protein density on body condition and ovarian follicular dynamics in peripubertal dairy heifers. P.K. Chelikani*¹, J.D. Ambrose², and J.J. Kennelly¹, ¹University of Alberta, ²Alberta Agriculture, Food & Rural Development, Edmonton, Canada.

Nutritional regulation of ovarian follicular dynamics in dairy heifers has received little attention. Our objectives were to determine the effects of diets varying in energy and protein levels on body condition and ovarian follicles during the pre and peripubertal period. Thirty Holstein heifers were randomly allotted (n=10/diet) at 100 kg body weight (BW) to either a Low (L: 2.25 ME Mcal/kg DM, 14% CP, ADG 0.5kg/d), Medium (M: 2.50 ME Mcal/kg DM, 16% CP, ADG 0.8kg/d) or High (H: 2.75 ME Mcal/kg DM, 18% CP, 1.1kg/d) diet. Ultrasound imaging of ovaries was performed on alternate days (d) for 22 d at 8 months (m) and for 45 d at 10 m of age (n=5/treatment). Serial blood samples for LH analysis were collected for 8 h at 8 and 10 m. At 1st ovulation, L heifers were 5.9 and 4.4 m older ($P < 0.01$) than H or M heifers, respectively (L: 456 d, M: 324 d, H: 278, SE 16). BW at 1st ovulation did not differ ($P > 0.05$) between treatments (H: 281 kg, M: 282 kg, L: 312 kg, SEM 11 kg). BCS and back-fat thickness (BF) at puberty were lower ($P < 0.05$) in L compared to H or M (BCS L: 2.82, M: 3.20, H: 3.36, SEM 0.09; BF (mm) L: 2.62; M: 2.84; H: 3.36) heifers. Mean concentrations, pulse frequency and amplitude of LH at 8 m did not differ ($P > 0.05$) between treatments. At 10 m, LH pulse frequency was lower ($P < 0.05$), and amplitude greater ($P = 0.06$) in L than H heifers (Pulses/8h: L: 1.17, M: 1.67 H: 2.6 SEM 0.40; Amplitude (ng/ml) L: 1.70, M: 1.14 H: 0.84, SEM 0.32). At 8m, the mean number of follicles #d10mm was lower ($P = 0.08$) in L compared to H or M heifers (L: 0.27, M: 0.43, H: 0.47, SEM 0.07). Maximum diameter (mm) of dominant follicle (DF) at 8m was lower ($P < 0.01$) in L than H or M heifers (L: 11.17, M: 13.00, H: 13.50, SEM 0.52). Size (mm) of the anovulatory DF at 10m was lower ($P < 0.05$) in L than H or M (L: 11.25, M: 12.83, H: 13.40, SEM 0.48). Growth rate (mm/d) of the anovulatory DF was greater ($P < 0.01$) in M than H or L (L: 0.64, M: 1.19, H: 0.67, SEM 0.12) heifers at 10 m. Size of the ovulatory DF was greater ($P = 0.05$) for H than M (M: 11.80, H: 14.90, SEM 0.93) heifers. These findings suggest that diets differing in energy and protein density have a significant influence on body condition, onset of puberty and follicular dynamics during the pubertal transition in dairy heifers.

Key Words: Dairy heifers, Nutrition, Reproduction

1354 Analysis of the spatial, hormonal, and developmental regulation of the estrogen receptor α gene in cattle. M. J. Meyer*¹, R. P. Rhoads¹, A. L. Marr², W. R. Butler¹, Y. R. Boisclair¹, and M. E. Van Amburgh¹, ¹Cornell University, Ithaca, NY, ²Elanco Animal Health, Greenfield, IN.

Estradiol elicits its biological effects by binding nuclear hormone receptors resulting in transcription of estrogen responsive genes. Two subtypes of this receptor, estrogen receptor α (ER α) and ER β , are known to exist. Despite the essential role of estradiol in driving a number of developmental processes, regulation of ER α has not been extensively studied in the bovine. A partial cDNA fragment corresponding to exon 1 of the bovine ER α was amplified by RT-PCR of total RNA extracted from bovine uterine tissue, and used to develop a ribonuclease protection assay (RPA). This assay was used to evaluate the spatial regulation of ER α gene expression in mature Holstein cows. ER α was expressed in the spleen, liver, adipose tissue, ovarian follicle, and uterus, but not in the heart, lung, or kidney. ER α was also expressed in parenchymal and extraparenchymal mammary tissues collected from both pre- and postpubertal Holstein heifers. In order to investigate transcriptional regulation of the ER α gene, nine nulliparous Holstein heifers were ovariectomized (OVX) at 2 years of age. OVX heifers were left untreated (n=3) or received estradiol delivered via an ear implant alone (E; n=3) or in concert with progesterone delivered via an intrauterine implant (E/P; n=3). After nine days of treatment, heifers were slaughtered and uterine tissue was collected for total RNA analysis. Uterine ER α gene expression was 2 fold greater in OVX than in either E and

E/P treated heifers ($p < 0.01$); E and E/P treated heifers did not differ. This RPA will be used to further evaluate the possible role of ER α receptor in regulating important processes such as mammary gland development.

Key Words: Bovine, Steroid, Gene Expression

1355 Effects of chronic in vitro growth hormone treatment on insulin receptor substrates and PI3 kinase in adipose tissue. F. Castro^{*1}, E. Delgado², and D. Lanna², ¹University of California, Davis/ CA/ USA, ²Esalq-USP/ SP/ Brazil.

Growth hormone (GH) has profound effects on carbohydrate and lipid metabolism, including a reduction in adipose tissue sensitivity to insulin. The objective of the present study was to characterize some components that may be involved in the cellular mechanism of this insulin resistance. Concentrations of insulin receptor substrates (IRS) including IRS-1, IRS-3 and phosphatidylinositol 3-kinase (PI3K); phosphorylation of IRS-3; and association of IRS-1/PI3K and IRS-3/PI3K were evaluated in adipose tissue cultured in the absence or presence of GH. Male Wistar rats had their epididymal fat pads removed and placed in medium 199. In a first protocol adipose tissue explants were incubated in medium 199 for 48h with: a) 100 ng/ml of insulin plus 10 nM dexamethasone or b) 100 ng/ml of insulin plus 10 nM dexamethasone and 100

ng/ml of hGH (human GH). The second protocol evaluated the effects of chronic exposure to hGH on adipose tissue response to short-term insulin stimulus. Explants were incubated for 24h in medium 199 with: a) no additions or b) 100 ng/ml hGH. After 24h, half of the explants were stimulated for 20min with 1 μ g/ml of insulin and homogenized in extraction buffer. The concentration, phosphorylation state and association of the proteins were studied using western blots. In adipocytes exposed to hGH for 48 hours, the amounts of the IRS-1, IRS-3 and PI3K decreased by 336% ($P < .01$, $n=6$), 278% ($P < .05$, $n=7$) and 268% ($P < .05$, $n=7$), respectively. Consistent with effects observed after 48 hours, adipose tissue treated with hGH for 24h had concentrations of IRS-1, IRS-3 and PI3K decreased by 294% ($P < .01$, $n=5$), 153% ($P < .01$, $n=8$) and 295% ($P < .01$, $n=6$), respectively. Short-term insulin stimulation increased degree of phosphorylation and associations of IRSs ($P < .01$). Short-term insulin effects were altered by chronic in vitro incubation with hGH, including: amount of phosphorylated IRS-3 was reduced by 286% ($P < .05$, $n=7$), and the amounts of IRS-1 and IRS-3 associated with PI3K were reduced by 4420% ($P < .10$, $n=6$) and 284% ($P < .01$, $n=6$), respectively. Results of this study suggest that chronic GH treatment in vitro alters the early steps of insulin signal transduction in rat adipose tissue, including decreased IRS-3 concentration.

Key Words: Insulin, Growth Hormone, Insulin Receptor Substrate (IRS)

Milk Protein and Enzymes

1356 Characterization of carbohydrate structure of MUC1 and MUCX in porcine and bovine milk by exoglycosidase treatment and lectin blot test. C. Liu*, A.K. Erickson, and D.H. Francis, South Dakota State University, Brookings, SD.

Mucins are glycoproteins characterized by a high level of O-linked glycosylation of their core proteins. Two types of mucins, MUC1 and MUCX, are found to be present in porcine and bovine milk. Little information is available about their carbohydrate portion. This study employed exoglycosidase treatment together with lectin binding studies to determine the carbohydrate structure of MUC1 and MUCX in porcine and bovine milk. Treatment with neuraminidase reduced the mobility of both mucins on SDS gels in both species, indicating the existence of terminal sialic acid (NeuAc) residues; treatment with β -galactosidase had no effect on the mobility of native mucins but decreased the mobility of neuraminidase-treated mucins, suggesting terminal β -D-galactose occurs more commonly in the penultimate position. Twenty five lectins were used to further identify certain carbohydrate structure associated with mucin core proteins. Regardless of species and mucin type, the presence of both N-linked and O-linked oligosaccharide chains was implicated by the binding of Concanavalin A and Jacalin. The presence of terminal N-acetylglucosamine (GlcNAc) was indicated by the binding of soybean agglutinin lectin (SBA) and *Vicia villosa* lectin (VVA), which both bind to MUC1 less strongly than to MUCX, implying a difference in terminal GalNAc abundance. Some carbohydrate structures were found to be species-specific and mucin type-specific. Bovine MUC1 contained exposed β -D-Gal- β (1,3)-D-GalNAc (T antigen) [peanut agglutinin (PNA) binding] while porcine MUC1 did not; terminal α (2,6)-linked NeuAc [elderberry bark lectin (EBL)] was found present in porcine MUC1 while it was lacking in bovine MUC1. Both porcine MUCX and Bovine MUCX contained exposed T antigen structure (PNA binding) and N-acetylglucosamine (GlcNAc) [*Solanum tuberosum* lectin (STL) binding]; however, bovine MUCX had α (2,6)-linked NeuAc [*Maackia amurensis* lectin II (MAAL II)] and terminal α (2,6)-linked NeuAc which were absent in porcine MUCX. The complexity and diversity of mucin glycosylation imply the functional importance of mucin carbohydrate. Further studies on the carbohydrate structure of milk mucins may contribute to an understanding of their possible functions between mother and young.

Key Words: Bovine milk mucins, Porcine milk mucins, Carbohydrate structure

1357 Structural studies of bovine β -casein by CD, FTIR and molecular modeling. P. X. Qi* and H. M. Farrell, Jr., USDA-ARS-ERRC, Wyndmoor, PA, USA.

The caseins of milk form micelles to carry the otherwise insoluble calcium and phosphate which are indispensable nutrients for humans. To

better understand the molecular basis for the calcium-phosphate transport complex, we studied the major component of this complex: β -casein. The assumption that β -casein is β -helix remains controversial. In this work, we report our studies on the association reaction of β -casein to address the question of whether or not a conformational change in the monomer precedes aggregation, or occurs as a result of aggregation. Circular dichroism (CD) and Fourier transformation infrared (FTIR) spectroscopies were used to investigate the temperature-induced changes in the secondary structure of the β -casein under physiological relevant conditions (water, pH and low ionic strength). The degree of self-association under these conditions was assessed by analytical ultracentrifugation. CD and FTIR spectroscopies, as well as secondary structure predictions suggest the possible existence of polyproline II left-handed helices in β -casein. These short helices may play an important role in the self-association process. Furthermore, CD and FTIR results show that the β -casein may fold considerably prior to self-association, but may further respond to close packing in the polymer. The binding of β -casein to hydrophobic probe 1-anilino-8-naphthalenesulfonate (ANS) indicates it may be a molten globule-like protein. Molecular modeling techniques were used to not only generate a three-dimensional structure but also provide dynamic information for the self-association process as well as its function in calcium transporting.

Key Words: β -Casein, Structure, Polyproline II

1358 Conformational change in alpha-lactalbumin produces an alternative biological function. K Stokes and B Alston-Mills*, North Carolina State University, Raleigh, North Carolina, USA.

Research within the past 10 years has suggested that the structure of alpha-lactalbumin is essential to its function, both as the modifier protein in the lactose synthase complex and as a modulator of mammary epithelial cell (MEC) proliferation. To directly test this hypothesis, we treated 3 mammary cell lines with 5 lots of bovine alpha-lactalbumin that differed in purity and tertiary conformation. Protein purity was determined by one- and two-dimensional PAGE and UV-spectroscopy and protein fold was determined by both fluorescence and circular dichroism. Two lots were purchased from Sigma (98H7003 and 99H7029) and used without further purification. PAGE revealed several minor impurities in lot 98H7003, but the major species was alpha-lactalbumin. Two wild-type (wt) recombinant lots were expressed, folded and purified: lot wt01 was pure and correctly folded and lot wt02 was pure, but misfolded. A third recombinant protein, D87A, was pure, but unable to bind calcium and lacked a well-defined tertiary structure. Correctly folded native alpha-lactalbumin (99H7029) and wild-type (wt01) and mutant (D87A) recombinant proteins did induce inhibition of MEC

proliferation. Only the misfolded native (98H7003) and wild-type recombinant (wt02) proteins significantly inhibited the proliferation of the MECs (95% confidence). After 24 hour treatment with the misfolded, native protein (1mg/ml), cell proliferation was reduced by 87%, 90% and 14% in the MCF-10a, MCF-7 and MDA-MB-231 cell lines, respectively. Moreover, recombinant lot wt02 (1mg/ml) also significantly inhibited the proliferation of MCF-10a and MDA-MB-231 by 12% and 21%, respectively. Circular dichroism revealed that wt02 had increased helical content which greatly contributed to its altered secondary structure. Alpha-lactalbumin protein in native and various non-native conformations have been isolated from various milks. The data presented here is in agreement with published reports and suggest that changes in the secondary of alpha-lactalbumin can produce a conformation that modulates cell proliferation *in vitro*.

Key Words: alpha-lactalbumin, protein conformation, cell proliferation

1359 Estrogen response of the human lactoferrin promoter in mammary gland cells. K Stokes¹, C Teng², and B Alston-Mills^{*1}, ¹North Carolina State University, Raleigh, North Carolina USA, ²National Institutes of Environmental Health Sciences, Research Triangle Park, North Carolina USA.

It is well documented that the expression of *lactoferrin* in the uterus is induced by estrogen. However, little data is available concerning the regulation of *lactoferrin* expression in the mammary gland. We employed transient transfection assays using mammary epithelial cell lines (MEC) to determine whether diethylstilbestrol (DES), a potent environmental estrogen, could stimulate human *lactoferrin* promoter activity *in vitro*. The estrogen response is mediated by the estrogen receptor (ER) through the estrogen response element (ERE) an possibly the estrogen receptor related receptor (ERR) through the steroid factor response element (SFRE). We demonstrated expression of these receptors in the human MECs MCF-7 and MCF-10a using RT-PCR methods. Both cell lines endogenously express ERR-alpha but only the MCF-7 cells express ER-alpha. Co-transfection of the reporter constructs and the ER-alpha expression vector, followed by 24 hour DES (10nM) treatment stimulated *lactoferrin* promoter activity by 7-fold in the MCF-7 cells and 3-fold in the MCF-10a cells. Mutational analysis of the potential cis-regulatory elements revealed that both elements are essential for maximal estrogen response. Mutation of the ERE decreased DES-induced promoter activity to 3-fold in MCF-7 cells and mutation of the SFRE completely abolished DES-induced promoter activity. The same trend was observed in the MCF-10a cells. These data suggest that *lactoferrin* is an estrogen-inducible gene in the mammary gland as well as the uterus and support recent reports of cross-talk between ER and ERR during estrogen signaling.

Key Words: human lactoferrin, gene regulation, diethylstilbestrol

1360 Disulfide bonding patterns between β -lactoglobulin and κ -casein in a heated and spray-dried milk-model. A. Bienvenue^{*1}, C.S. Norris², M.J. Boland², L.K. Creamer², and R. Jimenez-Flores¹, ¹DPTC, California Polytechnic State University, San Luis Obispo, CA, ²New Zealand Dairy Research Institute, Palmerston North, New Zealand.

The heat treatment used during the manufacturing of milk powder causes protein interactions that define functionality (Singh, H. & Creamer, L.K. 1991). Moreover, the genetic variant of β -lactoglobulin (β -LG) in homozygous milk influences dramatically its properties during heat processing (Hill, J.P. et al. 1998, US Patent 5,850,804). To better understand the effects of processing on the functionality of milk powder we characterized at the molecular level the protein-protein interactions after heating and drying. The objective of the project was to determine the position of the heat-induced disulfide interchange between β -LG and κ -casein (κ -CN). The powder sample was produced in the pilot plant of the Cal Poly DPTC in San Luis Obispo, CA. A simplified milk system was created by mixing affinity-purified β -LG (β -LG genetic variant AB) to casein micelles obtained by filtration of raw milk (κ -CN variant AA; β -LG variant BB) through a 0.1mm pore size ceramic membrane. The mixture was heated at 90°C for 15 minutes and spray dried. The high molecular weight molecules were segregated by size exclusion chromatography (Rasmussen, L.K. & Petersen, T.E., 1991), identified by SDS-PAGE, and hydrolyzed by trypsin. The native and disulfide-bond-reduced hydrolysates were analyzed by HPLC-MS at the NZDRI Palmerston North, NZ. Our SDS-PAGE analysis shows that we isolated

a disulfide-linked protein polymer that contained predominantly κ -CN and β -LG. By comparing our mass spectroscopy results to tryptic digest data banks; we identified 42 peptide fragments including 11 disulfide-linked peptides. We identified three different types of disulfide links: 1) The expected (Rasmussen et al. 1992) intermolecular bridges between two κ -CN molecules connected κ -CN Cys11 to κ -CN Cys11 and κ -CN Cys88 to κ -CN Cys11. 2) The heat induced association of two β -LG linked β -LG AA Cys66 to β -LG BB Cys106/119/121 and β -LG Cys160 to β -LG BB Cys106/119/121. 3) The heat-induced covalent bonding between β -LG and κ -CN involving κ -CN Cys88 to β -LG Cys66, κ -CN Cys11 to β -LG Cys160, and κ -CN Cys11 to β -LG BB Cys106/119/121. These peptides aid in the elucidation of protein interactions in dried milk.

Key Words: Heat-interactions, Disulfide bonds, Milk Powder

1361 Interactions between β -lactoglobulin and xanthan gum studied by capillary electrophoresis. M. Girard^{*}, S.L. Turgeon, and S.F. Gauthier, Université Laval, Québec, Canada.

Protein-polysaccharide interactions are of great interest to the food industry. The polysaccharide xanthan gum is often incorporated in dairy products and can interact, under certain conditions, with β -lactoglobulin, the major whey protein. Because these interactions can influence the behaviour of the biopolymers, they must be investigated. The aim of this work was to determine the strength and nature of the interactions under different conditions. A capillary electrophoresis technique has recently been developed to measure the interactions between homogeneous molecular weight polymers. This technique, known as Frontal Analysis Continuous Capillary Electrophoresis (FACCE), has been applied successfully to the study of interactions between xanthan gum, a heterogeneous biopolymer, and β -lactoglobulin. With FACCE technique, it was possible to determine precisely the amount of proteins that was not bound to the xanthan gum. The pH values studied were 5 and 6. The impact of the molecular weight on the interactions was assessed using native (5.36×10^7 Da) and microfluidized (3.25×10^7 Da) xanthan gum. Binding constants and binding site sizes were obtained with modified Scatchard plots. The binding constants were 8.96×10^4 M⁻¹ and 5.11×10^4 M⁻¹ for β -lactoglobulin/xanthan gum and 7.49×10^3 M⁻¹ and 3.08×10^3 M⁻¹ for β -lactoglobulin/microfluidized xanthan gum, at pH 5 and 6, respectively. The effect of the pH on the binding constants revealed the existence of electrostatic interactions between the biopolymers. Lower molecular weight xanthan gum had weaker interactions with β -lactoglobulin. The shape of the binding isotherms showed that the xanthan gum became saturated with proteins at a 10/1 protein/polysaccharide ratio.

Key Words: β -lactoglobulin, Xanthan Gum, Interactions

1362 Coisolation of Plasmin/Plasminogen with Xanthine Oxidoreductase. D.A. Clare^{*}, G.L. Catignani, and H.E. Swaisgood, Southeast Dairy Foods Research Center, Dept. of Food Science, NCSU, Raleigh, N.C.

Bovine milk xanthine oxidoreductase (XOX/XDH) was purified from fresh cream using a new combination of experimental methods. The initial goal was to maximize retention of xanthine dehydrogenase (XDH) activity during this process; thus, we added 50 mM dithiothreitol (DTT) at the beginning step. Ion exchange chromatography was performed using DEAE and hydroxyapatite resins, respectively. Peak protein fractions, as determined by measuring the A_{280nm} of the eluate, were evaluated for their purity by SDS-PAGE. XDH activity was monitored using hypoxanthine and nitro blue tetrazolium (NBT). Additional assays, with xanthine and nicotinamide adenine dinucleotide (NAD⁺), were also made with the most highly purified samples. Xanthine oxidase (XOX) activity was detected using hypoxanthine and molecular oxygen. Over time, we noted the slow appearance of smaller molecular weight protein bands, and their numbers increased during storage at refrigeration temperatures even in the presence of a high salt concentration (0.2M). We tested these samples for protease activity using polyacrylamide gels that were incorporated with casein. These zymograms (InVitrogen, Inc.) also contained an azure dye in the background of the gel to contrast the cleared zone produced by hydrolysis of casein. We have identified plasmin (PL) and plasminogen (PG) in most of the highly active XOX/XDH fractions using Western blotting techniques and an antibody specific for plasminogen. Plasmin enzymatic activity was measured using the substrate, tosyl-glycyl-prolyl-lysine-4-nitroaniline acetate (Chromozym PL

kit; Roche, Inc.). Three commercial preparations of XOX were also assayed for the presence of PL/PG, and each showed varying degrees of copurification as defined by the ratio of XOX to PL activity. The implications of these findings will be presented.

Key Words: Enzymes, Milk Proteins, Protease Activity

1363 Identification of catalytic amino acid residues at the active site of mouse glucosidase II. Jie Feng¹ and Inder K. Vijay^{*1}, ¹University of Maryland.

Following the action of glucosidase I to clip the terminal α 1,2-linked glucose, glucosidase II sequentially cleaves the two inner α 1,3-linked glucosyl residues from the oligosaccharide, Glc α 1,2Glc α 1,3Glc α 1,3Man9GlcNAc2, of the incipient glycoprotein during its biosynthesis. A model has been proposed in which the action of glucosidase II, in conjunction with calnexin and calreticulin, has been shown to facilitate the proper folding of N-linked glycoproteins in the secretory pathway. The enzyme is a heterodimeric protein in which α subunit has the catalytic activity, while β subunit provides the ER localization signal. Sequence alignments and analysis showed that the enzyme belongs to the glycoside hydrolase Family 31 with a putative active site that contains the DMNE motif. To obtain experimental evidence in support of this hypothesis, mouse glucosidase II gene was used to express the enzyme as a histidine-tagged fusion protein in Sf9 insect cells. The enzyme was expressed by co-infecting the cells with recombinant baculoviruses containing the genes of α and β subunits, and partially purified by Ni²⁺-agarose affinity chromatography. The enzyme expressed as fusion protein is catalytically active. It is a high mannose glycoprotein as it bound to concanavalin A-Sepharose beads, and its electrophoretic mobility was altered by treatment with endoglycosidase H. A total of nine mutations were carried out in the DMNE motif. The D564N, E567Q and scramble mutants completely lost the enzyme activity, while the other mutants, D564E, E567D, M565N566/AA, D-E-exchange, MN/AA-D-E-exchange, and F571A retained over 70% of the enzyme activity. The results indicate that the D564MNE567 motif is within the active site of the enzyme and Asp564 and Glu567 represent the acid-base catalyst. This work was supported by N.I.H. grant GM59943.

Key Words: glucosidase II, active site

1364 Stimulation of the functional expression of glucosidase I by calnexin and identification of catalytic amino acids at its active site. Xiaio-Lian Zhang¹ and Inder K. Vijay^{*1}, ¹University of Maryland.

The cDNA of rat glucosidase I was incorporated in-frame into pcDNA3.1A (-) MycHis and pBlueBacHis2A and expressed in COS7 and Sf9 cells, respectively. The fusion protein of the enzyme was expressed as a doublet of 93 and 95 kDa, which merged into a single 93 kDa polypeptide after deglycosylation with N-glycanase. The expressed fusion proteins had low catalytic activity. It was speculated that incomplete folding may be the cause. Co-expression of several molecular chaperones was investigated to enhance folding of the over-expressed enzyme. Among the chaperones examined, calnexin gave the best results. A physical association between calnexin and glucosidase I was shown by co-immunoprecipitation of both the enzyme and calnexin from cell lysates. Mutational analysis of amino acid residues within the previously-proposed substrate-binding, #glucosyl motif#, E592RHLD596LRCW, showed that aspartate and glutamate within this motif serve as the acid-base pair for the catalytic activity of the enzyme. Importantly, a double switch mutation, in which the positions of aspartate and glutamate within the motif are exchanged, retains full enzyme activity. Thus, the active site is flexible and engages in a dynamic interaction with the substrate. Glucosidase I cloned in higher eukaryotes also shows a highly conserved N-glycosylation sequon, NHT in close vicinity to the glucosyl motif. Mutation of asparagine to glutamine in this sequon of rat cDNA of the enzyme gave expression to non-glycosylated protein in COS7 cells. The non-glycosylated mutant enzyme still retained >90% of the activity of the WT enzyme, consistent with our earlier observation on the enzyme purified from the rat mammary gland. Calnexin has been reported to be a lectin-chaperone and shown to interact primarily with the glucose-containing oligosaccharide of nascent glycoproteins. Significantly, it was shown to associate with

the non-glycosylated form of the enzyme, albeit weakly. (Supported by N.I.H. grant GM59943 and CGP of MAES).

Key Words: glucosidase I, active site

1365 Photoaffinity labeling of the active site of glucosidase I. A.V. Romaniouk¹, A. Silva¹, and I.K. Vijay^{*1}, ¹University of Maryland.

N-glycosylation represents one of the most common protein modifications of eukaryotic cells. Regulation of glycosylation is critical for normal physiology and for many pathological conditions. Glucosidase I (Glc I) clips the terminal α 1,2-linked glucose of Glc3Man9GlcNAc2-polypeptide and triggers the post-translational folding and maturation of the incipient N-linked glycoprotein. It is, therefore, critically positioned to control the assembly of this important class of glycoproteins. Our laboratory has been investigating the biosynthesis and regulation of mammary glycoproteins for a number of years. Recently, we identified and proposed ERHLDLRCW as the substrate binding motif in the active site of mammalian glucosidase I. To probe the active site of the enzyme, we synthesized several novel photoactive reagents of 1-deoxynojirimycin (DNM); N-alanyl DNM, N-glycyl-DNM, N-carboxyethyl-DNM and the photoactive compound (4-[p-azidosalicylamido]butylamido-pentyl-1-DNM (ASBA-P-DNM). All DNM compounds were analyzed as potential inhibitors of Glc I, and ASBA-P-DNM was shown to be the most effective inhibitor of the enzyme. [I125]ASBA-P-DNM was used to photo label the purified Glc I enzyme from the bovine mammary gland. Mass spectroscopic analysis of the specifically tagged peptide of Glc I along with the information from the cDNA sequence and the substrate-binding motif will be used to map the architecture of the enzyme. (Supported by NIH grant GM59943)

Key Words: glucosidase I, photoaffinity labeling, active site

1366 Molecular models for bovine α _{s2}-casein. P.D. Hoagland* and H.M. Farrell, Jr., USDA ERRC, Wyndmoor PA.

To enable future molecular modeling of the casein sub-micelle, models for α _{s2}-casein were constructed to complement existing models for α _{s1}-, β -, and κ -caseins. Predicted helical structure, based on theoretical and experimental evidence, was used to organize the secondary structure of the seed model into five domains. Each domain was modeled using standard minimization and dynamics methods to first identify possible local interactions. The entire protein was then modeled using a negatively charged N-terminal domain [f1-f75], a spacer helix [f76-f90], a neutral hydrophobic domain [f91-f128], a polar/ionic [f129-f143] domain, a long spacer helix [f144-f176], and a positively charged C-terminal domain [f177-f207]. The models favored electrostatic interactions between the positive C-terminal domain with the negative N-terminal domain. These interactions arose from phosphoserine-arginine/lysine ionic pairs. They contributed greatly to the large negative minimization energy. The central hydrophobic domain [f91-f128] was directed to the exterior by its neighboring short spacer helix. An internal disulfide bond between Cys36 and Cys40 did not significantly alter the secondary structure of the N-terminal domain. This bond was located in an exterior loop that formed as a result of neighboring phosphoserine cluster, [f56-f58, f61], interactions with the local Arg45 and distant Arg160, Arg170 and Arg207. In general, ionic interactions observed in models built *in vacuo* persisted after solvation with water. The organization of these domains can be expected to contribute to the observed functional properties of α _{s2}-casein. Through ionic interactions, it can self-associate or form tight complexes with the other casein proteins. In the presence of Ca⁺⁺ α _{s2}-casein can help assemble and stabilize casein sub-micelles through its 2 clusters of phosphoserine in the N-terminal domain.

Key Words: α _{s2}-casein, molecular model, phosphoserine

1367 Effect of sugars on milk protein gels and stabilized-milk protein emulsion gels. L Matia* and E Dickinson, University of Leeds, Leeds, U.K.

The effect of sugars in dairy products and their aggregation processes needs further investigation to improve the understanding on interrelations among water, proteins, lipids and sugars used in so many formulations. The influence on rheological and microstructural properties of sucrose (0-66% w/v) or a mixture of sucrose + glucose (76% w/v) in the aqueous phase of oil-in-water emulsions and emulsion gels based on sodium caseinate (1.4% w/v) at *n*-tetradecane (30% v/v) has been investigated. The influence of sucrose (0-70% w/v) on pure caseinate gels (3%

w/v) has also been studied. The development of a three-dimensional network, following slow acidification on addition of glucono- δ -lactone granules (0.3 g GDL / g protein), was followed through the resulting increase in the small-deformation shear moduli (G' and G'') at 25.0°C. Sugar concentrations greater than 60% w/v led to larger emulsion droplets. Added sugar was found to increase substantially the elastic modulus and to reduce gelation times in all cases for emulsion and protein gels, especially at a high sugar /protein ratio. Sugar was also found to affect the large deformation rheology, promoting strain-weakening and a shorter linear regime. Confocal scanning laser microscopy has been used to detect the emulsion droplet network (dyed with Nile Red) or the caseinate network (dyed with Rhodamine B). High sucrose concentration seemed to affect the microstructure of emulsion and protein gels, leading to a more uniform network compared to sugar-free systems. In general, the pore size distribution of caseinate gels decreased with increasing sucrose concentration and different correlations from image analysis have been obtained.

Key Words: Sugar, Acid-induced gelation, Caseinate gels

1368 Impact of genetic variants of β -lactoglobulin on their binding capacity to peptide β -LG 102-105. I. Noiseux*, S.L. Turgeon, and S.F. Gauthier, *Centre STELA, Université Laval*.

In previous work, it was demonstrated that some peptides can bind to β -lactoglobulin (β -LG) under specific physicochemical conditions, and that material absorbing at 214 nm was released from the protein following its interaction with hydrophobic peptides β -LG 102-105 and α -S1-CN 23-34. The aim of the present study was to evaluate the binding capacity of β -LG AB, A and B for the peptide β -LG 102-105, an hydrophobic peptide of 554.7 Da. This peptide (1000 μ M) was combined with three concentrations (0, 50 and 100 μ M) of β -LG A, β -LG B and two different mix of β -LG AB, using different physicochemical conditions: pH 6.8 and 8.0, temperature of 25 and 40°C, and buffer molarity of 0.05 and 0.10 M. After overnight contact between β -LG and peptide, solutions were filtered (Microcon, MWCO 10 kDa) and the amount of unbound peptide was quantified by RP-HPLC (column C-18). Results indicated that β -LG variant A bound 16 to 92% of the peptide β -LG 102-105 depending of physicochemical conditions under study, whereas the binding capacity of β -LG B and β -LG AB for this peptide varied from 0 to 48%. All the β -LG variants led to the release of material absorbing at 214 nm following their interaction to the peptide, but material released from β -LG A was different than those observed for variant B or for the mix AB. The higher binding capacity of β -LG A compared to β -LG B could be explained by the different conformation of the EF loop adopted by these variants at neutral pH.

Key Words: β -Lactoglobulin, Variant, Peptide

1369 Study on the molecular mass changes of bovine k-casein glycomacropeptide and on its separation in ultrafiltration with and without application of electric fields. M.-J. Michel*, Y. Pouliot¹, M. Britten², I. Noel¹, and R. Lebrun³, ¹Dairy Research Center STELA, Université Laval, ²Food Research and Development Center, FRDC, ³Laboratory of engineering of membrane process, UQTR.

Glycomacropeptide (GMP) constitutes a potential ingredient for the development of functional foods or nutraceuticals. The use of membrane separations for the purification of GMP at large scale is however limited by the heterogeneity of its molecular mass. GMP has a molecular mass of 7 kDa but polymeric forms of GMP can have mass greater than 40 kDa. Variations of the molecular weight of GMP must be limited in order to facilitate its passage on the side permeate during the ultrafiltration of whey. The objective of our work was to identify the physicochemical conditions limiting polymerization. GMP was prepared from the hydrolysis of sodium caseinate by chymosin (60 min, 35°C, pH 6.6). The enzymatic reaction was stopped by an adjustment at pH 4.6 and a heating (1 min, 80°C). The peptide was filtered, dialyzed (MWCO 3.5 kDa) and freeze-dried. An isoelectric point of 4.18 was determined experimentally. The molecular association behavior of GMP was studied as a function of its pH (3.5 to 7.5), ionic strength (0.02 to 0.14), temperature (5, 25 and 50°C) and peptide concentration (0.15 to 2.00% w/v). Size exclusion chromatography (HPSEC) showed that the size of the GMP was minimal at pH lower than 4.0, at 50°C and at ionic strength of 0.14. Various fractions separated by HPSEC were analyzed in reversed phase chromatography (RP-HPLC). No evidence was found

that the associative behavior of GMP would be related to its level of glycosylation. Model solutions of 0.1% (w/v) GMP at pH 3.0 and 4.6 were ultrafiltered using 10 or 30 kDa UF-membranes. Superimposing an electrical field (20 or 40 V/m, anode on the permeate side) at pH 3.0 and 4.6 had limited impact on the transmission of GMP but improved UF-flux.

Key Words: glycomacropeptide, ultrafiltration, electric fields

1370 Characterization of heat-induced whey protein-anionic surfactant complexes. H.J. Giroux* and M. Britten, *FRDC, Agriculture and Agri-Food Canada, St-Hyacinthe, Qc, Canada*.

Low molecular weight surfactants interact with proteins and modify their structure, thermal stability and functional properties. Three anionic surfactants (sodium dodecyl sulfate (SDS), sodium stearyl-2 lactylate (SSL) and diacetyl tartaric acid ester of monoglyceride (DATEM)) were mixed with whey protein dispersions at concentrations ranging from 0 to 640 μ mol/g protein. Thermal behavior was studied by differential scanning calorimetry at pH 7.5. Protein surfactant mixtures were heated at 75°C for 30 min (pH 7.5) and the resulting complexes were analyzed. Zeta potential was determined by microelectrophoresis. Surface tension was measured using du Nouy ring method. Protein solubility profile was established between pH 2 and 6. Denaturation temperature of whey protein increased with anionic surfactant concentration and reached a plateau value at concentrations larger than 80 μ mol/g protein. Maximum denaturation temperatures for protein dispersions mixed with SDS, SSL and DATEM were respectively 85.0 \pm 0.3, 81.7 \pm 0.7 and 77.4 \pm 0.6°C. Zeta potential of heat-induced complexes decreased with increasing surfactant concentration and leveled off at concentrations larger than 320 μ mol/g protein. The surface tension of mixed dispersions, was measured as a function of surfactant concentration. The profiles before heating showed a transition associated with the unfolding of the protein structure. After heat treatment, this transition disappeared except for low protein concentration. Heat induced complexes showed low solubility between pH 4.8 and 5.4. The pH where minimal solubility occurred shifted to lower values when the concentration of surfactant increased. This shift resulted from the effect of negatively charged surfactants on the isoelectric point of complexes. The high pH portion of the solubility profile suggests that DATEM, unlike SDS or SSL, does not adsorb extensively to whey proteins. Our results confirm that hydrophobic interactions is the main factor responsible for the formation of heat-induced complex between whey protein and anionic surfactants.

Key Words: Whey protein, Surfactants, Heat

1371 Characterization of bovine lactoferrin isolates by cation-exchange chromatography. G. Brisson*,¹ M. Britten², and Y. Pouliot¹, ¹Dairy Research Centre (STELA), Laval University, Quebec (Quebec), Canada, ²Food Research and Development Centre (FRDC), St-Hyacinthe (Quebec), Canada.

Lactoferrin isolates (>85% of total proteins) are sold as bioactive components for use as nutraceuticals. Lactoferrin is an iron-binding glycoprotein that can be purified from bovine milk or from cheese whey. Two isomeric forms of lactoferrin have been reported in bovine milk, revealing differences in one glycosylation site. The objective of the present work was to investigate the performance of a cation-exchange chromatography technique using a S-HyperD column for the characterization of the lactoferrin profile in bovine commercial lactoferrin isolates. The lactoferrin elution profile was obtained using a 50 mM phosphate buffer (pH 7.0) with a sodium chloride (1.0 M) sequential step gradient. Three commercial bovine lactoferrin isolates were studied and each was fully separated into three main peaks. Peak fractions were analyzed by sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE) and reverse phase chromatography (RP-HPLC) and all three peaks were identified as lactoferrin. The first two peaks are associated to the two different glycosylated isomeric forms of lactoferrin in milk, as assessed by SDS-PAGE. The third peak detected is corresponding to another lactoferrin molecular form. The nature of this form needs to be further investigated but we suggest that is corresponding to differences in lactoferrin glycosylation level, possibly related to the raw material used for the purification. The experimental conditions used in our study have allowed the detection of minor fractions of lactoferrin isomeric forms.

Key Words: Lactoferrin, Cation-exchange chromatography

1372 Effect of calcium on reaction products released during thermolysin hydrolysis of tryptic peptides from β -casein. J.-F. Lapointe^{*1}, G. Henry², D. Molle², S.F. Gauthier¹, and Y. Pouliot¹, ¹Centre de recherche STELA, ²INRA, Laboratoire de Recherches de Technologie Laitiere.

Thermolysin is a metalloendopeptidase that requires calcium to maintain its structural stability. The objective of this study was to evaluate the effect of calcium ions on the reaction products released during thermolysin hydrolysis of tryptic fragments from β -casein. Tryptic fragments β -CN 1-25 and β -CN 29-99 were isolated from a tryptic hydrolysate of purified β -casein. Both fragments were solubilized (2 mg.ml⁻¹) in water or Tris buffer (50 mM) added with CaCl₂ (0.1 and 10 mM), then hydrolysed at 40°C with 0.01% of thermolysin. During hydrolysis, aliquots were taken over a 24 hours period and reaction products were identified by mass spectrometry (LC-MS and MS-MS). Results indicated that calcium ions enhanced the kinetics of reaction, and modified the peptidic profile resulting from thermolysin hydrolysis of both fragments. Specifically, the sequence β -CN 6-22 which contains 4 phosphoserine residues was found in higher proportion in hydrolysate prepared without calcium than in its presence. Also, the presence of calcium seemed to promote the cleavage of the peptidic bound E₁₁-I₁₂, yielding to large amount of the sequence β -CN 6-11. Binding of calcium ions to phosphoserine residues thus could influence the attack of β -casein by thermolysin and might be used to produce specific peptide sequences during hydrolysis of β -casein with thermolysin.

Key Words: β -casein, Thermolysin, Enzyme specificity

1373 Use of a model system to determine the effects of milk protein and denatured whey protein concentrations on mass balance during cheese making. N. Remillard^{*1}, G. Trudeau², and M. Britten, ¹FRDC, Agriculture and Agri-Food Canada, St-Hyacinthe, Qc, Canada, ²Agropur, Granby, Qc, Canada.

The distribution of milk constituents between cheese and whey is a critical issue for cheese factories. A laboratory scale model system has been

developed in order to determine mass balance during cheese making. Coagulation vats (12 x 12 cm) with 144 ml capacity were used. A cutting device made of 11 parallel and equally spaced blades produced 1 cm³ identical coagulum cubes. Curd cooking was performed by placing vats in a water bath under orbital stirring. A screen was placed between the vats and the covers; reversing the vats allowed whey drainage and curd recovery. Drained curds were centrifuged for a second whey extraction. Total mass recovery averaged 98.6%. Composition analyses of cheese milks and wheys allowed calculation of protein and fat retention coefficients. The model system was used to study the effects of milk protein (MP) concentration and the addition of denatured whey protein (DWP) on Mozzarella cheese mass balance. Skim milk true protein concentration was adjusted between 2.7 and 3.3% by the addition of milk ultrafiltration retentate or permeate. Whey protein concentrate was heat denatured, homogenized and added to milk at levels ranging from 0 to 0.3% on a true protein basis. The fat to protein ratio was standardized to 1.4 with cream. Cheese milks were prepared according to a split plot factorial design (2⁴) repeated four times. Cheese moisture increased from 44.4 to 46.7% when 0.3% DWP was added to milk. Adjusted yield (Y) increased linearly with MP concentration (dY/dMP = 3.2) and DWP level (dY/dDWP = 1.8). However, adjusted yield leveled off with DWP higher than 0.2%. When MP concentration was higher than 3.0%, protein retention was not affected by DWP. However at lower MP concentration (2.7%), increasing DWP level reduced protein retention coefficient (from 0.799 to 0.792). Lipid retention tended to increase with increasing MP concentration, which explains the strong effect of MP concentration on adjusted yield compared to the effect of DWP.

Key Words: cheese, mass balance, whey protein

Nonruminant Nutrition

Phytase, Other Enzymes, and Mineral Nutrition

1374 Characteristics of phytase secreted in saliva of the transgenic enviro-pigTM. M. Cottrill, J. P. Phillips, R. G. Meidinger, M. Z. Fan, R. R. Hacker, and C. W. Forsberg^{*}, University of Guelph, Guelph, Ontario.

The Enviro-pigTM produces a salivary phytase enzyme encoded by the AppA phytase gene from *Escherichia coli*. The objective of this research was to compare the biochemical and catalytic properties of the pig salivary phytase with those of the phytase produced from the same gene expressed in *E. coli*. The phytase in saliva of a transgenic phytase pig from a representative transgenic line and the one from *E. coli* were purified to homogeneity by a series of chromatographic steps and their properties compared. As previously reported the salivary phytase was glycosylated with a molecular mass of 50,844 Da while that produced by *E. coli* was unglycosylated with a mass of 44,708 Da. The salivary phytase exhibited K_m and V_{max} values of 0.27 ± 0.02 mM and 1,400 ± 30 μ mol.(mg protein)⁻¹.min⁻¹, respectively, for the hydrolysis of phytate while the phytase produced in *E. coli* exhibited K_m and V_{max} values of 0.29 ± 0.03 mM and 1,775 ± 50 μ mol.(mg protein)⁻¹.min⁻¹, respectively. The K_m values were similar but the V_{max} values were different (P > 0.05). Both enzymes hydrolyzed phytate with maximum activities at pH 4.5, and both initially cleaved the 6-position of phytate and formed the same intermediate inositol phosphate degradation products. The salivary phytase and the *E. coli* phytase were stable in the presence of pepsin in buffered solutions at pH values of 1.5 and above, but both enzymes lost activity in the presence of stomach contents at pH 1.5, but not pH 2.0 suggesting the presence of a stabilizing factor active in stomach contents at low pH. Because stomach contents are at a pH value above 2.0 during feed consumption and digestion, inactivation of phytase below pH 2 is not a serious concern under normal physiological conditions.

Key Words: Phytase, Saliva, Enviro-pigTM

1375 Phosphorus associated with soybean meal is completely digested and absorbed in the transgenic phytase growing-finishing enviro-pigTM. A. Ajakaiye^{*}, M. Z. Fan, C. W. Forsberg, J. P. Phillips, R. G. Meidinger, M. Z. Weiderkehr, T. Archbold, S. P. Golovan, R. R. Hacker, and D. Barney, University of Guelph, Guelph, Ontario, Canada.

The objectives of this study were to compare true phosphorus (P) digestibility and the endogenous P outputs between the transgenic growing-finishing enviro-pigTM and the non-transgenic growing-finishing pig by regression analysis technique. Four transgenic G₁ phytase pigs, with average initial and final BW of 31 and 51 kg respectively were fitted with a simple T-cannula at the distal ileum and fed four diets according to a 4 x 4 Latin square design. The diets were cornstarch-based and contained four levels of P (0.99, 1.95, 2.94 and 3.96 g/kg DMI) from soybean meal (SBM). Chromic oxide (0.35%) was added as a digestibility marker. Each experimental period consisted of 8 d with 4-d adaptation and 4-d collection of salivary juice, ileal digesta and fecal samples. There were no effects (P > 0.05) of diets and periods as well as circadian rhythm (am vs. pm) on salivary phytase activity (102.8 ± 48.9 - 104.6 ± 69.3 μ mol/mg protein/min). Compared with the results of the non-transgenic growing-finishing pig reported in our previous studies (Ajakaiye *et al.*, 2001, J. Anim. Sci. 79 suppl. 1, 397), there were differences (P < 0.05) in true ileal (108.5 ± 3.7 vs 59.0 ± 8.3%) and fecal (101.9 ± 3.9 vs 51.3 ± 7.9%) P digestibility values in SBM. However, there were no differences (P > 0.05) in the ileal (0.58 ± 0.09 vs 0.58 ± 0.18 g/kg DMI) and the fecal (0.66 ± 0.11 vs. 0.45 ± 0.21 g/kg DMI) endogenous P outputs between the transgenic and the non-transgenic growing-finishing pigs. In conclusion, the transgenic growing-finishing enviro-pigTM can completely digest and absorb P associated with SBM with no changes in the recycling and outputting the gastrointestinal endogenous P.

Key Words: Phosphorus, True digestibility, Growing-finishing transgenic phytase pig

1376 Efficacy of a new phytase preparation on phosphorus and calcium digestibility and on bone mineralization in weanling piglets. S. Jakob*, R. Maillard, O. Nore, and P.A. Geraert, *Aventis Animal Nutrition, Antony, France.*

An experiment was conducted to evaluate the efficacy of a new phytase preparation (PhyA) in comparison with a commercially available phytase representing the largest share of the phytase market (PhyB). Weanling piglets (n=24, 6.6 kg initial wt.) were divided into 4 groups consisting of 6 animals each. The animals were housed individually in metabolic cages. They were fed *ad libitum* for 27 d 4 different diets based on corn - soybean meal low in digestible P. Dietary treatments were: 1) negative control (NC; .144% dig. P & .76% Ca), 2) NC + 500 U / kg PhyA, 3) NC + 500 U / kg PhyB and 4) positive control (PC; .238% dig. P & .78% Ca). Feces of the animals were collected quantitatively during the last 5 d of the experiment for determination of P and Ca digestibility. The animals were euthanized on the last day of the experiment following the last sampling and the metacarpal of the left foot of each animal was dissected for determination of the bone mineralization (total ash, P and Ca contents). As compared with the NC, supplementing the diets with PhyA or PhyB increased (P < .01) the digestibility of P (20.11%, 50.28%, 43.63% resp.) and Ca (34.2%, 48.62%, 50.98% resp.) as well as contents of total ash (10.45%, 13.12%, 12.42% resp.), P (1.66%, 2.18%, 2.04% resp.) and Ca (3.56%, 4.69%, 4.32% resp.) in the bones. The supplementation of the diets with PhyA increased (P < .01) digestibility of P and improved bone mineralization as indicated by increased (P < .01) contents of total ash, P and Ca when compared with the PC. In comparison with the PC, a supplementation with PhyB increased digestibility for P (P < .01) and Ca (P < .05) whereas no effect (P > 0.1) on bone mineralization was observed. Comparing results obtained in the two groups supplemented with phytase, PhyA showed an increased (P < .01) P digestibility which is reflected in tendency by higher ash (P < .08) and P (P < .07) contents in the bones. In summary, the new phytase preparation (PhyA) effectively improved P and Ca digestibility which is reflected by increased P, Ca and ash contents in the bones.

Key Words: Piglet, Phytase, Phosphorus

1377 The effects of supplemental plant or microbial phytase and organic acid on growth performance and nutrient digestibilities in nursery pigs. O. S. Kwon*, I. H. Kim¹, J. W. Hong¹, Y. K. Han², J. H. Kim³, S. H. Lee¹, B. J. Min¹, and W. B. Lee¹, ¹*Department of Animal Resource & Science, Dankook University, Cheonan,*, ²*Feed Res. Inst., National agri. Coop. Fed.,* ³*Agribands Purina Korea, Inc., Seoul, Koera.*

This study was carried out to evaluate the effects of adding phytase and organic acid on growth performance, nutrient digestibility, and inorganic phosphorus and calcium of serum in nursery pigs fed corn-soybean meal diets. A total 60 crossed pigs (average 15.14±0.32kg BW, Landrace×Duroc×Yorkshire) were used in this experiment. Pigs were allotted into five treatments. Each treatment had four replicates with three pigs per replicate. This study was carried out for 20 days. The five treatments were Con(Control diet: Diet was formulate with 85% of NRC requirement for P), PP(Control diet+plant phytase 0.8%), MP(Control diet+microbial phytase 0.1%), PMP(Control diet+plant phytase 0.8%+microbial phytase 0.1%) and PMO(Control diet+plant phytase 0.8%+microbial phytase 0.1%+organic acid 2.0%). For overall period, average daily gain was increased by MP compared with PMO(P<0.05). Gain/feed was successfully improved by PM compared with PMO(P<0.05). There were no significant differences in DM and N digestibility among the treatments. PP and PM had improved digestibility of Ca compared to PMO(P<0.05). Pigs fed PP and MP tended to have higher digestibility of P than pigs fed PMO(P<0.05). Calcium content in serum of PMO was significantly different among the treatments(P<0.05). However, PM was lower than other treatments on calcium content of serum(P<0.05). MP was higher in inorganic phosphorus of serum than other treatments(P<0.05). In conclusion, phytase supplementation in pig diet improved growth performance and nutrient digestibility. However, there was not synergic effect between phytase and organic acid supplementation.

Key Words: Pigs, Phytase, Organic acid

1378 Phytase proved ineffective for young weaned pigs. H. M. Miller¹ and P. Toplis*², ¹*University of Leeds, Leeds, UK,* ²*Primary Diets Ltd, Melmerby, UK.*

European countries are keen to reduce phosphorus pollution and hence favour using phytase in pig diets instead of inorganic phosphates. Although phytase is widely used in grower-finisher diets little published information exists for starter diets. This experiment aimed to investigate the effect of including phytase instead of an equivalent amount of dicalcium phosphate (DCP) in starter diets on their resulting performance. One hundred and twenty eight piglets (62.5% Large White, 25% Landrace, 12.5% Duroc) were weaned, at 23 0.86 days of age and 7.0 0.12 kg BW, into commercial flatdeck accommodation. Eight piglets were allocated to each pen (1.99 m²) on the basis of weight, litter and sex. Four pens were randomly allocated to one of 4 treatments. Treatments were: 1) standard diets (S), 2) S plus 500 FTU phytase/kg feed (Ph+), 3) S minus 6.3 kg DCP per metric tonne of mixed feed (-DCP) and 4) -DCP plus 500 FTU phytase/kg feed (Ph-). Diets were milk-based and formulated to contain 4,167 kcal DE/kg, 1.75% total lysine in Wk1, and 3,810 kcal DE/kg, 1.6% total lysine in Wk2 and 3. Feed and water were provided *ad libitum*. Piglets were weighed on d0 and 20. Daily FI per pen was recorded from d0 to 20. Data were analysed using the GLM procedure of Minitab 12.2. S pigs grew faster to a heavier d20 weight than Ph+ and Ph- pigs: -DCP pigs performed worst (DLWG 330, 286, 298 and 262 g/d, respectively, SEM 9.0, P < 0.01; d20 weight 13.6, 12.8, 13.0 and 12.3 kg, respectively, SEM 0.17, P < 0.01). DCP supplemented diets performed best. Removal of DCP reduced performance. This was partly counteracted by phytase inclusion, however, phytase unexpectedly caused a fall in performance when added to the standard diet. This work suggests phytase cannot completely replace DCP in milk-based diets for early-weaned pigs.

Key Words: Phytase, Weaner pig, Growth

1379 Phytase and dietary zinc and copper effects on performance and mineral status of grow-finish pigs. J. W. Spears*¹, M. D. Corns¹, E. van Heugten¹, W. L. Flowers, and G. M. Hill², ¹*North Carolina State University,* ²*Michigan State University.*

Two-hundred and forty pigs (22.4 kg initial wt) were used in a 2 x 5 factorial design to estimate Zn and Cu requirements of grow-finish pigs fed phytase. Zinc was added as ZnSO₄ to provide 0, 10, 20, 30 or 60 ppm supplemental Zn and Cu (from CuSO₄) was supplemented at 0 or 5 ppm. Two treatments with no added phytase were also included in the experimental design. One non-phytase treatment was supplemented with adequate Zn (60 ppm) and Cu (5 ppm) while the other supplied no supplemental Zn or Cu. The control (no added Zn or Cu) growing and finishing diets analyzed 38 and 34 ppm of Zn and 6.9 and 5.3 ppm of Cu, respectively. Phytase (Allzyme[®]) was added to provide 11,500 PTU/kg diet and growing and finishing diets were formulated to contain 0.4 and 0.3% total P, respectively. Phytase addition improved (P<0.05) gain (0.84 vs 0.79 kg/d) and gain:feed (0.389 vs 0.375) compared to pigs not receiving phytase and similar levels of Zn and Cu. Plasma P concentrations were higher(P<0.05) and fecal P concentrations lower (P<0.05) in phytase-fed pigs. Pig performance was not affected by dietary Zn or Cu in pigs fed phytase. Plasma, liver and bone Zn concentrations and plasma alkaline phosphatase activity were increased(P<0.05) by Zn supplementation, primarily due to addition of 10 ppm Zn, with relatively small increases with further supplementation. Copper supplementation increased liver Cu, but did not affect plasma ceruloplasmin or red blood cell superoxide dismutase activity. Addition of 10 to 20 ppm of Zn to a corn-soybean meal based diet with phytase should provide adequate Zn to maximize performance and maintain normal Zn status. The control diet containing 6 ppm of Cu and phytase was adequate to meet nutritional Cu requirements of grow-finish pigs.

Key Words: Zinc, Copper, Phytase

1380 Nitrogen and phosphorus balance in growing pigs fed crude protein-adequate or -deficient, low-phosphorus diets with graded levels of phytase. J.S. Sands*¹, D. Ragland¹, and O. Adeola¹, ¹*Purdue University.*

Growth response, N and P balance were evaluated in pigs fed CP-adequate or reduced, low-P diets with graded levels of supplemental phytase (PT). Forty-eight 10-kg pigs were used in a randomized complete block design with a 2 x 3 factorial arrangement of treatments to

assess the growth response of pigs to diets containing CP at 200 g/kg or 160 g/kg and PT at 0, 600, or 1200 phytase units (PTU)/kg for 28 d in Exp. 1. Pigs fed CP-adequate diets had higher ($p < 0.05$) ADG (0.47 vs 0.42 kg/d), and gain to feed ratio (0.48 vs 0.42) than those fed reduced-CP diets. Phytase linearly increased ($P < 0.001$) BW and ADG, and tended to have a positive, linear effect on ADFI ($P < 0.10$) in CP-adequate but not reduced-CP diets. In, Exp. 2, thirty-six 15-kg pigs were used to evaluate N and P balance. Diets were the same as those used in Exp. 1. Diets were fed for a 5-d adjustment period followed by a 5-d collection period in which total feces and urine were collected separately. Significant CP x PT interactions were observed for N retention. Nitrogen retention was significantly increased from 55.9% to 64.0% with 1200 PTU/kg of diet in pigs fed reduced-CP but not in CP-adequate diets. Phytase supplementation resulted in a linear improvement ($P < 0.001$) in the P digestibility (49.9 to 63.8% and 48.4 to 62.1 % in the CP-adequate and reduced-CP diets, respectively). Consequently, fecal P output was linearly reduced ($P < 0.001$). Retention of P was improved by up to 48% and 30% in pigs fed CP-adequate and reduced-CP diets, respectively. A reduction ($P < 0.01$) in urinary P output by 0.35 g/d led to higher retention of absorbed P in pigs fed the reduced-CP diet. The addition of phytase to reduced-CP, low-P diets further improved N and P balance in growing pigs.

Key Words: Pigs, Nitrogen, Phosphorus

1381 Growth response to phytase and apparent ileal and fecal digestibility of nutrients in pigs fed diets of different intrinsic phytate concentration. J.S. Sands^{*1}, D. Ragland¹, R.N. Dilger¹, and O. Adeola¹, ¹*Purdue University*.

The purpose of this study was to assess the response to supplemental phytase (PT) in pigs fed diets containing different concentrations of intrinsic phytate (PA). The high PA diet contained 3.9 g/kg and the low PA diets contained 2.2 g/kg with PT added at 0 and 1200 PTU/kg in a 2 x 2 factorial arrangement of treatments. In Exp. 1, a total of 48, 18-kg pigs were assigned to 4 dietary treatments to measure growth response for 28 d. Body weight and ADG were affected by PT ($P < 0.05$), but not by PA. There were no detectable interactions between PT and PA level for any of the growth response criteria measured. In Exp. 2, 8 pigs (28-30 kg BW) were surgically fitted with simple T-cannula approximately 10 cm cranial to the ileo-cecal junction. Pigs were allowed 10 d to recover from surgery and then assigned to metabolism crates in a replicated 4 x 4 Latin square design. Each period consisted of 7 d. Pigs were weighed at the beginning of each period and feed was allotted for the period at a daily rate of 9% of metabolic BW. The apparent total tract digestibility (ATTD) of N was not significantly affected by dietary treatment. The ATTD of P was increased ($P < 0.01$) by the addition of PT to both the low and high PA diets. Significant PT x PA interactions were observed for ATTD and apparent ileal digestibility (AID) of P. The addition of PT increased the ATTD of P from 23.7 to 38.9% and 21.2 to 43.9% in the low and high PA diets, respectively. The AID of amino acids, and N were not significantly affected by intrinsic PA concentration or PT addition. The AID of P was significantly improved ($P < 0.001$) with the addition of PT. The AID of P was increased from 16.3 to 30.5% and 10.6 to 36.1% in the low and high PA diets, respectively. In conclusion, phytase addition to diets high in PA did not improve amino acid or N digestibility, but resulted in a greater increase in P digestibility compared to diets low PA.

Key Words: Amino Acid Digestibility, Phosphorus, Phytase

1382 Digestibility of low phytic acid corn (LPA) and elevated fat and protein corn (EFP) with phytase in finishing pigs. S. L. Hankins^{*}, A. L. Sutton, and B. T. Richert, *Purdue University, West Lafayette, IN*.

Two trials were conducted to compare the effect of four corn hybrids and phytase inclusion on nutrient digestibility and excretion in pigs. In experiment 1 (Exp. 1), 12 crossbred barrows (BW = 95 kg) were used in two replicates for a total of 24 collections (6 pigs/TRT). Pigs were blocked by weight and ancestry and assigned to one of the following TRT: 1) EFP corn based diet (EFP), 2) LPA1 corn diet (LPA1), 3) LPA2 corn diet (LPA2), 4) EFP-LPA1 corn based diet (EFP-LPA1). In experiment 2 (Exp. 2), 24 crossbred barrows (BW=106 kg) were assigned to similar corn hybrids as Exp. 1 and collected in two replicates (6 pigs/TRT). Diets included: 1) EFP, 2) EFP-LPA1, 3) diet 1 with

300 PU/kg, and 4) diet 2 with 300 PU/kg. The EFP and EFP-LPA1 diets were identical in both experiments. Diets were formulated to 0.53% digestible Lys and 0.30% total P with other nutrients meeting or exceeding NRC (1998) requirements. In both studies, pigs were housed in metabolism stalls and had a 5 d adaptation to TRT and stalls followed by a 3 d total feces and urine collection. Pigs were offered TRT diet at 3 times maintenance requirements in two equal feedings with free access to water. In Exp. 1, total N excreted tended ($P < 0.10$) to be lower for pigs fed the EFP-LPA1 TRT (17.3 g/d) compared to pigs fed the LPA1 TRT (23.4 g/d). Pigs fed the EFP TRT had 34-52% greater ($P < 0.05$) fecal P (DM basis) and 33-44% greater fecal water soluble P than the LPA1, LPA2, and EFP-LPA1 in Exp. 1. In Exp. 2, total ammonium N excretion was reduced 9% ($P < 0.01$) from pigs fed the EFP corn diets compared to pigs fed the EFP-LPA1 corn diets. Fecal P was reduced ($P < 0.0001$) when pigs were fed the EFP-LPA1 corn diets (2.2 g/d) compared to the EFP corn diets (4.5 g/d). Total P excreted was reduced ($P < 0.001$) to 2.8 g/d for pigs fed the EFP-LPA1 corn diets compared to 4.6 g/d for pigs fed the EFP corn diets. While phytase addition in Exp. 2 did not effect total P excretion, fecal P was reduced 8% ($P < 0.0001$) with phytase addition to the EFP corn diet. This study suggests that feeding genetically enhanced corn to pigs can reduce nutrient excretion if the increased availability of nutrients is properly accounted for to meet and not exceed nutrient requirements.

Key Words: Pigs, Digestibility, Phosphorus

1383 The effect of CP level and phytase inclusion on apparent amino acid digestibilities and the estimation of endogenous amino acid losses using an enzymatically hydrolyzed casein diet. J.P. Rice^{*1}, J.S. Radcliffe¹, R.S. Pleasant², and J.L. Pierce³, ¹*Purdue University, West Lafayette, IN*, ²*Virginia-Maryland College of Veterinary Medicine, Blacksburg, VA*, ³*Alltech, Inc., Nicholasville, KY*.

Twelve crossbred barrows fitted with steered ileo-cecal valve cannulas were used in a 6 x 6 Latin square design to test the effects of phytase on amino acid apparent ileal digestibility (AID) and to determine endogenous amino acid digestibilities using an enzymatically hydrolyzed casein (EHC) diet. Pigs were individually housed and allowed ad libitum access to water. Feed was provided at 9% of metabolic BW (BW^{0.75}) in two daily feedings. Diets were corn-soybean meal based, with the exception of the EHC diet, and contained 0.15% aP, 0.44% Ca, and Cr₂O₃ (0.05%) as an indigestible marker. Diets 1, 2 and 3 contained 13.0, 12.0 and 11.0% CP, respectively. Diets 4, 5 and 6 were Diet 3 with the addition of 250, 500 or 750 U of phytase per kg of diet, respectively. Each period consisted of a 7d adjustment, a 3d total collection, a 12h ileal collection, and a 3d adjustment to the EHC diet followed by a 12h ileal collection. Digesta samples from both collection periods were analyzed for amino acid content using HPLC. The addition of phytase to the low P diet did not improve ($P > 0.10$) the AID of Lys, Met, Thr, Trp, or CP. Decreasing the CP content of the diet resulted in a quadratic decrease in Lys ($P < 0.08$), Met ($P < 0.02$), Thr ($P < 0.08$), and CP ($P < 0.04$) AID. The quadratic effect was the result of a decreased amino acid AID in the 11.0% CP diet compared to diets containing 12.0% and 13.0% CP. Differences in amino acid AID between the 13.0% and 12.0% CP diet were small, and in many cases slightly higher for the 12.0% CP diet. No effect ($P > 0.10$) of dietary CP level was observed for Trp AID. On average, endogenous losses were estimated to be 0.5, 0.2, 0.5, 0.1, and 9.8g/kg of diet consumed for Lys, Met, Thr, Trp, and CP, respectively. As a result, the endogenous fraction of amino acids collected in ileal digesta was proportionally greater in the lower CP diets. Estimates of endogenous amino acid losses fell within the range of those presented in recent literature.

Key Words: Pig, Phytase, Amino acid

1384 Apparent digestibility coefficients of nutrients are improved by phytase supplementation in corn distiller's dried grain with solubles for rainbow trout (*Oncorhynchus mykiss*). Zongjia Cheng^{*} and R.W. Hardy, *University of Idaho, Hagerman Fish Culture Experiment Station*.

Environmental concerns about water pollution caused by excessive nutrient discharges on fish farms are increasing during the last two decades. Phytase supplementation in plant protein-based fish diets may improve

the availability of phytate-phosphorus and other nutrients. In this experiment, corn distiller's dried grain with solubles (DDGS) was supplemented with different dosages of microbial phytase (Natuphos 5000G) to test the effect of phytase on apparent digestibility coefficients (ADCs) of nutrients for rainbow trout. Five diets were pelleted with 0.5% chromium oxide as an inert marker. One diet was a casein-gelatin, semi-purified reference diet, which constituted 70% of the other 4 diets to which DDGS was added and phytase was supplemented. A total of 300 fish (initial mean BW 140.8 ± 11.1 g) were stocked into ten 40-L digestibility tanks with 30 fish per tank. Fish were assigned randomly to each diet. The collection of feces lasted for 2 weeks, feces were collected by the sedimentation technique. Fish were fed once daily at 1330 h, tanks were completely cleaned after feeding, and feces were collected the next day at 1300 h. Results showed that ADCs (%) in DDGS supplemented with 0, 750, 1500, and 2250 FTU/kg diet of phytase were: dry matter, 65.5, 73.4, 76.9, 74.8, respectively ($P = 0.0006$); crude protein, 90.7, 92.9, 93.2, 93.0, respectively ($P = 0.0003$); crude fat 83.8, 89.0, 90.9, 90.9, respectively ($P = 0.0001$); gross energy, 71.8, 78.0, 78.9, 77.8, respectively ($P = 0.0026$); and phytate-P, 34.9, 91.8, 99.5, 93.9, respectively ($P = 0.0001$).

Key Words: Apparent digestibility coefficients, Corn dried distiller's grain with solubles, Phytase and rainbow trout

1385 Effect of phytase supplementation on apparent digestibility coefficients of nutrients in soybean meal-based semi-purified diets for rainbow trout (*Oncorhynchus mykiss*). Zongjia Cheng^{*1}, R.W. Hardy¹, V. Verlhac², and J. Gabaudan², ¹University of Idaho, Hagerman Fish Culture Experiment Station, ²Research Center for Animal Nutrition and Health, STE Chimique Roche, Ltd, France.

Global production of soybean meal (SBM) continues to increase, making it the most promising alternate protein source for fish feeds in terms of future availability. However, the availability of phosphorus (P) and zinc (Zn) in SBM are very low. Phytase supplementation may have an effect on improving availability of P and Zn, and other nutrients. In this study, SBM (50% of the diet) was formulated into a casein-gelatin semi-purified diet and supplemented with 5 dosages of phytase (Ronozyme P (L), Roche Vitamins France). Duplicate tanks were assigned randomly to each diet. Three hundred rainbow trout, mean BW of 100.1 ± 7.4 g, were stocked in ten 40-L tanks. Experimental diets were fed once daily at 1300 h to apparent satiation for one week before fecal collection began. Feces were collected at 0800 h the next day by stripping all fish. Collection of feces was repeated three days until sufficient amount was obtained. The average apparent digestibility coefficients (ADCs, %) of SBM-based semi-purified diets supplemented with 0, 500, 1000, 2000, and 4000 FTU/kg diet were: dry matter, 77.1, 79.0, 78.4, 80.2, 79.2, respectively ($P > 0.05$); crude protein, 97.1, 97.9, 96.2, 98.5, 98.3, respectively ($P < 0.05$); lysine, 97.9, 98.8, 97.1, 98.9, 98.9, respectively ($P < 0.005$); total-P, 39.9, 80.8, 87.9, 91.9, 95.1, respectively ($P < 0.0001$); phytate-P, 0.5, 52.4, 59.8, 78.3, 67.4, respectively ($P = 0.0034$); and Zn, 28.7, 52.8, 69.3, 73.4, 81.7, respectively ($P < 0.0001$).

Key Words: Soybean meal, Phytase, Rainbow trout

1386 Performance of growing-finishing pigs fed diets supplemented with a carbohydrase combination. J. N. Hsu, L. C. Cheng, T. S. Sheu, and C. Y. Liu^{*}, Animal Technology Institute Taiwan, ROC.

Fiber-degrading enzymes break down fibrous constituents of dietary ingredients and increase energy utilization and nutrient digestibility in pigs. To evaluate the effect of Safizym (a combination of cellulase, β -glucanase and xylanase) on performance in growing-finishing pigs, two trials were conducted. In trial 1, 48 finishing pigs (average 60 kg; 4 pigs/pen, 4 replicates/treatment) were fed a corn-soybean-wheat bran diet supplemented with 0, 0.04 or 0.08% of Safizym. ADG, ADFI and F/G were: 789, 828, 876 g/d; 2.74, 2.65, 2.85 kg/d; 3.48, 3.23, 3.26, respectively. Although Safizym supplement numerically improved ADG and F/G, there were no significant differences among treatments. Backfat thickness was reduced in pigs fed carbohydrases (2.54, 2.38, 2.23 cm; $P < 0.05$) with no difference in loin eye area (42.7, 47.7, 48.5 cm²). Trial 2 involved 60 growing pigs (average 32.7 kg; 4 pigs/pen, 5 replicates/treatment). Control diet (C) was formulated with 3 and 6% wheat bran for growing and finishing phases. Instead 10 and 25% wheat bran was used for separate phase in high fiber diet with (S) or without (F)

Safizym (0.08%). At the end of the trial, ADG was lower in pigs fed high fiber diet and recovered by Safizym (for C, F, S; 805, 706, 784 g/d, $P < 0.01$). In comparison with increased F/G (3.85) in pigs fed high fiber diet, F/G was similar between control and enzyme-supplemented high fiber group (3.14 vs 3.15). There was no difference in backfat thickness among treatments (2.71, 2.66, 2.65 cm); however, loin eye area was smaller in pigs fed high fiber diet (46.7, 42.1, 46.9 cm², $P < 0.01$). The results show that, despite the high inclusion of wheat bran in diets, growth performance and carcass characteristics were improved in pigs fed a combination of carbohydrases.

Key Words: Pigs, Enzymes, Performance

1387 Growth and feed intake of pigs fed wheat-based diets differing in digestible energy content without or with xylanase. W. R. Caine^{*1}, B. T. Li¹, J. He², W. C. Sauer², S. Jaikaran¹, and P. H. Simmins³, ¹Alberta Agriculture, Food and Rural Development, ²University of Alberta, ³Finnfeeds International Ltd.

Growing pigs eat to meet their energy requirement, but cannot always compensate the variation of digestible energy (DE) content of wheat in their diet without addition of xylanase. The objective of the study was to evaluate performance of young pigs receiving wheat-based diets differing in DE content supplemented without or with xylanase. Diets were formulated using 672.3 g/kg of one of six wheat sources (W1, W2, W3, W4, W5 and W6) with bulk weights of 67.2, 68.3, 69.9, 75.9, 79.5 and 57.6 kg/hL, respectively. Xylanase (Porzyme[®] 9300, minimum level of 4000 U/g product; 1 mg/kg of diet) was added into half of each diet. Seventy-two individually penned barrows (10.5 ± 0.6 kg), were fed one of the six diets without or with xylanase. Daily feed intake (FI), ADG and feed conversion efficiency (FCE) of the pigs were measured for 21 d and 7-d fecal collections used to determine dietary DE content. The FI and ADG of pigs fed diets formulated using W1 to W5 were similar and higher ($P < 0.05$) than those of pigs fed the W6-diet without xylanase. Addition of xylanase increased ($P < 0.05$) FI and ADG of pigs fed the W6-diet, although improvements were not apparent ($P > 0.05$) for pigs receiving the other diets. The FCE of pigs were similar among the diets. The DE content of the W1, W2, W3 and W5 diets (range of 3529 to 3569 kcal/kg) were higher ($P < 0.05$) than those of the W4 and W6 diets (range of 3414 to 3457 kcal/kg) with the exception of the W1-diet containing xylanase (3481 kcal/kg). Daily DE intake of pigs fed the W6-diet increased ($P = 0.0001$) by 77 kcal/d with the addition of xylanase, but was not different ($P > 0.1$) for pigs fed W1 to W5 diets. Supplementation of xylanase improves the feed value of wheat sources with low DE content.

Key Words: Pigs, Wheat source, Xylanase

1388 Effect of RovabioTM Excel AP on nutrient digestibility and on performance of weaned piglets. S. Jakob^{*1}, G. Gotterbarm¹, and F. X. Roth², ¹Aventis Animal Nutrition, Antony, France, ²Division of Animal Nutrition and Production Physiology, TU-Munich, Weihenstephan, Germany.

An experiment was conducted to evaluate the influence of a RovabioTM Excel AP (β -glucanase and xylanase; Aventis Animal Nutrition, Antony, France) addition to a diet for weanling piglets. At 28 d of age, 48 piglets (8.02 ± 1.1 kg) were divided into 2 groups consisting of 24 animals each and assigned to 2 different treatments: 1) a basal diet based on barley and soybean meal (XP 18.5 %, Lys 1.1 %, ME 12.8 MJ / kg) and 2) a experimental diet consisting of the basal diet supplemented with RovabioTM Excel AP at a level of 50 mg / kg. The piglets were housed individually and fed *ad libitum* for 5 weeks. For the last 12 d of the experiment, the diets of 8 animals of each dietary treatment group were supplemented with .5 % Celite 545 (Merck, Darmstadt, Germany) as digestibility marker. Feces of the animals fed the marker supplemented diet were collected the last 5 d of the experiment. For all animals, average daily weight gain (ADG), final body weight (FBW), daily feed consumption (DFC), feed conversion ratio (FCR) was recorded and additionally in the fecal samples the dry matter (DM), energy and protein digestibility was calculated. The pigs fed the experimental diet supplemented with RovabioTM Excel AP showed a greater ADG ($P < .078$) as well as a greater FBW ($P < .058$). No influence on DFC ($P = .139$) and FCR ($P = .496$) was observed. However, energy digestibility was higher ($P < .096$) for the diet supplemented with RovabioTM Excel AP. Dry matter and protein digestibility was not influenced ($P = .139$; $P > .9$, resp.). In conclusion, our data suggests that a supplementation of a

barley based diet for weaning piglets with .005 % Rovabio™ Excel AP improves zootechnical parameters, namely ADG and FBW, as well as energy digestibility.

Dietary treatment	FBW (kg)	ADG (g)	DFC (g)	FCR	Dry Matter	Digestibility (%)	Energy	Protein
Basal	23.04	427	658	1.54	80.9	80.6		78.2
Basal + Rovabio™								
Excel AP	24.29	458	691	1.51	82.5	82.5		78.2

Key Words: Piglet, Xylanase, β -Glucanase

1389 Addition of a fungal xylanase to wheat-based diets for growing pigs. M. Cervantes*, M.A. Barrera, A.B. Araiza, N. Torrentera, S. Espinoza, and M. Cervantes, ICA, Universidad Autónoma de Baja California.

An experiment was conducted to evaluate the effect of adding a fungal xylanase to wheat-based diets on the performance of growing pigs. Thirty crossbred (Landrace-Hampshire-Duroc) pigs (24.1 kg av. initial body wt.) were randomly allotted to six dietary treatments, based on weight, age, litter and sex, according to a Randomized Complete Block Design. The treatments were: 1) base diet, 96.8% wheat, vitamins and minerals, 2) + 100 ppm xylanase, 3) + 200 ppm xylanase, 4) + 300 ppm xylanase, 5) + 0.53% lysine + 0.12% threonine + 0.05% methionine, 6) control, wheat-soybean meal diet. The basal diet contained wheat as the only source of energy and protein; thus, it was deficient in lysine, threonine and methionine. These amino acids were added to diet 5 to match their content in the control diet, which was formulated to meet the requirements of growing pigs. Vitamins and minerals were added to meet or exceed the requirement. Feed and water were offered ad libitum. Average daily weight gain, feed intake, lysine intake, threonine intake, and feed/gain were: 282, 311, 306, 331, 848, 837 g/d; 1.15, 1.33, 1.31, 1.24, 1.88, 1.81 kg/d; 4.3, 4.9, 4.8, 4.7, 17.0, 16.0 g/d; 4.4, 5.0, 5.0, 4.7, 9.2, 12.0 g/d; 4.50, 4.38, 3.85, 4.49, 2.22, 2.16, respectively. The addition of xylanase did not affect the daily weight gain, but feed/gain tended ($P < .10$) to improve when 300 ppm xylanase were added. Pigs fed the diet added with crystalline lysine, threonine, and methionine grew faster and more efficiently, and had a higher intake of feed, lysine, and threonine ($P < .01$) than those fed the basal diet added with the enzyme. No difference was found in weight gain and feed/gain between pigs fed the amino acid added and the control diet. These data show no effect of supplemental xylanase in wheat-based diets, although a slight improvement in feed conversion can be obtained. Also, these data indicate that crystalline lysine, threonine and methionine can replace completely the soybean meal in wheat-based diets for growing pigs.

Key Words: Pigs, Wheat, Xylanase

1390 The effect of multi-enzyme supplementation on the ileal and fecal digestibility of corn-soybean meal based diet in the finishing pigs. B. J. Min^{*1}, I. H. Kim¹, J. W. Hong¹, Y. H. Han², J. H. Lee³, O. S. Kwon¹, S. H. Lee¹, and W. B. Lee¹, ¹Department of Animal Resource & Science, Dankook University, ²Feed Res. Inst., National agri. Coop. Fed., ³EASY-BIO SYSTEM, Inc., Seoul, Korea.

This experiment was to determine the influence of the addition of a microbial phytase and multiple enzyme (α -galactosidase and β -mannanase) to corn-soybean meal based diets on ileal and fecal digestibility in the finishing pigs. Four Duroc x Yorkshire x Landrace barrows (66.4 \pm 0.7 kg average initial BW) were surgically fitted a simple T-cannulas approximately 15 cm prior to the ileo-cecal junction. The experimental designs were 4 x 4 latin squares with pigs and periods as blocking criteria. Each period was 4 d of adjustment to the experimental diets, 3 d of total feces and 2 d (12 h/d) of ileal digesta collection. Dietary treatments included 1) CON (corn-SBM based diet), 2) HME (CON diet + 0.1% high level multi-enzyme; phytase 50g + enzyme 350g + carrier 600g), 3) MME (CON diet + 0.1% medium level multi-enzyme; phytase 40g + enzyme 280g + carrier 680g), 4) LME (CON diet + 0.1% low level multi-enzyme; phytase 30g + enzyme 210g + carrier 760g). Proximate DM and N digestibilities of small intestine for pigs fed multi-enzyme treatments were increased ($P < 0.05$) compared to pigs fed CON diet. However, fecal digestibilities of DM and N were not affected by treatments. Apparent ileal and fecal digestibilities of Ca and P were significantly

increased ($P < 0.05$) in multi-enzyme treatments compared to CON treatment. The digestibility of amino acids tended to be higher for the multi-enzyme treatments compared to CON treatment without significant differences except for arginine, aspartic acid and proline. In this study, supplemental multi-enzyme was an effective means of improving ileal digestibility of DM, N, Ca and P by finishing pigs fed corn-soybean meal-based diet.

Key Words: Enzyme, Ileal digestibility, Pigs

1391 Influence of 1-dose Fe dextran administration with organic trace mineral supplementation on the performance of piglets. S. P. Acda¹, J. W. Joo², W. T. Kim², Y. H. Shim², S. H. Lee², and B. J. Chae^{*2}, ¹Institute of Animal Science, University of the Philippines Los Banos, College, Laguna, Philippines, ²Division of Animal Resources, Kangwon National University, Chuncheon 200-701, Kangwon, Korea.

This study was designed to evaluate the influence of 1-dose Fe dextran with organic trace mineral supplementation on the performance of piglets from dams fed diets with either inorganic (ITM) or organic trace minerals (OTM). It also determined the effect of source of trace minerals on the reproductive performance of sows. The trace mineral premix was prepared using metal proteinates or the corresponding inorganic salts for the OTM or the ITM, respectively. Each mineral premix provided 100 ppm Fe/175 ppm Fe, 35 ppm Cu/170 ppm Cu, 90 ppm Zn/120 ppm Zn, and 40 ppm Mn/35 ppm Mn when added at .20% in sows/piglets' diets, respectively. The first dose of Fe dextran was administered to piglets at 3 d and the second dose at 10 d after birth. One dose Fe dextran supplied 100 mg of Fe. A total of 16 gestating sows (Landrace x Yorkshire x Duroc) in parities 2 to 4 were randomly distributed to four treatments: 1) diet with ITM/1-dose Fe dextran to piglets, 2) diet with ITM/2-dose Fe dextran to piglets, 3) diet with OTM/1-dose Fe dextran to piglets, and 4) diet with OTM/2-dose Fe dextran to piglets. The total born alive, weaned, body weight at birth and at weaning were not affected by the sow's dietary treatment. Although organic trace mineral supplementation tended to increase milk Fe content ($p < .10$) at 7 d postpartum, piglets in all treatments equally performed from birth to weaning. The 2-dose Fe dextran neither improved the average daily gain (ADG) nor influenced the survival of piglets from birth to weaning (21 d). Results suggest that 1-dose Fe dextran given to suckling pigs is adequate to sustain their needs for growth throughout the lactation period (21 d). Furthermore, there was a 21% improvement in both the ADG and the average daily feed intake (ADFI) ($p < .05$) in weaned pigs fed the diet with OTM. Cu and Fe in the liver ($p < .01$), and Zn in both the bone ($p < .01$) and the serum ($p < .01$) were higher in piglets fed OTM than those fed ITM. It would be concluded that 1-dose Fe dextran administration with organic mineral supplementation show similar growth performance compared to 2-dose Fe dextran administration with inorganic mineral supplementation in young pigs.

Key Words: Organic mineral, Fe, Piglet

1392 Effects of feeding organic trace minerals on the production traits of sows and neonates. B. J. Chae^{*1} and S. P. Acda², ¹Division of Animal Resources, Kangwon National University, Chuncheon 200-701, Korea, ²Institute of Animal Science, University of the Philippines Los Banos, College, Laguna, Philippines.

A feeding trial using sows and their neonates was conducted to determine the effects of the source and level of organic trace mineral supplementation on the reproductive performance of sows and the subsequent performance of neonates through 2 wk postweaning. A total of 16 gestating sows (Landrace x Yorkshire x Duroc) in parities 2 to 4 were randomly assigned to 4 dietary treatments following a 2 x 2 factorial arrangement in a completely randomized design. One of the two factors evaluated the effect of the source (inorganic vs organic), and the second factor evaluated the effect of the level (low vs high) of trace minerals added to the diet. The trace mineral premixes were formulated to provide low concentration of trace minerals (50 ppm Fe/87.5 ppm Fe, 17.5 ppm Cu/85 ppm Cu, 45 ppm Zn/60 ppm Zn, and 20 ppm Mn/17.5 ppm Mn), or high concentration of trace minerals (100 ppm Fe/175 ppm Fe, 35 ppm Cu/170 ppm Cu, 90 ppm Zn/120 ppm Zn, 40 ppm Mn/35 ppm Mn), when included at .20% in sows/piglets' diets, respectively. The total number born, total born alive and weaned, and the average neonate weight at birth were neither affected by the dietary source nor level of trace minerals, but an interaction effect ($p < .05$) between the

source and level of trace minerals was observed on the average weight at weaning. The neonates from sows fed the low level of organic trace minerals gained weight at equal rate as those farrowed by sows fed the high level of inorganic trace minerals. Sows fed the organic trace minerals nursed their piglets with milk higher in Fe and Zn ($p < .05$) compared to those fed diet with inorganic trace minerals. Consequently, the weaned pigs fed diet with organic form of trace minerals tended to grow at a faster rate, consumed less feed and tended to utilize their feed more efficiently ($p < .10$). It was further observed that the organic trace minerals significantly increased ($p < .05$) Fe contents in the liver and serum, and Zn in the serum and bone. In conclusion, sows and neonates fed the organic minerals at low level showed similar performance compared to those fed the inorganic minerals at high level as specified in this study.

Key Words: Organic mineral source, Reproductive, Neonates

1393 Evaluation of recombinant human lactoferricin culture as a substitute for antibiotic in pig starter diets. J. W. Hong^{*1}, I. H. Kim¹, T. H. Moon², J. H. Kim³, O. S. Kwon¹, and S. H. Lee¹, ¹*Department of Animal Resource & Science, Dankook University, Cheonan*, ²*EASY-BIO SYSTEM, Inc., Seoul*, ³*Agribands Purina Korea, Inc., Seoul, Korea*.

Sixty [(Duroc×Yorkshire)×Landrace pigs] (7.63 ± 0.41 kg average body weight and 25 d average age) were used in a 20-d growth assay to determine the effects of recombinant human lactoferricin culture (RHLC) on growth performance, digestibility and serum IgG concentration in weaning pigs. Dietary treatments included 1) Negative control (NC : without antibiotic), 2) Positive control (PC : NC diet+0.01% chlortetracycline), 3) RHLC0.3 (NC diet+0.3% RHLC), 4) RHLC0.5 (NC diet+0.5% RHLC). Through entire experimental period, pigs fed RHLC diet grew faster than pigs fed PC diet while no difference was found among other treatments. ADFI of pigs fed RHLC0.3 diet was higher than that of pigs fed PC diet ($P < 0.05$). However, pigs fed RHLC0.5 diet had improved gain/feed compared to pigs fed PC diet. Pigs fed PC and RHLC diets was significantly increased in dry matter digestibility compared to pigs fed NC diet ($P < 0.05$). However, nitrogen digestibility in pigs fed RHLC0.3 diet tended to increase compared to other treatments without significant difference. There was no significant difference in IgG concentrations of serum. In conclusion, the dietary RHLC seemed to be approximately 0.3% when the pigs fed in the antibiotic-free diet for weaning pigs.

Key Words: Recombinant human lactoferricin culture, Antibiotic-free diet, Pigs

1394 Effects of iron-enriched yeast supplementation on iron utilization in nursery pigs. J. W. Hong^{*1}, I. H. Kim¹, J. H. Lee², O. S. Kwon¹, S. H. Lee¹, B. J. Min¹, and W. B. Lee¹, ¹*Department of Animal Resource & Science, Dankook University, Cheonan*, ²*EASY-BIO SYSTEM, Inc., Seoul, Korea*.

Eighty crossbred [(Duroc×Yorkshire)×Landrace] pigs were used to determine the effects of iron-enriched yeast (IEY), fumaric acid and ascorbic acid complex supplementation on iron utilization in nursery pigs fed a corn-SBM based diet. Treatments were 1) CON (basal diet+100ppm ferrous sulfate monohydrate), 2) IEY-A (basal diet+100ppm iron-enriched yeast and fumaric acid complex), 3) IEY-B (basal diet+50ppm iron-enriched yeast, fumaric acid and ascorbic acid complex), 4) IEY-C (basal diet+100ppm iron-enriched yeast, fumaric acid and ascorbic acid complex). Through entire experimental period, pigs fed IEY-C diets were significantly increased in ADG, ADFI and gain/feed compared to pigs fed CON diet ($P < 0.05$). Also, apparent digestibility of dry matter in pigs fed IEY-C diet was greater than for pigs fed CON diets ($P < 0.05$). However, apparent digestibility of nitrogen was not significantly different among the treatments. Pigs fed IEY-B and IEY-C diets significantly increased their serum iron values compared to pigs fed CON and IEY-A diets ($P < 0.05$). However, pigs fed CON diet significantly increased their total iron binding capacity values compared to pigs fed IEY-C diet ($P < 0.05$). In conclusion, the availability of iron from IEY, fumaric acid and ascorbic acid complex is significantly better than ferrous sulfate monohydrate supplementation.

Key Words: Iron-enriched yeast, Performance, Pigs

1395 Interaction of chromium methionine supplementation and feed restriction on reproductive performance of Japanese quail. G. Contreras^{*}, R. Soto, A. Montoya, and R. Barajas, *FMVZ-Universidad Autonoma de Sinaloa (Mexico)*.

This study was to determine the effect of chromium methionine supplementation and feed restriction on reproductive performance of Japanese quail. Three hundred twenty Japanese quail breeders (240 females and 80 males; 13 weeks old) were used in a randomized design experiment with 2 x 4 factorial arrangement to test two chromium (from chromium-methionine;Cr) feed supplementary levels (0 and 100 ppb of Cr) and four feed restriction (FR) levels (0, 10, 20, and 30%). Quails in groups of eight (6 females and 2 males) were randomized designated to be placed in 40 wire cages (50 x 60 cm), with automated drinker and fed with a 22% CP and 2.9 ME Mcal/kg diet. Five cages (8 quails) were randomly designated to each of eight treatment resultant of factorial arrangement. After two weeks of starter the trial, eggs were collected across four weeks, select for hatching, placed in hatching machine and incubated. Egg production was diminished ($P < 0.01$) with FR of 30%, Cr had no effect ($P = 0.25$). Hatching egg was decreased ($P < 0.01$) by FR-20 and FR-30, Cr tended ($P = 0.09$) to improved it, and an interaction Cr x FR was observed ($P < 0.01$), FR-20% with Cr-100 shown similar values than control (70 vs. 66%). Fertility was reduced by FR ($P < 0.01$) at any level, interaction FR x Cr ($P < 0.01$) was observed, FR-20% supplemented with 100 ppb of Cr exhibit similar fertility to the 0% of FR treatment (55 vs. 50%). It is concluded that diet supplementation with 100 ppb of chromium from methionine, helps to maintain the reproductive performance of Japanese quail breeders under up to 20% feed restriction program.

Key Words: Japanese quail, Chromium, Feed restriction

1396 True phosphorus digestibility and the endogenous phosphorus outputs associated with canola meal for growing pigs. M. Z. Fan^{*}, T. Archbold, A. Ajakaiye, Y. Shen, K. Bregendahl, J. L. Atkinson, and R. R. Hacker, *University of Guelph, Guelph, Ontario, Canada*.

The objective of this study was to measure true phosphorus (P) digestibility and the endogenous P associated with canola meal for growing pigs. Four Yorkshire barrows, with average initial and final BW of 30 and 50 kg, were fitted with a simple T-cannula at the distal ileum and fed four diets according to a 4 x 4 Latin square design. The diets were cornstarch-based containing four levels of P from canola meal (2.25, 3.01, 4.38, and 5.54 g/kg DMI). Chromic oxide (0.4%) was included as a digestibility marker. Each experimental period consisted of 8 d with 4-d adaptation and 4-d collection of ileal digesta and fecal samples. The apparent ileal and fecal P digestibility values in canola meal were affected ($P < 0.05$) by P contents in the assay diets. The apparent ileal and fecal P digestibility values changed from 34.3 to 45.2% and from 41.7 to 33.0%, respectively, as the P content increased from 2.25 to 5.54 g/kg DMI. There were linear relationships ($P < 0.05$), expressed as g/kg DMI, between the apparent ileal and fecal digestible P and the total intake of dietary P. There were no differences ($P > 0.05$) in true P digestibility values (42.2 ± 14.0 vs $31.0 \pm 4.1\%$) and the endogenous P outputs (0.49 ± 0.20 vs 0.28 ± 0.06 g/kg DMI) associated with canola meal between the ileal and the fecal levels. Although canola meal is rich in total P content, P associated with canola meal is poorly utilized by growing pigs.

Key Words: True phosphorus digestibility, Canola meal, Growing pigs

1397 Cloning and characterization of genomic fragments encoding a putative ovine epidermal growth factor pueodogene. Sushil J. John* and Sylvie Bilodeau-Goeseels, *Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, Alberta, Canada.*

Mature epidermal growth factor (EGF) is a 53 amino acid polypeptide, known to stimulate cell proliferation as well as DNA synthesis in many cell types. In humans, it is processed from a 1200 amino acid precursor protein encoded by 24 exons within a 127 kb gene. The mature region is encoded by exons 20 and 21. EGF has been a potential feed additive since it has been shown to improve nutrient uptake and reduce intestinal infection in animals systems. Despite this economic promise, EGF sequence has not been reported from any ruminant sp. In this study, we report the first isolation and sequence characterization of genomic fragments encoding the mature region of a putative ovine EGF. We have isolated using PCR, two fragments spanning exons 20 and 21 respectively of the ovine EGF gene. Analysis of the nucleotide sequence from the two fragments shows 70% and 62% homology respectively with the published human EGF gene sequence. The exon-intron junctions are also conserved between the two species. Comparison of the deduced protein sequence of the ovine EGF with known EGF proteins from other species showed a homology varying from 38-40%, indicating an unique nature of ovine EGF protein. Although, some critical amino acids important for its function are conserved, presence of 3 stop codons in position 22, 33 and 41 are aspects that indicate this gene encodes a truncated, non-functional protein. In conclusion, we have isolated genomic fragments encoding the mature region of the putative ovine EGF gene, however analysis of the deduced protein sequence indicates that it is a pseudo-gene.

Key Words: Ovine, Epidermal Growth Factor, Genomic

1398 Expression of growth hormone receptor (GHR) 1A, IGF-I, total GHR and cyclophilin (cyclo) mRNA in hepatic tissue of periparturient Holstein cows. R. P. Radcliff*, B. L. McCormack, and M. C. Lucy, *University of Missouri, Columbia MO.*

Growth hormone plays a central role in the change in nutrient metabolism that occurs during the initiation of lactation. Growth hormone's actions are mediated by GHR whose mRNA is present in three alternatively spliced forms; GHR 1A, 1B and 1C. Liver specific GHR 1A mRNA is transiently decreased around parturition but the exact timing of the decline is not known. Our objective was to characterize GHR 1A, total GHR (1A, 1B and 1C), IGF-I and cyclo mRNA expression in liver of periparturient dairy cattle. Liver biopsies (n = 143) were collected from sixty-six Holstein cows at the University of Missouri Dairy Farm. At least two cows were sampled on each d from 15 d before to 14 d after parturition. Total cellular RNA was isolated and reverse transcribed to cDNA. Target cDNA was measured by quantitative real time polymerase chain reaction using probes and primers specific to each gene. The GHR 1A mRNA declined 2 d before parturition, was lowest 3 to 4 d after parturition and then increased (day; $P < 0.001$). Mean GHR 1A for weekly periods relative to parturition (d #15 to #8, d #7 to #1, d 0 to 7 and d 8 to 14) was 34 ± 3^a , 20 ± 4^b , 3 ± 4^c and 14 ± 4^b fg/ng cDNA respectively (means with different superscripts differ $P < 0.05$). The IGF-I mRNA declined 1 d after parturition, was lowest 2 to 5 d after parturition and then increased (day; $P < 0.01$). Mean IGF-I for weekly periods relative to parturition was 4.2 ± 0.4^a , 2.7 ± 0.5^{bc} , 1.4 ± 0.5^c and 3.1 ± 0.5^{ab} fg/ng cDNA. Total GHR mRNA was not affected by day ($P > 0.1$). Cyclophilin was not a valid housekeeping gene because its mRNA increased from 2 wk before parturition (72 ± 8^a , 99 ± 9^b , 116 ± 10^b and 102 ± 10^b fg/ng cDNA; day, $P < 0.01$). A detailed profile of GHR 1A, IGF-I, total GHR and cyclo mRNA expression during the periparturient period was provided. The decreases in GHR 1A and IGF-I during the transition period are rapid and occur immediately before (GHR 1A) or shortly after (IGF-I) parturition. Changes in IGF-I are correlated with changes in GHR 1A but not total GHR.

Key Words: GHR 1A, liver, cattle

1399 Inhibition of nitric oxide synthase increases glucose uptake and lipolysis in ovine hind-limb by a mechanism independent of insulin. J.J. Cottrell^{*1,2}, M.B. Mc Donagh², R.D. Warner^{1,2}, and F.R. Dunshea², ¹Victoria University, Werribee, Victoria, Australia, ²Natural Resources and Environment, Werribee, Victoria, Australia.

The jugular vein, abdominal aorta and lateral saphenous veins were catheterised in eight Border Leicester x Merino cross lambs (50-55 kg) to determine the effect of nitric oxide synthase (NOS) inhibition on hind-limb metabolism. Lambs were housed in metabolism crates with *ad libitum* access to food and water. Two bleeds were conducted 3 days apart, starting on the 3rd day post-surgery. Lambs were infused with either the NOS inhibitor L-arginine methyl ester hydrochloride (L-NAME) 30mg/kg or saline via the jugular catheter in a balanced randomised crossover design. On each infusion day, blood samples were obtained between -60 to 360 minutes relative to the infusion. Post infusion area under the curve for acute and semi-acute (15-120 and 120-360 post-infusion, respectively) responses were calculated relative to mean pre-infusion concentrations of glucose, lactate and non-esterified fatty acids (NEFA). Arterial plasma samples were pooled over pre-infusion, acute and semi-acute phases for analyses of plasma insulin, all data was analysed with ANOVAs. L-NAME acutely increased the glucose arteriovenous difference (AVD) (-6.4 v. 2 mM.min for control and L-NAME treatment, respectively, $P = 0.049$) indicating increased uptake of glucose by the hind limb. L-NAME also increased lipolysis and/or inhibited fatty acid uptake within the hind-limb, as shown by acute (1.8 v. -1.2 mM.min, $P = 0.06$) and semi-acute (4.3 v. -5.2 mM.min, $P = 0.021$) decreases in NEFA AVD. These metabolic changes were independent of insulin concentration, which was unchanged by L-NAME infusion (-42 v. -51 mU/mL.min, $P = 0.94$, and -91 v. 66 mU/mL.min, $P = 0.35$ for acute and semi-acute phases). L-NAME did not appear to alter hind limb glycogenolysis as indicated by unchanged lactate AVD (1.4 v. 0.6 mM.min, $P = 0.82$ and 4.5 v. -10.1 mM.min, $P = 0.26$ for acute and semi-acute phases). In conclusion, NO regulates carbohydrate and fat metabolism in the hind limb of the lamb by a mechanism independent of insulin. *Supported in part by Meat and Livestock Australia.*

Key Words: Nitric oxide, Hind limb, Ovine

1400 Glucose and hormonal profiles of Large White and Genex-Meishan gilts in early and late gestation. C. Farmer^{*1} and J.R. Cosgrove², ¹Agriculture and Agri-Food Canada, Dairy and Swine R & D Centre, Lennoxville, QC, Canada, ²Genex Swine Group, Regina, SK, Canada.

This project was done to determine the effect of genotype, namely Large White (LW) vs Genex-Meishan (GM; containing 50% Meishan genetics) on circulating concentrations of glucose, insulin, IGF-I and cortisol in early and late pregnancy. Jugular canulae were inserted non-surgically in 8 LW and 9 GM gilts on days 37 and 106 of gestation to obtain serial blood samples on days 38 and 107. Three preprandial samples (the mean of which represented the baseline) were obtained at 0740, 0750 and 0800 as well as postprandial samples every 20 min thereafter until 1100. Glucose and insulin concentrations were measured in all samples while values for cortisol and IGF-I were determined on all preprandial samples and hourly on postprandial samples. All gilts were weighed and their backfat measured on days 38 and 107 of gestation. Average ages of gilts at mating were 240.6 and 245.3 days for LW and GM, respectively. GM gilts were lighter on days 38 (138.3 vs 151.4 kg, SEM = 3.4 , $P = 0.02$) and 107 (173.4 vs 183.7 kg, SEM = 3.7 , $P = 0.07$) of gestation and their backfat was greater on both days 38 (23.2 vs 17.3 mm, SEM = 1.3 , $P = 0.004$) and 107 (24.3 vs 16.8 mm, SEM = 1.4 , $P = 0.002$). There was a breed x stage of gestation effect on baseline IGF-I concentrations ($P = 0.019$) with values being greater ($P = 0.003$) in GM on day 38 only. Baseline concentrations for glucose ($P < 0.001$) and insulin ($P = 0.02$) were lower in GM than in LW gilts on both days of gestation and baseline insulin was greater ($P < 0.0001$) on day 38 compared to day 107 of gestation in both breeds. There was a breed x stage of gestation interaction on the area under the curve (AUC) for IGF-I ($P = 0.028$). The AUC for postprandial values of IGF-I was greater ($P = 0.004$) in GM than LW on day 38 while that of glucose was lower ($P < 0.001$) in GM on both days; AUC for insulin and cortisol were unaffected by breed ($P > 0.10$). Glucose AUC was also altered by stage of gestation,

being greater ($P < 0.001$) on day 107 than on day 38. Meishan-derived and LW gilts therefore differ in their metabolism and this varies with stage of gestation (Thanks to Genex Swine Group for the animals and to Shur-Gain for supplying the feed).

Key Words: Swine, Gestation, Meishan

1401 Effect of time and day of injection on plasma β -hydroxybutyrate, NEFA, and urea N during 14-day subcutaneous injections of several dosages of glucagon in dairy cows. G. Bobe^{*1}, B. N. Ametaj², R. N. Sonon¹, D. C. Beitz¹, and J. W. Young¹, ¹*Iowa State University, Ames, IA*, ²*Purdue University, West Lafayette, IN*.

We showed previously that single injections of 2.5 and 5 mg glucagon decreased plasma NEFA concentrations in dairy cows in midlactation. Furthermore, we showed that plasma β -hydroxybutyrate (BHBA) and NEFA concentrations are decreased only in cows with elevated plasma BHBA and NEFA concentrations, respectively, during 14-day continuous intravenous infusions of glucagon beginning at d 21 postpartum, whereas plasma urea N (PUN) concentrations were not affected. We tested whether time and day of injection changes the plasma BHBA, NEFA, and PUN response during 14-day subcutaneous injections of several dosages of glucagon. Multiparous Holstein cows ($n=9$) were assigned randomly to 3 groups and received beginning d 8 postpartum 0 (Saline), 2.5 (7.5 mg/d Glucagon), or 5 mg (15 mg/d Glucagon) in 60 ml saline (pH 10.25) by subcutaneous injections of glucagon every 8 h for 14 d. Plasma BHBA, NEFA, and PUN responses were measured by taking 18 serial samples during the 8 h after the first (D1-2PM), second (D1-10PM), middle (D7-2PM), and third last (D13-2PM) injection. Glucagon injections decreased plasma BHBA and NEFA concentrations only in cows with elevated plasma BHBA (>8 mg/dl) and NEFA (>0.5 mM) concentrations, respectively ($P \leq 0.1$). Glucagon decreased primarily plasma BHBA concentrations 6-8 hrs after injections at d 7 and d 13 of the injection period and plasma NEFA concentrations for 1-4 hrs at the first injection day, with responses in greater magnitude and at earlier injection times in "15 mg/d Glucagon" cows ($P \leq 0.1$). Glucagon injections did not affect PUN concentrations ($P \geq 0.1$). We conclude that 5 mg subcutaneous glucagon injections every 8 h for 14 d beginning at d 8 postpartum decrease elevated plasma BHBA and NEFA concentrations more effectively than the 2.5 mg dosage in dairy cows. The effects of time and day of glucagon injections on plasma BHBA and NEFA concentrations depend on glucagon dosage, time postpartum, and plasma BHBA and NEFA concentrations. (Partly supported under CREES-USDA agreement 99-35005-8576).

Key Words: Fatty Liver, Glucagon, NEFA

1402 Effect of time and day of injection on plasma glucose and insulin during 14-day subcutaneous injections of several dosages of glucagon in dairy cows. G. Bobe^{*1}, B. N. Ametaj², R. N. Sonon¹, D. C. Beitz¹, and J. W. Young¹, ¹*Iowa State University, Ames, IA*, ²*Purdue University, West Lafayette, IN*.

We showed previously that single injections of 2.5 and 5 mg glucagon increased plasma glucose and insulin concentrations in midlactation dairy cows for 5 and 2 h, respectively. Furthermore, we showed that plasma glucose and insulin response changed during 14-day continuous intravenous infusions of glucagon beginning at d 21 postpartum. We tested whether time and day of injection changes the plasma glucose and insulin response during 14-day subcutaneous injections of several dosages of glucagon. Multiparous Holstein cows ($n=9$) were assigned randomly to 3 groups and received beginning d 8 postpartum 0 (Saline), 2.5 (7.5 mg/d Glucagon), or 5 mg (15 mg/d Glucagon) in 60 ml saline (pH 10.25) by subcutaneous injections of glucagon every 8 h for 14 d. Plasma glucose and insulin response were measured by taking 18 serial samples during the 8 h after the first (D1-2PM), second (D1-10PM), middle (D7-2PM), and third last (D13-2PM) injection. Glucagon injections of 2.5 and 5 mg increased plasma glucose concentrations for 3 and 4 hrs, respectively, and plasma insulin concentrations for 3 and 5 hrs, respectively, at 2 PM but not at 10 PM ($P \leq 0.1$). The time effect of glucagon was associated with increased plasma glucose and insulin concentrations prior to injection at 10 PM ($P \leq 0.1$). During the glucagon injection period, the length of the plasma glucose and insulin response increased and the peak response decreased but increased in significance, with responses in greater magnitude and at earlier injection times in "15 mg/d Glucagon" cows ($P \leq 0.1$). Elevated liver TAG concentrations

(>15 mg TAG/g wet weight) diminished plasma glucose and insulin peak responses to glucagon, in particular in "7.5 mg/d Glucagon" cows ($P \leq 0.1$). We conclude that cows in the early postpartal period and cows with fatty liver have a decreased response to glucagon injections that can be overcome by increased glucagon dosages. Time and day of glucagon injections affect plasma glucose and insulin responses to glucagon injections with greater increases in plasma glucose and insulin concentrations with higher glucagon dosages, progressing lactation, and lower liver TAG, plasma glucose and insulin concentrations. (Partly supported under CREES-USDA agreement 99-35005-8576).

Key Words: Fatty Liver, Glucagon, Insulin

1403 Effect of oxytocin injection before milking, attachment delay of milking teat cup and milking frequency on performance of Holstein cows. G. Ghorbani^{*1} and A. Jafari¹, ¹*Isfahan University of Technology*.

In order to determine the effect of oxytocin injection before milking, attachment delay of milking teat cup and milking frequency, six primiparous and six multiparous Holstein cows were selected. Levels of first factors were oxytocin injection before milking, attachment delay of teat cup and rapid attachment of milking teat cup and levels of second factor were two times milking per day and three times milking per day. Collected data were analyzed in a 6 by 6 latin square design in a 3 by 2 factorial experiment. Oxytocin injection compared to attachment delay of teat cup significantly increased milk production and 3.2 percent FCM in primiparous cows, multiparous cows and total cows. Also fat yield in primiparous cows, and fat, protein and lactose yield in multiparous cows and total cows, were increased significantly, but decreased percentage of fat and total solid in multiparous cows and total cows. Attachment delay of teat cup compared to rapid attachment of teat cup significantly decreased milk production and 3.2 percent FCM in primiparous cows, multiparous cows and total cows. Also fat, and lactose yield in primiparous cows; fat, protein and lactose yield and total solid percentage in multiparous cows and dry matter intake and fat yield in total cows were decreased significantly, but fat percentage increased in multiparous cows and total cows. Three times milking per day compared to two times milking per day significantly increased milk production, 3.2 percent FCM, fat and lactose yield in primiparous cows; 3.2 percent FCM in multiparous cows and milk production, 3.2 percent FCM, protein yield and lactose percentage in total cows, but decreased percentage of protein, lactose and total solid in primiparous cows. The results of this experiment indicated that oxytocin injection before milking, rapid attachment of teat cup and three times milking per day have the best effect on the cows performance in the middle of lactation.

Key Words: oxytocin, Attachment of teat cup, milking frequency

1404 Endocrine responses to isoglucogenic infusions of whey protein and propionic acid in dairy cows. L. Misciattelli^{*}, M. Vestergaard, and T. Hvelplund, *Danish Institute of Agricultural Sciences*.

Endocrine responses to isoglucogenic infusions of a whey protein isolate into the duodenum and propionic acid into the rumen was assessed in order to investigate the mechanisms that regulate milk production in response to changes in protein supply. Four mid-lactation dairy cows with rumen, duodenal and ileal cannulas were used in 4x4 Latin square design, with 14 d periods. The 4 treatments provided the cows with equal quantities of glucogenic substrates, but differing in the proportion coming from propionate or amino acids. The cows were fed 12.7 kg DM/d of a TMR low in intestinally absorbable protein. The ration composition was (% DM): clover grass silage (55), peas (23), rumen protected fat (7), beet molasses (14) and minerals (1). The data was analysed with PROC GLM for standard Latin square design, with one missing observation (treatment 200:200). Plasma obtained by venepuncture at 13:00 on d 11, 12 and 13 was analysed for BHBA, urea, NEFA, glucose (GLUC), tri-acyl glycerides (TG), fructose amine (FCA), IGF-I and triiodothyronine (T3). Catheters were placed in a jugular vein on d 14, and blood samples were taken at 3 h intervals for a 24 h period and analysed for: insulin (INS), glucagon (GLG) and growth hormone (GH). Milk yield, milk protein %, plasma BHBA, urea and NEFA increased significantly with increasing proportion of protein infused, while plasma GH was negatively correlated with protein infusion level. The results suggest that the stimulatory effect of extra absorbable protein

on milk yield mainly was due to an increased supply of amino acids to the mammary gland rather than an endocrine mediated effect.

Whey protein, g/d	600	400	200	0	SEM	P
Propionate, g/d	0	100	200	300		
Milk yield, kg/d	20.2	19.7	18.0	16.3	0.6	*
Milk protein %	3.27	3.27	3.23	3.08	0.03	*
BHBA, mmol/L	2.9	2.5	1.7	1.7	0.2	*
UREA, mmol/L	8.0	7.7	7.6	6.3	0.2	*
NEFA, meq/L	0.135	0.132	0.122	0.115	0.003	*
GLUC, mmol/L	3.54	3.72	3.96	3.75	0.08	T
TG, mmol/L	0.15	0.15	0.18	0.14	0.02	NS
FCA, μ mol/L	216	210	252	206	9.6	NS
INS, pmol/L	92	101	104	96	6.7	NS
GLG, ng/L	139	132	127	129	7.8	NS
GH, μ g/L	3.2	3.1	3.2	5.9	0.9	*
IGF-I, μ g/L	100	97	95	92	5.4	NS
T3, nmol/L	1.42	1.55	1.50	1.51	0.07	NS

NS: $P \geq 0.1$, T: $P < 0.1$, *: $P < 0.05$

Key Words: Protein, Milk production, Hormonal regulation

1405 Glucose metabolism and insulin sensitivity in Gulf Coast Native and Suffolk ewes during late gestation and early lactation. C.C. Williams^{*1}, K.J. Calmes¹, J.M. Fernandez¹, C.C. Stanley¹, J.C. Lovejoy², H.G. Bateman¹, L.R. Gentry¹, D.T. Gantt¹, and G.D. Harding¹, ¹Louisiana State University Agricultural Center, Baton Rouge, LA 70803, ²Pennington Biomedical Research Center, Baton Rouge, LA 70808.

Two experiments were conducted to evaluate possible differences in glucose metabolism and insulin responsiveness in Gulf Coast Native (GCN) and Suffolk (SFK) ewes. In experiment 1, 30 GCN and 41 SFK ewes in late gestation were used to identify hyperglycemia and hyperinsulinemia. Blood samples were obtained via jugular venipuncture and analyzed for plasma insulin, glucose, thyroxine, albumin, and urea N (PUN) concentrations. In experiment 2, at 2 wk postpartum, 19 GCN and 19 SFK ewes were administered frequently sampled intravenous glucose tolerance tests (FSIVGTT) consisting of a pulse dose of glucose (0.5 mg/kg BW) followed by an infusion of insulin (0.03 IU/kg BW). Blood samples were collected via jugular catheter at timed intervals over a 3 hr period after glucose infusion. Samples from the FSIVGTT were analyzed for insulin and glucose concentrations, and the minimal model computer program was then used to assess glucose effectiveness (S_G), an estimate of insulin-independent glucose disappearance; insulin sensitivity (S_I), an estimate of insulin-dependent glucose disappearance; and acute insulin response (AIR_G), insulin secretion relative to glucose administration. Concentrations of albumin, thyroxine, and PUN were measured in samples collected prior to glucose infusion. In experiment 1, insulin concentrations were greater ($P < 0.01$) in SFK ewes while glucose concentrations were not different ($P > 0.05$) between breeds. Concentrations of albumin ($P < 0.01$), thyroxine ($P < 0.05$), and PUN ($P < 0.05$) were greater in SFK ewes. In experiment 2, S_G and S_I did not differ between breeds, while AIR_G tended to be greater ($P = 0.06$) in SFK ewes. There were no differences ($P > 0.05$) in albumin, thyroxine, or PUN concentrations. These data indicate slight differences in insulin sensitivity between GCN and SFK ewes during late gestation. However, there were no apparent differences in glucose metabolism between these breeds during the early lactation period.

Key Words: Glucose metabolism, Insulin sensitivity, Sheep

1406 Influence of zinc deficiency on the mRNA expression of zinc transporters in adult rats. MW Pfaffl^{*1} and W Windisch¹, ¹Department of Animal Physiology, Center of Life and Food Sciences, Techn. Univ. Munich.

The accumulation of zinc (Zn) in the cell is a sum of influx and efflux processes via transporter proteins, like the four Zn transporters (ZnT1-4), the divalent cation transporter 1 (DCT1) and of storage processes mainly bound to metallothionein (MT). To study the effect of Zn deficiency on mRNA expression levels adult rats were used as an animal model. Rats were fed an almost Zn free diet for 29 d, which induced Zn mobilization from body Zn stores. Tissues representing Zn absorption (jejunum, colon), Zn storage and utilization (muscle, liver), and Zn excretion (kidney) were retrieved. Real-time reverse transcription

(RT) polymerase chain reaction (PCR) assays were developed and a relative quantification on the basis of GAPDH was applied. Assays allowed a relative and accurate quantification of mRNA molecules with a sufficiently high sensitivity and repeatability. All known Zn transporter subtypes were found in the tissues. Expression patterns and reactions to Zn deficiency were specific for the tissue analyzed. The table shows the n-fold expression levels up (+) or down (-) regulated by Zn deficiency. Expression results imply that some transporters are expressed constitutively, whereas others are highly regulated (*) in tissues responsible for Zn homeostasis. The most distinct changes of expression levels were shown in colon which can therefore be postulated as a highly Zn sensitive tissue. MT was down-regulated in all tissues, in parallel with intracellular Zn status, and is therefore a potent candidate gene for Zn deficiency. This study provides the first comparative view of regulation of gene expression and fully quantitative expression analysis of all known Zn transporters in a non growing adult rat model.

	MT	DCT1	ZnT1	ZnT2	ZnT3	ZnT4
jejunum	-1.39	+1.27	-3.79	-5.56	+8.04	+1.24
colon	-6.74***	-5.53	+10.06*	+1.39*	+9.29	+2.09*
liver	-154.7***	-1.88	+1.04	-1.71	-1.03	+1.13
muscularity	-1.28	-1.26	-1.55	-3.04	-9.98	-1.20
kidney	-1.27	+2.56	-4.57	+1.07	+4.49*	-1.18

Key Words: Zinc deficiency, Zinc transporters 1-4, Adult rat model

1407 Metabolic effects of zinc deficiency on the somatotrophic axis in non-growing rats as a new animal model to adult individuals. MW Pfaffl¹, RM Bruckmaier^{*1}, and W Windisch¹, ¹Department of Animal Physiology, Center of Life and Food Sciences, Techn. Univ. Munich.

Model studies on zinc (Zn) deficiency are usually performed with fast growing rats. But the intensive anabolic situation produces severe interactions between Zn deficiency per se and the metabolism in toto. Respective results may thus not fully reflect the situation in adults. To overcome this methodological disadvantage, we developed an animal model to study Zn deficiency in adult non-growing rats. Feed intake was restricted to 8 g/d containing 2 g Zn/g fortified with pure phytate in Zn deficiency rats and 58 g Zn/g in controls (n=7). At day 1, 2, 4, 7, 11, 16, 22, and 29 of Zn deficiency, 3 animals each were euthanized. Zn deficiency was evident from reduced plasma Zn, plasma alkaline phosphatase activity and severe mobilization of Zn from tissue stores (mainly skeleton), while feed intake and body weight remained unaffected. Metabolic effects on key players of the somatotrophic axis were analyzed on mRNA and protein level. A relative quantification in real-time RT-PCR was applied in liver RNA. Expression levels of insulin-like growth factor 1 (IGF-1), IGF-1 receptor (, growth hormone receptor, and three IGF binding proteins (IGF-BP1-3) were quantified. All transcripts were expressed in liver and each factor exhibited a specific pattern. IGF-BP2 mRNA declined slightly (1.8-fold down-regulation, $P < 0.05$). All other transcripts remained unchanged over 29 d Zn deficiency. Growth hormone and IGF-1 plasma concentrations, analyzed by radioimmunoassay, remained constant during Zn depletion (3314 ng/ml and 27546 ng/ml, respectively). Furthermore non-esterified fatty acids (NEFA) and glucose plasma levels were measured enzymatically. Concentrations of NEFA (0.580.16 ng/ml) and glucose (25434 ng/ml) did not change with time. In conclusion, Zn deficiency did not affect mRNA expression and protein levels on key players of the somatotrophic axis, except for IGF-BP2, as well as key metabolites.

Key Words: Zinc deficiency, Somatotrophic axis, Adult rat model

1408 Effect of drinking diluted seawater on some physiological aspects of camels. H. Abdel Rahman^{*1}, M. El Sherif², S.S. Omar¹, M.A. ElSayed¹, and N.M. Ibrahim², ¹Minufiya University, Faculty of Agriculture, ²Desert Research Institute, Egypt.

Four she camels *Camelus dromedaries*, aged 12 years and weighed 558.6 kg on average, were kept in 15 x 11 m open yard and fed *ad libitum* on fresh acacia and clover hay. Tap water (680 ppm TDS) was available *ad libitum* for 2 weeks in each summer and winter as control periods (CP), followed by consecutive 20 days treatment periods (TP), when they drank diluted sea water (SW) mixed at the rate 1/1.5 sea/tap water containing TDS 14539 ppm. Blood samples were collected on the day before and last day of treatment with saline water. Diurnal changes in

respiration rate (RT), rectal (RT), skin (ST), coat CT), ambient temperatures and relative humidity were recorded. Activity of glutamic pyruvic (GPT), glutamic oxalic (GPT) transaminases and concentration of Na, K, Mg, T3 and T4 in blood plasma were determined. Drinking SW decreased RT ($P < 0.01$), increased CT ($P < 0.05$) and insignificantly RR specially in summer. Significant diurnal changes were detected in RT, ST, CT ($P < 0.01$) and RR ($P < 0.05$) in the same order of AT changes. Drinking SW also significantly increased plasma concentration of Na, K, hemoglobin, MCH and MCHC indices, activity of GPT and decreased T3 and T4. Generally, camels can tolerate drinking diluted seawater containing enormously high total dissolved salts up to 14540 ppm.

Key Words: Drinking seawater, physiological aspect, camels

1409 Effect of different levels of passive immunity on response to intravenous immunoglobulin in calves. C. J. Hammer^{*1}, J. D. Quigley², and H. D. Tyler¹, ¹Iowa State University, ²APC Company, Inc.

Adequate concentrations of IgG are imperative for the health and survival of neonatal calves. Oral and intravenous IgG supplements have been developed to supplement or replace maternal colostrum (MC) when it is unavailable or when the calf has failure of passive transfer. The objective of this study was to determine the effect of different levels of passive immunity on calf response to administration of intravenous immunoglobulin (IVIG). The IVIG was concentrated from bovine abattoir blood to a final concentration of approximately 35 g IgG/L. Dairy breed bull calves ($n = 32$) were removed from their dams immediately after birth and assigned to one of four treatment groups. Calves in the high group (H) received 2 L of pooled MC at 1 h and 12 h after birth. Calves in the low group (L) received 1 L of MC mixed with 1 L of milk replacer at 1 h and 12 h after birth. Calves in the deprived group (D) received 2 L of milk replacer at 1 h and 12 h after birth. Calves in the control group (C) received 2 L of pooled MC at 1 h and 12 h after birth. At 3 d of age, calves in the H, L, and D group all received 500 ml of IVIG administered via jugular catheter. Calves in the control group received 500 ml of 0.9% NaCl. Blood was collected by jugular venipuncture prior to infusion, and again at 1, 3, 7, 10, 14, 21, and 28 d post infusion for determination of plasma IgG by turbidimetric immunoassay. Mean plasma IgG concentrations at 3 d of age were different between the H, L, and D group of calves, but not between H and C. Mean plasma IgG at 3 d of age were 12.1, 6.3, 0.0, and 11.8 g/L for calves in H, L, D, and C, respectively. Calves in all treatment groups had a greater rise in mean plasma IgG compared to C calves at 1 d post infusion. Mean increase in plasma IgG at 24 h post infusion were 1.8, 2.4, 3.0, and #0.1 g/L for calves in H, L, D, and C, respectively. These data indicate that IVIG can increase plasma IgG levels in calves regardless of the level of passive immunity present at infusion.

Key Words: Calf, Immunoglobulin, Colostrum

1410 Characterization of *Staphylococcus* species in bulk tank milk. N. V. Hegde^{*}, R. Butchko, and B. M. Jayarao, The Pennsylvania State University, University Park, PA, USA.

A total of 126 dairy herds from 14 counties in Pennsylvania were examined for number and type of *Staphylococcus* species. *Staphylococcus aureus* (SA) was detected in 49 of 126 (40.2 %) of bulk tank milk (BTM) samples. Counts ranged from 0 - 275 cfu/ml (mean, 45 cfu/ml). Coagulase negative *Staphylococcus* (CNS) were observed in 117 of 126 (92.8 %) of BTM samples. Counts ranged from 0 - 15,175 cfu/ml (mean, 1246 cfu/ml). A total of 434 isolates from 122 BTM samples were examined to species level; 434 isolates belonged to 18 different species. *Staphylococcus aureus*, *S. xylosus*, *S. chromogenes*, and *S. hyicus* were detected in 40.1, 30.3, 25.4, and 25.4% of bulk tank milk samples, respectively. High CNS counts (>1,000 cfu/ml) were associated with high bulk tank somatic cell counts (mean, 414,109 cells/ml) and/or high standard plate counts (mean, 12,289 cfu/ml). A critical review of farm management practices using a self administered questionnaire followed by consultations with dairy producers strongly indicated that; 1) Dairy producers who used sand as bedding had low (<500 cfu/ml) CNS counts in bulk tank milk, and 2) Most of the dairy producers (94%) who practiced fore-stripping, and pre-and post-dipping had low (<500 cfu/ml) CNS counts.

The findings of the study suggest that proper management practices related to bedding and milking practices can influence the number and type of CNS in bulk tank milk.

Key Words: bulk tank milk, *Staphylococcus aureus*, coagulase negative staphylococci

1411 Leptin attenuates the central effects of neuropeptide-Y on somatotropin but not gonadotropin secretion in cows. M. R. Garcia^{*1,2}, M. Amstalden^{1,2}, D. H. Keisler³, N. Raver⁴, A. Gertler⁴, and G. L. Williams^{1,2}, ¹Texas A&M University Agricultural Research Station, Beeville, TX/USA, ²Texas A&M University, College Station, TX/USA, ³University of Missouri, Columbia, MO/USA, ⁴The Hebrew University of Jerusalem, Rehovot/Israel.

Objectives were to determine whether the action of centrally-administered neuropeptide-Y (NPY) on secretion of LH and GH in ovariectomized cows could be attenuated by recombinant ovine leptin (oleptin). A secondary interest was to examine the interactive effects of NPY and leptin on FSH secretion. Six ovariectomized cows, each surgically-fitted with third-ventricle guide cannulas, were assigned randomly to each of three treatment groups in a Latin Square arrangement: 1) Saline-Saline-Saline (SSS); s.c. and i.v. saline at 0 and 70 min, respectively; intracerebroventricular (ICV) infusion of phosphate buffered saline (PBS)-0.3% bovine serum albumen (BSA) at 90 min, 2) Saline-Saline-NPY (SSN); same as group 1 except 500 μ g pNPY in PBS-0.3% BSA at 90 min, and 3) Leptin-Leptin-NPY (LLN); s.c. and i.v. oleptin (30 μ g/kg) in saline at 0 and 70 min, respectively; 500 μ g pNPY ICV in PBS-0.3% BSA at 90 min. Plasma concentrations of leptin increased ($P < 0.01$) 4-fold (39 ± 9 ng/ml) after leptin treatment and remained elevated, relative to controls (6 ± 2 ng/ml), throughout the remainder of the sampling period (200 min). Secretory patterns of LH, FSH, and GH did not change ($P > 0.1$) after leptin treatment. Variation ($P \leq 0.05$) in baseline and mean serum concentrations of LH, FSH, and GH were detected between replicates, days, and animals. Variation ($P < 0.01$) in pulse amplitude and frequency of GH and FSH were detected between replicates. Plasma concentrations of LH began to decline immediately after the infusion of NPY in SSN and LLN treatments, and were markedly lower ($P < 0.01$) than SSS within 2 h after infusion. Plasma concentrations of GH were greater ($P < 0.01$) during the first h following NPY treatment in SSN, but this increase was attenuated in LLN. Serum GH did not change in the SSS group, and FSH was similar among all treatments. Results confirm suppressive and stimulatory effects of NPY on LH and GH, respectively, and that leptin can attenuate the action of NPY on GH but not LH secretion in cows.

Key Words: Leptin, NPY, GH

1412 Effects of three post-weaning management regimes on protein-abundance of lipogenic enzymes and adipogenic activities in adipose tissues of beef cattle. E. Okine^{*1}, M.A. Price¹, L. Goonewardene², P. Mir³, Z. Mir³, J.A. Basarab², V. Baron⁴, and J.J. Kennelly¹, ¹AFNS, University of Alberta, Edmonton, AB T6G 2P5, ²Livestock Industry Division, AAFRD, Edmonton, AB. T6H 5T6, ³Agriculture and Agri-Food Canada, Lethbridge, AB T1J 4B1, ⁴Agriculture and Agri-Food Canada, Lacombe, T4L 1W1.

The objectives of this study were to determine the effects of three post-weaning management regimes on the activities and protein-abundance (PA) of acetyl CoA carboxylase (ACC) and fatty acid synthetase (FAS) in subcutaneous adipose tissue of 54 steers. Incorporation of [14 C]palmitate into triglycerides and adipogenic activities (using cultured mouse 3T3-L1 preadipocytes) in these steers were also determined. The regimes were feedlot (F), background-feedlot (BF) and background-pasture-feedlot (BPF). ACC activity in the F group was 75 and 65% ($P < 0.05$) lower than BF and BPF groups, respectively. PA of ACC ranged from 10 to 17 OD mm^{-2} ($P < 0.05$) in F, BF and BPF groups. Similar results were obtained for FAS activity and abundance in these steers. Esterification of palmitate was ($P < 0.05$) higher for BF and BPF steers vs F steers. Cellular-GPDH activity (a marker for adipocyte differentiation) and retinol concentrations were higher ($P < 0.05$) in the F group and not different for BF and BPF groups. The high enzyme activities and esterification rates in BF and BPF steers indicate that fatty acid synthesis was still active in these groups compared to F steers. These results were reflected in the marbling grades for the F, BF and BPF groups which were: A and AA (83.3, 70.8 and 100%), AAA (16.6, 25

and 0%), B1 (0, 4.2 and 0%), respectively. We conclude that adipogenic and anti-adipogenic components interact to determine the activities and protein abundance of ACC and FAS in adipose tissue. As cattle near finish, the effects of anti-adipogenic components may outweigh the influence of adipogenic substances leading to low PA and activities of ACC and FAS and low esterification rates.

Key Words: Cattle, Lipogenesis, Adipogenicity, Acetyl-CoA carboxylase, Adipose tissue, Fatty acids synthesis

1413 Effects of diets high in linoleic acid on carcass fat and CLA content, serum leptin, and age at puberty in beef heifers. M. R. Garcia^{1,2}, M. Amstalden^{1,2}, C. D. Morrison³, D. H. Keisler³, and G. L. Williams^{1,2}, ¹Texas A&M University Agricultural Research Station, Beeville, TX, USA, ²Texas A&M University, College Station, TX, USA, ³University of Missouri, Columbia, MO, USA.

Objectives were to determine the effects of feeding a diet high in linoleic acid on total carcass fat content and fatty acid composition, circulating metabolic hormones, and age at puberty in developing crossbred (Angus or Red Angus x Hereford x Brahman) beef heifers. Heifers were weaned and blocked by BW (Heavy, n=10; Light, n=10) and allocated randomly within block to receive isocaloric and isonitrogenous diets formulated with either added fat (HF, n = 10) or no added fat (C, n = 10) from 4 mos of age until post-pubertal slaughter. Whole sunflower seed (55 % oil content) was utilized in HF diets to provide 5 % added fat from the start of the study until heifers weighed 250 ± 8 kg, at which time added fat was increased to 7 % of DM until slaughter. Puberty was confirmed based on serum concentrations of progesterone ≥ 1 ng/ml for 2 consecutive samples and visual confirmation of corpora lutea (CL) by transrectal ultrasonography. Heifers were slaughtered at 325 ± 10 d of age. Total carcass composition was estimated from longissimus muscle, with CLA composition determined in internal and s.c. fat. HF-Heavy heifers tended ($P < 0.10$) to reach puberty later than all other heifers, and one HF-Light heifer did not reach puberty during the study. Linoleic acid and *cis-9, trans-11* CLA tissue content was higher ($P \leq 0.03$) in the HF group, but neither total carcass fat nor percent DM differed due to diet, although the percent protein tended ($P < 0.10$) to be lower in HF heifers. Serum leptin did not differ due to diet; however, leptin increased ($P \leq 0.01$) linearly throughout the study. Serum GH and IGF-I increased or remained relatively constant during the first 2-10 weeks of feeding, then began a slow decline ($P < 0.05$) until the onset of puberty, with serum IGF-I lower ($P \leq 0.01$) in HF heifers. Serum insulin and total cholesterol increased ($P < 0.01$) throughout the study in both groups, but only total cholesterol was affected by the HF diet ($P < 0.05$). Growing diets high in linoleic acid appear to have little or no effect on total carcass fat, serum leptin, or age at puberty in beef heifers despite increased CLA tissue content.

Key Words: Puberty, CLA, Leptin

1414 The role of ghrelin and GHS receptor on proliferation and differentiation of ovine preadipocytes. SG Roh*, KC Choi, Y Shrestha, C Yoon¹, and S Sasaki, *Lab of Animal Molecular Physiology, Faculty of Agriculture, Shinshu University, JAPAN*, ¹Dept of Animal Science, Iksan College, Iksan, KOREA.

Ghrelin is a novel endogenous natural ligand for the growth hormone secretagogue receptor (GHS-R or ghrelin receptor) that has been recently isolated from the rat stomach. Thess 28 amino acids constituting peptide has n-octanoylation in its serine-3 residue, which is essential for the ghrelin activation. Ghrelin has been demonstrated to regulate pituitary GH secretion via GHS-R when administered into the central nervous system or peripherally along with GHRH and somatostatin. GHS-Rs have been identified in many other tissues, other than the hypothalamic neurons and in the brainstem, like heart, lung, pancreas, intestine, uterus and adipose tissue, but their functions are unknown on these tissues. The mechanism by which ghrelin and GHS-R affect the proliferation and differentiation of ovine preadipocytes has remained largely unknown. This study was conducted to examine the role of ghrelin and GHS-R on the proliferation and differentiation of ovine primary preadipocytes in culture. The preadipocytes, which were obtained from sheep subcutaneous adipose tissues, were proliferated to confluence and then differentiated to adipocytes in differentiation medium for 10 days. The confluent preadipocytes and differentiated adipocytes at days 3, 7 and 10 were harvested for total RNA extraction and RT-PCR of GHS-R mRNA. Ghrelin decreased the proliferation of preadipocytes. The level

of GHS-R mRNA was significantly increased during the differentiation period, although this was not detected in the confluent preadipocytes. Furthermore, ghrelin stimulated the differentiation of preadipocytes and increased the level of GHS-R during the differentiation. In conclusion, our results demonstrate that ghrelin and GHS-R have an important role on the process of adipogenesis of ovine preadipocytes.

Key Words: Ghrelin, Adipocyte, Sheep

1415 Slow-release somatotropin reduces plasma leptin in lactating dairy cows. F. Rosi^{*1} and L. Pinotti^{2, 1}, *Zootecnia Generale, Facoltà di Agraria*, ²Dept. VSA, *Facoltà di Medicina Veterinaria- Università di Milano I-20133 Milan Italy*.

Somatotropin has dramatic effects on adipose tissue and lipid metabolism. Leptin, produced and released primarily by adipose cells, exerts a regulatory control on energy homeostasis. The aims of this study were to determine the effects of bST administration on milk production, plasma leptin and selected plasma metabolites in lactating dairy cows. Forty Holstein cows (90±33) were randomly divided into 2 groups: Control and bST. The bST group received 640mg/4wk of slow-release bST (Posilac) for two cycles. Milk yield and composition were measured at 7 days post-injection of each cycle. Blood samples were collected on the same day before feeding, and analyzed for leptin, NEFA, total protein, α -amino nitrogen, and urea nitrogen. Both milk yield and milk fat percentage were increased (29.9 vs. 35.3 kg/d; $P \leq 0.01$; 3.59 vs. 3.92%; $P \leq 0.05$) by bST administration, while milk protein content was unaffected by treatment (3.19 vs. 3.13%). At 7 days post-injection, bST decreased ($P < 0.01$) plasma leptin by 33% (4.26 vs. 2.86 μ g/l) whereas plasma NEFA was drastically increased (225 vs. 875 μ mol/l; $P \leq 0.01$). Plasma total protein was increased by bST (78.9 vs. 81.4 g/l; $P \leq 0.05$), while both α -amino nitrogen and urea in plasma of treated cows were reduced ($P \leq 0.01$) by 20% (2.54 vs. 2.03 mmol/l; 6.55 vs. 5.27 mmol/l, respectively). These data confirmed a galactopoietic effect of bST, which imposed, on peak of response, a higher demand of nutrients sustained by an enhanced lipolysis in adipose tissue. Lower plasma leptin observed in present study could be due to reduced body fat mass as consequence of lipolysis induced by bST. This is in line with higher plasma NEFA concentration observed in bST group. Plasma nitrogen metabolites indicate a higher efficiency in protein metabolism in treated cows. This study show that plasma leptin is linked with the nutritional status of cows, even though other hormones and metabolites are also involved in the signaling and control of body energy store.

Key Words: bST, Leptin

1416 The influence pre-calving Somatotropin treatment on the quantity and quality of colostrum in beef cattle. N. Macewko, G.A. Angliss, E.F. Jones, K.E. Govoni, M.F. Loughlin, D. Cissel, S.A. Zinn, D. Schreiber, and T.A. Hoagland, *University of Connecticut, Storrs, Connecticut*.

Fourteen Hereford beef cows (3-8 years old) were randomly assigned to receive no Posilac (Monsanto) or Posilac (500mg) every two weeks for either four (three injections) or eight (five injections) weeks before calving. At calving, all cows were milked with a portable vacuum machine for 15 minutes. The weight and colostrometer reading of the milk was recorded. Samples of milk were obtained for determination of IgM, IgG1, and IgG2 concentrations. Percent fat, protein, and total solids of the milk were determined. The weight of milk was similar for the control, four, and eight week Posilac treated cows (1.5, 1.3, and 1.3 kg respectively; SEM=0.3). Colostrometer readings and the concentrations of IgM and IgG1 were not significantly influenced by the Posilac treatments. There was a linear effect ($P \leq 0.05$) of Posilac treatment on milk IgG2 concentrations for the control, four and eight week Posilac treated cows (5370, 5864, and 8208 mg/dl respectively; SEM=1452). The percent fat, protein, and total solids were similar in the milk across treatments; however, the percent protein and total solids were greater ($p=0.21$) in the Posilac treated groups. The average daily gain from birth to weaning (0.9, 1.1, and 1.2 kg/day; SEM=0.05 respectively for the control, four, and eight week Posilac treated cows) was significantly ($P \leq 0.05$) greater for the calves suckling the Posilac treated cows. In conclusion, Posilac treatment pre-calving influenced the quality of colostrum by increasing the concentration of IgG2 and increased the average daily gains of the calves suckling the treated cows.

Key Words: colostrum, beef cows, immunoglobulins

1417 Protocols for detection of EPSP synthase gene in sheep fed diets containing Roundup Ready® canola. R. Sharma*¹, T.W. Alexander^{1,2}, D. Damgaard¹, R.J. Forster¹, and T.A. McAllister¹, ¹*Agriculture and Agri-Food Canada, Lethbridge, AB,* ²*University of Alberta, Edmonton.*

Standardized protocols were developed for detecting the gene encoding 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) in samples collected from sheep fed barley-based diets containing 6.5% (DM basis) Roundup Ready® canola (RRC). Glyphosate tolerance in RRC is conferred by the coding region of EPSPS derived from *Agrobacterium tumefaciens* CP4. Genomic DNA was extracted from diets and rumen digesta using a modified CTAB extraction procedure, but was found unsuitable for reproducible PCR amplification of EPSPS gene fragments from complete diets. Passing the genomic DNA from the CTAB extraction through a DNeasy™ plant mini-kit column (Qiagen), however, did produce a good yield of PCR-quality DNA. A Wizard™ genomic DNA purification kit (Promega) was used for extraction of DNA from blood samples. Primer sets were designed and PCR reaction conditions standardized that allowed amplification for of eight different regions (144- to 527-bp fragments) of the 1.3-kb EPSPS coding region. Positive PCR controls for both plant and bacterial DNA were included in screening diet and digesta samples, PCR controls for animal DNA with ovine tissues, and all three controls with fecal samples. Screening samples for the presence of the transgene entailed PCR assays for the eight fragments at two genomic DNA concentrations (ng and pg range). Using positive controls (spiked samples), the assay was confirmed sensitive enough to detect pg quantities of transgene in diet and blood, and ng quantities in digesta samples. Results of PCR assays were confirmed with Southern blot hybridizations. This protocol has been optimized for DNA extraction and sensitivity of detection, and has proven highly reliable. Transgene fragments were not detected in blood samples collected from sheep 2 to 3 h after feeding the RRC diet. Rubisco small subunit-specific (~500 bp) and chloroplast DNA-specific fragments (653 bp) could be detected in digesta and fecal samples, whereas no fragments of the EPSPS coding region were found.

Key Words: EPSP Synthase, Roundup Ready®, PCR

Ruminant Nutrition Feed Additives, Fiber, and Minerals

1419 Preliminary report on chemical composition and ruminal degradation of *Aloe vera*. J. A. Vergara, M. A. Cuauero, and O. E. Araujo Febres*, *The University of Zulia, Maracaibo, Venezuela.*

Ruminal degradability of dry matter (DMS) and organic matter (DMO) of *Aloe vera*(AV) and *Brachiaria humidicola*(BH) as a reference were evaluated. Ten grams samples of AV and BH milled to 3 mm were incubated in nylon bags at 0, 6, 12, 24, 48 and 72 h in two crossbred steers with permanent rumen canulae (350 kg LW). Non-linear regression was used to calculate the parameters: a, b and c, while a + b was the potential degradability (PD); c, ruminal degradation rate (DR); a, instant degradability (ID). A completely randomized design with 4 replicates was used; means of degradation at 48 and 72 h and equation parameters were compared by LS Means. Chemical composition of AV was: DM: 90%; OM: 86.9%; crude protein: 7.5%; ADF: 39.6%; and NDF: 38.5%. DMS of AV was stabilized among 48 and 72 h (89.90%) higher than (P<0.05) values for BH at 48 h. Same performance had DMO. PD of MS and MO of AV (99.87% and 99.84%) were higher (P<0.05) than BH values (71.44% and 68.67%). DR of MS in the rumen was similar among byproducts (0.022 vs. 0.029, respectively); while DR of MO was 0.031 and 0.022 for AV and BH, respectively. The higher value (P<0.05) of DI of AV (40.9%) increased PD. AV degradability and Venezuelan production potential of this specie determine a high importance for animal feeding in arid zones.

Key Words: Aloe vera, Ruminal Degradability, Arid Zone

1418 Influence of nutrition and body condition score on plasma concentrations of IGF-I and thyroxine (T4) in gestating beef cows. C. A. Lents*¹, R. P. Wettemann¹, J. M. Bolanos², F. J. White¹, I. Rubio¹, N. H. Ciccioli¹, and L. J. Spicer¹, ¹*Department of Animal Science, Oklahoma Agricultural Experiment Station, Stillwater, 74078,* ²*Ministry of Agriculture, San Jose, Costa Rica.*

Pregnant Angus x Hereford cows (n = 73) were used to determine the effects of nutrient intake and body condition score (BCS; 1 = emaciated and 9 = obese) on concentrations of IGF-I and T4 in plasma. At 2 to 4 mo of gestation, cows were blocked by BCS and assigned to one of four nutritional treatments: high (ad libitum access to a 50% concentrate diet in the drylot), or adequate native grass pastures and one of three amounts of a 40% CP supplement each day (moderate, 1.6 kg; low, 1.1 kg; or very low, 0.5 kg). After 115 d of treatment, all cows grazed dormant native grass pasture and received 1.6 kg/d of a 40% CP supplement. At 70 and 125 d of treatment, cows were gathered and plasma samples were collected by tail venipuncture (fed sample). After 18 h without feed and water, a second plasma sample was collected (fasted sample). Concentrations of IGF-I and T4 were determined by RIA. BCS was similar for all groups (4.6 ± 0.1) at the initiation of treatment. After 70 d, BCS was greatest (P < 0.01) for high cows and similar for moderate, low, and very low cows. High cows had greater (P < 0.05) concentrations of IGF-I in fasted samples than all other groups, but IGF-I was similar in fed samples for all treatments. Treatment and access to feed did not influence plasma concentrations of T4. BCS at 70 d was correlated with plasma IGF-I in fasted samples (r = 0.43; P < 0.001) but not in fed samples. After 125 d of treatment, BCS was greatest (P < 0.01) for very high cows (6.4 ± 0.1), similar for moderate and low cows (4.8 ± 0.1), and least (P < 0.01) for very low cows (4.5 ± 0.1). Plasma concentrations of IGF-I at 125 d in fasted and fed samples were not influenced by previous treatments and were greater (P < 0.001) in fasted than fed cows. Body condition at 125 d was correlated with IGF-I in plasma in fasted samples (r = 0.33; P < 0.01) and in fed samples (r = 0.41; P < 0.01). We conclude that concentrations of IGF-I in plasma of cows are correlated with BCS in late gestation.

Key Words: BCS, IGF-I, Thyroxine

1420 Influence of addition of fibrolytic enzymes on enzyme activities and fermentation patterns of pure substrates *in vitro*. D. Colombatto*, D. P. Morgavi, and K. A. Beauchemin, *Research Center, Lethbridge, Alberta, Canada.*

A completely randomized study was carried out to investigate possible modes of action of an enzyme mixture (Liquicell 2500, Specialty Enzymes and Biochemicals, CA) with potential to be used in ruminant diets. The enzyme contained mainly xylanase and cellulase activities, with residual amylase and pectinase. Microcrystalline cellulose (CE), oat spelt xylan (XYL) and a mixture (1:1 v/v, CEXYL) were incubated in Hungate tubes (100 mg/tube, eight replicates), untreated or treated with Liquicell 2500 applied at 0.51 and 2.55 l g DM⁻¹ (L1 and L2, respectively). Interaction time was 20 h at 24°C. Rumen fluid was collected 5 h post-feeding from a steer fed alfalfa hay *ad libitum*, and incubated at 39°C with anaerobic buffer (1:4 v/v). At 1, 6, 18 and 48 h post incubation, samples from the liquid fraction were analyzed for xylanase, endoglucanase (CMCase), β-glucosidase and β-xylosidase activities (39°C and pH 6.0). Volatile fatty acids (VFA) were quantified at 6, 18 and 48 h. Samples from 6 and 18 h of incubation were processed to obtain a feed-particle associated bacterial fraction (FPA), which was analyzed for enzymic activities as previously described. Addition of Liquicell 2500 at L2 increased (P<0.05) the initial (up to 6 h) xylanase, CMCase and β-glucosidase activities in the liquid fraction by an average of 85%, indicating that the exogenous mixture supplied extra enzymes and that these enzymes were resistant to the proteolytic action of rumen fluid. Across substrates, xylanase, and CMCase activities in the FPA fraction after 18 h were increased (P<0.05) with L2 by an average of 32%, suggesting an increase in the fibrolytic activity of rumen microbes. Total VFA were numerically (P>0.05) increased by L2 com-

pared to the controls (146 vs. 142, 141 vs. 127, and 153 vs. 148 mmol for CE, XYL and CEXYL, respectively), largely due to a numerical increase ($P>0.05$) in acetate production. Selected exogenous enzymes can increase the fibrolytic capacity of rumen fluid *in vitro*.

Key Words: Fibrolytic enzymes, Rumen, *in vitro*

1421 Screening of fibrolytic enzymes as feed additives for ruminants: can the effect of enzyme additives on *in vitro* fermentations be predicted by enzyme activities and feed hydrolysis? D. Colombatto*, D. P. Morgavi, A. F. Furtado, and K. A. Beauchemin, *Research Center, Lethbridge, Canada.*

A completely randomized study examined 23 commercial enzyme preparations (EP) for their biochemical properties and their ability to influence the hydrolysis (in absence of rumen fluid) and the *in vitro* rumen degradation of alfalfa hay (AH) and corn silage (CS). The EP's were analyzed for protein contents and for main and side fibrolytic activities (16 in total), at 39C and pH 6.0. The release of reducing sugars (RS) from AH and CS was determined by triplicate incubations of 25 mg substrate with EP for 15 min at 39C and pH 6.0. In the degradation study, triplicate amounts (1 g) of AH and CS were weighed into fermentation flasks, to which individual EP's (1.5 mg/g DM forage) were added 20 h before inoculation with rumen fluid. Anaerobic buffer (pH 6.0) was added 3 h later, and flasks were stored at 25C until inoculated with rumen fluid collected from 3 lactating dairy cows fed a TMR. Dry matter degradation (DMD) was determined after 18 h incubation at 39C. The protein contents and enzymic activities were correlated to the RS released and the DMD of each substrate using the Stepwise Regression procedure of SAS. Protein content explained 60 and 59% of the variation in RS released from AH ($RS = 0.0115x - 0.2175$, $P<0.0001$), and CS ($RS = 0.0038x + 0.2550$, $P<0.0001$). Activity against β -glucan explained a further 24% ($P<0.10$) of the model for AH, whereas activities against xylan, cellulose, starch and cellobiose explained a further 37% of the model ($P<0.10$) for CS. There was a significant relationship ($P<0.05$) between activity against oat spelt xylan and substrate DMD. However, the relationship was positive with AH ($DMD = 0.042x + 453.6$, $P<0.01$, $R^2 = 0.29$) but negative with CS ($DMD = -0.033x + 446.6$, $P<0.04$, $R^2 = 0.19$). Protein content and enzymic activities explained the release of reducing sugars, but they accounted for little of the variation on *in vitro* rumen DMD of AH and CS.

Key Words: Enzyme activity, Degradation, Relationship

1422 Fibrolytic exogenous enzymes improve performance in steers fed sugar cane and stargrass. A. Gomez¹, J. Perez¹, G.D. Mendoza^{*1}, E. Aranda¹, A. Hernandez¹, J.A. Ramos¹, and R. Rojo², ¹*Colegio de Postgraduados, Montecillo, Texcoco, Mexico*, ²*Universidad Autonoma de Guerrero, FMVZ-URCCH, Cuajinicuilapa, Gro. Mexico.*

This experiment was conducted to study the effects of fibrolytic enzymes (Fibrozyme) on gain and digestibility of steers grazing stargrass and sugar cane plus urea as a complementary forage in tropical conditions. Twenty crossed (*Bos taurus* x *Bos indicus*) steers (270–30 kg BW) were used in a grazing trial (80 days), feeding individually concentrate (1 kg/d, 14% CP) and urea treated sugar cane (USC), in a completely randomized design according to the following treatments: 1) Grazing control (GC); 2) USC-0; 3) USC + 15 g/d Fibrozyme (USC-15); 4) USC + 30 g/d Fibrozyme (USC-30). The stocking density was 6 steers/ha. Forage intake was estimated with two markers (chromic oxide and acid insoluble ash). Gain was improved with fibrozyme showing a linear ($P < 0.01$) response to Fibrozyme level (g/d: C 484; USC-0 548; USC-15 634; USC-30 776) associated to a linear ($P < 0.05$) increment of sugar cane intake (kg/d: C 0.0; USC-0 3.04; USC-15 3.15; USC-30 3.24) and a higher DM digestibility ($P < 0.05$) than control group (%: C 65.0; USC-0 73.4; USC-15 71.4; USC-30 72). No effect was detected in stargrass or total DM intake. Results indicated that Fibrozyme improved nutrient intake from sugar cane improving daily gain.

Key Words: Fibrolytic enzymes, Sugar cane, Steers performance

1423 Exogenous fibrolytic enzymes and sugar cane improve performance in steers fed stargrass. A. Gomez¹, J. Perez¹, G.D. Mendoza^{*1}, E. Aranda¹, A. Hernandez¹, J.A. Ramos¹, and R. Rojo², ¹*Colegio de Postgraduados, Montecillo, Texcoco, Mexico*, ²*Universidad Autonoma de Guerrero, FMVZ-URCCH, Cuajinicuilapa, Gro. Mexico.*

One of the principal factors limiting animal production when ruminants are grazing tropical pastures, is forage availability through the year. In this way, several strategies with complementary forages like as sugar cane have been used to improve ruminant production. The use of fibrolytic exogenous enzymes may enhance digestion of forages by cattle. This experiment was carried out to study the effect of exogenous fibrolytic enzymes (Fibrozyme) and chopped sugar cane treated with urea (1%) and minerals (0.5%), on gain and digestibility of steers grazing stargrass in humid tropic. Twenty crossed (*Bos taurus* x *Bos indicus*) steers (275–25 BW) were used in a grazing trial (80 days), feeding individually concentrate (1 kg/d, 14% CP) and sugar cane treated with urea and minerals (SCT), in a completely randomized design according to the following treatments, 1) Grazing control (GC); 2) SCT-0; 3) SCT + 15 g/d fibrozyme (SCT-15); 4) SCT + 30 g/d Fibrozyme (SCT-30). The stocking density was 6 steers/ha. Forage intake was estimated with markers (Chromic oxide and acid insoluble ash). Gain was improved with fibrozyme showing a linear ($P < 0.01$) response to exogenous fibrolytic enzymes level (g/d: GC 482^a; SCT-0 682^b; SCT-15 789^c; SCT-30 992^d) associated to a linear ($P < 0.01$) increment of sugar cane intake (kg/d: GC 0.0^a; SCT-0 3.03^b; SCT-15 3.10^c; SCT-30 3.24^d). Intake of stargrass was reduced ($P < 0.05$) by enzymes (kg/d: GC 11.54^a; SCT-0 9.11^a; SCT-15 8.38^b; SCT-30 8.32^c), but no effect ($P > 0.05$) were detected in total DM intake (kg/d: GC 12.47^a; SCT-0 13.07^a; SCT-15 12.41^a; SCT-30 12.68^a) and digestibility (%: GC 65.00^a; SCT-0 70.21^a; SCT-15 68.24^a; SCT-30 67.79^a). Results indicated that Fibrozyme and chopped sugar cane treated with urea and minerals improved daily gain and could be used in grazing steers in humid tropics.

Key Words: Fibrolytic enzymes, Sugar cane, Steers performance

1424 Effects of fibrolytic enzyme supplementation for dairy goats in mid lactation. E. González¹, G. Caja^{*1}, E. Albanell¹, C. Flores¹, A. Castro¹, R. Casals¹, X. Such¹, A. Bach², and C. Torre², ¹*Universitat Autònoma de Barcelona, Spain*, ²*Agribrands Europe-España S.A., Spain.*

Twenty-four multiparous Murciano-Granadina dairy goats in mid lactation (wk 13 to 26) were used in a single cross-over design to evaluate the effects of supplementation with an exogenous fibrolytic enzyme complex (*Promote*TM) on feed intake and lactation performances. At the end of lactation trial, eight goats (four per treatment) were selected to measure the total tract digestibility from wk 27 to 30 of lactation. Degradability of DM and NDF, as well as gas production, were also studied under *in vitro* conditions. Goats received an *ad libitum* total mixed ration composed of 65% forage (dehydrated mixture of 50% alfalfa and 50% maize-whole plant) and 35% concentrate to which the enzyme was added. Treatments were according to concentrate: Control (C; without enzyme) and Enzyme (E; *Promote*TM, included at 0.47 g/kg). Feed intake (2.02 kgDM/d), milk yield (1.51 l/d), 4% ECM (1.80 l/d), and milk composition (TS, 13.9%; fat, 5.25%; CP, 3.75%; true protein, 3.54%) were not affected by enzyme supplementation, although CN tended to decrease in the E treatment (C, 2.87%; E, 2.81%; $P < 0.09$). Body weight change (C, -0.1 kg; E, +1.90 kg; $P < 0.10$) and body condition score change (C, +0.09; E, +0.19; $P < 0.14$) tended to be higher with enzyme treatment. Digestibilities of DM (C, 68.9%; E, 72.0%) and OM (C, 70.4%; E, 73.4%) were higher ($P < 0.05$) with enzyme supplementation, digestibility of CF tended to decrease (C, 41.9%; E, 37.6%; $P < 0.14$), while digestibilities of CP (61.9%), NDF (54.3%) and ADF (48.8%) were not affected with the enzyme addition. Total tract digestibility results could not be supported by the *in vitro* trial on which similar effects were observed both for degradability (DM, 51.8%; NDF, 37.7%) and gas production (335 ml/gDM) at 48h. Supplementing dairy goat diets with *Promote*TM, under the conditions of this trial, did not affect significantly lactation performances but enhanced DM and OM digestibility.

Key Words: Fibrolytic Enzymes, Dairy Goats, Digestibility

1425 Effects of direct-fed microbials on ruminal fermentation, digestibility, and bacterial protein synthesis during continuous culture. W. Z. Yang*, K. A. Beauchemin, and D. D. Vedres, *Agriculture and Agri-Food Canada, Lethbridge, Canada.*

A dual effluent continuous culture system (CC) was used to investigate the effects of adding bacterial direct-fed microbials (DFM) to a feedlot finishing cattle diet on ruminal fermentation, ruminal digestibility, and microbial protein synthesis in a 4 × 4 Latin square design. The treatments were control, *Propionibacterium* P15 (PB), *Enterococcus faecium* EF212 (EF), and *Enterococcus faecium* EF212 combined with a yeast culture (EFY) (Chr. Hansen BioSystems Co. Milwaukee, WI). Fermenters were fed twice daily a feedlot finishing cattle diet that consisted of 87% barley grain, 8% barley silage and 5% supplement (DM basis). The DFM products (240 mg/d) were delivered equally twice daily into the fermenters just before feeding. Mean ruminal pH did not differ among treatments and ranged from 5.86 to 5.91. Total VFA concentration and its molar proportions were not affected by DFM supplementation except for caproic acid which was higher ($P < 0.05$) for control than for the DFM addition. Number of lactate-utilizing bacteria ($P < 0.10$) and total bacteria ($P < 0.15$) tended to be greater for control than for DFM supplementation. Ruminal degradabilities of DM, OM, fiber, and CP and microbial protein synthesis were not affected by adding DFM. The present results indicate that addition of DFM such as PB, EF or EF combined with a yeast culture did not affect ruminal fermentation or nutrient degradation during CC. The mode of action of DFM in the digestive tract may depend on DFM species and the presence of ruminal protozoa. *Propionibacteria* may have an effect when there is excess lactic acid produced in the rumen while *Enterococcus faecium* may enhance nutrient absorption in the small intestine rather than affect rumen fermentation.

Key Words: Direct-fed Microbials, Ruminal Fermentation, Continuous Culture

1426 Effects of ruminal pH and fibrolytic enzymes on digestibility, bacterial protein synthesis, and ruminal fermentation during continuous culture. W. Z. Yang*, K. A. Beauchemin, and D. D. Vedres, *Agriculture and Agri-Food Canada.*

A dual effluent continuous culture system (CC) was used to investigate the effects of ruminal pH and the addition of fibrolytic enzymes to a dairy cow diet on ruminal fermentation, digestibility, and microbial protein synthesis. The experiment was a split-plot design with completely randomized main plots and four replications. Main plots were pH (5.5, 6.0, and 6.5) and sub-plots were fibrolytic enzyme supplementation (control and enzyme). The enzyme product used was a commercial blend which contained relatively high xylanase and cellulase activities (Promote[®], Agribands Inc., St. Louis, MO). Total VFA concentration and its molar proportions were increased ($P < 0.01$) with increasing ruminal pH. Ruminal degradabilities of DM, OM, fiber and CP were all affected ($P < 0.01$) by ruminal pH; considerable increase in digestion was observed when ruminal pH increased from low (5.6) to medium (6.0), but the further increase in digestion was small when pH increased from medium to high (6.6). Enzyme supplementation did not affect total ruminal VFA but increased molar proportions of acetate ($P < 0.08$) and reduced that of propionate ($P < 0.15$), as a result of increased ($P < 0.01$) ruminal degradation of NDF and ADF. However, degradation of CP and microbial protein synthesis were not affected by adding fibrolytic enzymes into the diet. Furthermore, exogenous enzymes had no effect on feed digestion when ruminal pH was on average below 5.6, suggesting that exogenous enzymes act synergistically with ruminal microbial enzymes rather than by direct hydrolysis. The present results indicate that manipulation of ruminal pH in CC was highly effective in altering ruminal fermentation pattern and fiber degradation. Fibrolytic enzymes have the potential to improve ruminal fiber degradation, but have a limited effect on ruminal OM and CP degradation.

Key Words: Fibrolytic Enzymes, Ruminal pH, Digestibility, Continuous Culture

1427 Fibrolytic enzymes as feed additives for lactating dairy cows: effects on chewing behavior, salivation and ruminal pH. G. R. Bowman*¹, K. A. Beauchemin¹, and J. A. Shelford², ¹*Agriculture and Agri-food Canada, Lethbridge, Canada*, ²*University of British Columbia, Vancouver, Canada.*

A study was conducted to determine the effects of supplementing a lactating dairy cow diet with a fibrolytic enzyme product (Promote[®], Agribands International, St. Louis, MO) on chewing behavior, salivation and ruminal pH. This product is characterized mainly by xylanase and cellulase activities. Four multiparous (MP) and four primiparous (PP) lactating dairy cows fitted with ruminal cannulas and housed in a stallion barn were used in a duplicated 4 × 4 Latin square design. Diets consisted of rolled barley, 37% barley silage, and 18% alfalfa haylage (55:45 forage to concentrate, DM basis) and differed in enzyme application: 1) control, 2) enzyme applied to entire concentrate (45% of TMR), 3) enzyme applied to supplement before pelleting (4% of TMR), and enzyme applied to a premix (0.2% of TMR). Enzyme supplementation did not alter daily DM intake (MP 23.2 ± 0.7, PP 20.6 ± 1.0), time spent eating (MP 323 ± 35, PP 347 ± 29 min/d) or ruminating (MP 556 ± 47, PP 497 ± 40 min/d). However, when enzymes were added to the diet daily saliva production increased by 16% ($P < 0.05$) (control 260 ± 35 l/d, enzymes 293 ± 44 l/d), with no difference among enzyme application treatments. Enzyme supplementation did not alter mean ruminal pH (5.62 ± 0.19) or the amount of time pH dropped below 5.5 (10.5 ± 5.6 h/d) or 5.8 (17.0 ± 5.0 h/d). These results indicate that supplementation of dairy cow diets with this fibrolytic enzyme product did not alter the physical effectiveness of the feed as measured by chewing variables. Enzyme supplementation had no effect on rumen pH likely due to the increase in saliva production. Increased total saliva production due to enzyme supplementation may have been a physiological response to increased fermentation products within the rumen.

Key Words: fibrolytic enzymes, salivation, ruminal pH

1428 Effects of *Saccharomyces cerevisiae* culture and *Saccharomyces cerevisiae* live cells on in vitro mixed ruminal microorganism fermentation. H. A. Lynch and S. A. Martin*, *University of Georgia, Athens.*

The objective of this study was to compare the effects of a *Saccharomyces cerevisiae* live cell product to a *Saccharomyces cerevisiae* culture product on the in vitro mixed ruminal microorganism fermentation of ground corn, soluble starch, alfalfa hay, and Coastal bermudagrass hay. In the presence of ground corn, neither concentration (0.35 or 0.73 g/L) of *Sacc. cerevisiae* culture or *Sacc. cerevisiae* live cells had any effect on final pH, H₂, CH₄, propionate, or butyrate. *Sacc. cerevisiae* culture had no effect on acetate, but both concentrations of *Sacc. cerevisiae* live cells decreased ($P < 0.05$) acetate and the acetate:propionate ratio. When soluble starch was the substrate, both concentrations of *Sacc. cerevisiae* live cells and 0.73 g/L of *Sacc. cerevisiae* culture decreased ($P < 0.05$) the acetate:propionate ratio. Even though the treatment effects were not statistically significant, both concentrations of *Sacc. cerevisiae* live cells and 0.73 g/L of *Sacc. cerevisiae* culture numerically decreased lactate concentrations compared to the control incubations. When alfalfa hay was the substrate, *Sacc. cerevisiae* culture and *Sacc. cerevisiae* live cells had no effect on propionate, butyrate, or the acetate:propionate ratio. Both concentrations of *Sacc. cerevisiae* culture decreased ($P < 0.05$) final pH and in vitro dry matter disappearance and the 0.73 g/L treatment decreased ($P < 0.05$) acetate, whereas both treatments of *Sacc. cerevisiae* live cells increased ($P < 0.05$) final pH and decreased ($P < 0.05$) acetate and in vitro dry matter disappearance. Neither yeast treatment had much effect on the Coastal bermudagrass hay fermentations. In general, both *Sacc. cerevisiae* supplements seemed to have similar effects on the mixed ruminal microorganism fermentation.

Key Words: *Saccharomyces cerevisiae*, Rumen, Fermentation

1429 Response of lactating Holstein dairy cows to betaine supplementation. R.O. Kellems*, *Plant and Animal Sciences Department, Brigham Young University, Provo, Utah 84602.*

A 42-day lactation trial was conducted to determine the effect betaine supplementation would have on the lactation performance of Holstein cows. One hundred and seventy-four early lactation (103.8 average days in milk) Holstein cows and 1st lactation heifers receiving a common

ration were paired (lactation number, milk production, days in milk) and assigned to either the Control or Betaine Group (87 animals per group). The same Total Mixed Ration (TMR) was prepared for both groups and after the Control Group was fed, then 0.225 kg/cow/d of a betaine supplement (48.15 % betaine) was added and mixed into the remaining TMR and fed to the Betaine Group. The betaine used in this trial had been isolated from sugar beet molasses using an ionic exchange extraction procedure. No differences ($P>0.05$) were observed in average daily milk production (kg/cow/d)(43.85, 42.52), feed consumption (kg/cow/d)(27.6, 27.4), or yield of milk components (protein (kg/cow/d)(1.35, 1.33) and butterfat (kg/cow/d)(1.40, 1.32), respectively, for the Control and Betaine Groups.

Key Words: Betaine, Lactation, Milk Components

1430 Rumen microbial ecology and *Saccharomyces cerevisiae* CNCM I 1077: ten years of collaborative research. F. Chaucheyras-Durand^{*1,2} and G. Fonty², ¹Lallemand Animal Nutrition, Toulouse (France), ²INRA Microbiology Laboratory, Theix (France).

Rumen stability is a key factor for health, welfare and performance of ruminants. With high yielding animals, which have strong nutritional requirements, this is of particular importance to prevent any imbalance of the rumen microbial ecosystem and to optimize its fermentative efficiency. Since 10 years, INRA and Lallemand Animal Nutrition have been developing research programs with the aims to select a ruminant specific strain of yeast (*Saccharomyces cerevisiae*) as a rumen flora enhancer, and to better understand the effects and the modes of action of this particular strain (CNCM I-1077) in the rumen. Using *in vitro* models associating SC I-1077 and either lactate producing bacteria (*Streptococcus bovis*) or lactate fermenting bacteria (*Megasphaera elsdenii*, *Selenomonas ruminantium*), SC has shown its efficiency both to limit lactate production and to stimulate lactate utilization. In fistulated sheep fed a diet rich in rapidly fermentable carbohydrates, lactate accumulation in the rumen was prevented by daily distribution of SC. In consequence, rumen pH and fibrolytic activities of the ecosystem were stabilized and the acidosis risk was diminished. Moreover it has been shown that fibre degradation was stimulated in the rumen of fistulated lambs receiving the yeast daily, and that cellulolytic bacterial populations were higher and more stable than in control lambs. In parallel ruminal ammonia concentration was lower in the presence of SC, suggesting an improvement in nitrogen retention by the animal. In the rumen of young lambs receiving SC daily, the establishment of some microbial communities (cellulolytic bacteria, ciliate protozoa) was accelerated, enabling the lambs to be prepared earlier to solid feed intake and weaning. Nutritional effects as well as metabolic interactions between live SC and rumen microbes have been identified as modes of action. These scientifically sound data demonstrate that SC I-1077 can optimize the ruminal microbial balance, that is of primary importance to maintain rumen function, health and performance of producing ruminants. Practical experience on production performances will be presented. Precise recommendations on targeted situations when the use of SC I-1077 is of particular interest will be given.

Key Words: Rumen stability, *Saccharomyces cerevisiae*, Rumen microbial ecosystem

1431 Supplementation of a fibrolytic enzyme complex in the concentrate of dairy ewes during lactation. C. Flores¹, G. Caja^{*1}, R. Casals¹, E. Albanell¹, X. Such¹, G. Vera¹, E. Gonzalez¹, A. Bach², and C. Torre², ¹Universitat Autònoma de Barcelona, Spain, ²Agribands Europe-Spain S.A., Spain.

A total of seventy-two multiparous ewes from two dairy breeds (Manchega; n=36) and (Lacaune; n=36) were used in a 2x2 factorial design to evaluate the effects of diet supplementation with an exogenous fibrolytic enzyme complex (*Promote*TM) on lactation performance and feed intake during suckling and milking periods. A suckling-milking mixed period was used during wk 5. Ewes were fed ad libitum a diet based on 70% forage (dehydrated mixture of 50% alfalfa and 50% maize-whole plant) and 30% concentrate to which the enzyme was added. Experimental concentrates were: Control (C; without enzyme) and Enzyme (E; *Promote*TM included at 0.47 g/kg). At the same time, twenty-four dry and open ewes (Manchega, n=12; Lacaune, n=12) were used to measure the fill value of the whole diet in sheep, according to the French system (INRA, 1989). During the suckling period (wk 1 to 4)

milk yield (2.41 L/d), ECM-4% fat (2.10 L/d), milk composition (fat, 6.41%; CP, 5.25%; true protein, 4.68%; CN, 3.99%; and TS, 17.24%), feed intake (2.95 kg of DM/d), lamb growth (275 g/d), as well as body weight change (-4.98 kg) and body condition score change (-0.58 units), were not affected by the enzyme supplementation. During the milking period (wk 6 to 12) milk yield (1.80 L/d), ECM-4% fat (1.67 L/d), milk composition (CP, 5.79%; true protein, 5.43%; CN, 4.43%; and TS, 17.10%) and feed intake (2.92 kgDM/d) were not affected by the enzyme supplementation, although body weight change increased (C, +0.52; and E, +1.60 kg; $P<0.01$), and milk fat tended to decrease (C, 6.82; and E, 6.52%; $P<0.06$). Breed effect was significant ($P<0.01$) in both suckling and milking periods, with the Manchega ewes yielding less milk with greater milk composition than the Lacaune ewes, but the interaction of treatment x breed was not significant. Enzyme supplementation reduced feed intake in the dry ewes (C, 2.01; and E, 1.76 kg of DM/d; $P<0.001$) giving sheep fill values for the whole diet of 80 and 75 gDM/kgPV^{0.75} for C and E, respectively. In conclusion, no improvements were detected when *Promote*TM was added to the concentrate of diets fed to dairy ewes.

Key Words: Fibrolytic Enzymes, Dairy Ewes, Intake

1432 Effects of glycosylation on the stability of fungal xylanase exposed to proteases or rumen fluid *in vitro*. W. F. J. van de Vyver¹, K. A. Dawson², and J. M. Tricarico^{*2}, ¹University of Pretoria, Pretoria, South Africa, ²Alltech Biotechnology Inc., Nicholasville, KY.

A series of studies was conducted to examine the effects of glycosylation on the enzymatic activity of a commercial xylanase when exposed to proteases or rumen fluid *in vitro*. The xylanase was partially purified from a crude fermentation extract from *Trichoderma longibrachiatum* by gel filtration followed by ammonium sulfate precipitation and dialysis. The partially purified xylanase was enzymatically deglycosylated with PNGase F or Endo H. Native or deglycosylated xylanases were incubated with strained rumen fluid (RF), *Prevotella ruminicola* culture supernatant (Pr), or a commercial protease from *Bacillus subtilis* (Bs). Xylanase and protease activities were determined on samples collected after *in vitro* incubation at 37°C for 0, 3, 6, 9, and 24 h. The protease activities of RF, Pr and Bs were 0.018, 0.046 and 1.009 mg azocasein degraded per ml per h, respectively. Xylanase activity was lower ($P<0.05$) in the PNGase F-deglycosylated enzyme than in the native enzyme after incubation in RF for 3 and 6 h, but did not differ after incubation for 9 and 24 h. Conversely, xylanase activity was not different in the PNGase F-deglycosylated and native enzymes after incubation in Pr for 3 and 6 h, but was lower ($P<0.05$) in the deglycosylated enzyme after incubation for 9 and 24 h. Deglycosylation with Endo H had no effect on xylanase stability in RF or Pr. Xylanase activity for native and PNGase F- or Endo H-deglycosylated enzymes did not differ during incubation with Bs. However, 60% of the original xylanase activity was lost within the first 3 h of incubation in Bs while losses were less than 20% for the same period of time in the presence of Pr and RF. These results indicate that glycosylation enhances xylanase stability when enzymes are exposed to protease activities similar to those encountered in the rumen and therefore is an important characteristic for exogenous enzyme supplements for ruminants.

Key Words: Ruminants, Xylanase, Glycosylation

1433 The effects of enzyme treatment on ruminal digestibility of feather meal with and without supplemental blood. C.A. Moran^{*}, J. Skaggs, and J.M. Tricarico, Alltech Inc. Nicholasville, KY.

This study investigated the effects of an enzymatic feather treatment, prior to conventional hydrolysis, on rumen digestibility of feather meal (FM). The treatments were allocated to a 2 x 2 factorial structure with Factor 1) presence or absence of 1lb/tonne protease and 5lbs/tonne sodium metabisulfite and Factor 2) presence or absence of 3% blood during feather hydrolysis. Two ruminally fistulated steers, receiving a 50% concentrate diet, were used to examine *in situ* digestibility of the FM. The remaining dry matter and crude protein (CP) of FM were determined after incubation in the rumen for 0, 8, 24 and 48h. Rumen degradable and undegradable protein (RDP and RUP) were estimated over a range of ruminal passage rates from CP analysis. The addition of blood increased ($P<0.001$) the soluble CP fraction (A) and decreased ($P<0.001$) the undegradable CP fraction (C) regardless

of enzyme treatment. Enzyme treatment decreased ($P<0.001$) fraction A in the presence and absence of blood but only increased ($P<0.001$) fraction C when blood was present. Neither blood nor enzyme addition had an effect on the potentially degradable crude protein fraction (B) or its fractional degradation rate (k_d). The main effects of blood addition were to increase ($P<0.001$) the RDP and decrease ($P<0.001$) the RUP content of FM. Conversely, the main effect of enzyme addition was to decrease ($P<0.001$) the RDP content of FM at $k_p = 0.02\text{ h}^{-1}$ (39.6 vs 43.6), 0.05 h^{-1} (37.1 vs 40.9), and 0.08 h^{-1} (36.3 vs 40.0). Moreover, the RUP content of FM was greater ($P<0.001$) when enzyme was added for the following passage rates; $k_p = 0.02\text{ h}^{-1}$ (60.4 vs 56.4), 0.05 h^{-1} (62.9 vs 59.1), and 0.08 h^{-1} (63.7 vs 60.0). These results suggest the enzyme reduced the particle size of FM thereby exposing the surface area to more heat and the concomitant denaturation of the final product. Further work is necessary to determine the optimum cooking and drying temperatures and times for use with the protease.

Key Words: Feather meal, protease, rumen digestibility

1434 The effect of direct-fed microbials on calf health and performance. L.D. Roth*, Conklin Co. Inc., Shakopee, MN.

The effect of direct-fed microbials (DFM) on young calf health and performance was evaluated in three trials. Calves were assigned to either control (current management practices) or DFM (1 billion colony-forming units (*Enterococcus faecium* and *Lactobacillus acidophilus*) and 200 million live yeast cells (*Saccharomyces cerevisiae*) daily plus current management practices). The DFM was supplemented as an oral gel for the first 7 d and thereafter supplemented with the starter feed. In Trial 1, 18 female Holstein calves were assigned at birth to either the control or DFM treatments for 47 d and fed milk replacer. The control and DFM groups were similar for birthweight (39.50 and 41.62 kg per calf) and scour treatments (0.33 and 0.67 per calf), respectively. However, DFM supplementation increased ($P<0.05$) weaning weight (69.80 vs 63.28 kg per calf) and average daily gain (0.60 vs 0.51 kg) compared to the control treatment. In Trial 2, 28 female Holstein calves were randomly assigned at birth to either the control or DFM treatments for 45 d and fed whole milk and starter feed. Birth weights (44.22 and 42.17 kg per calf), weaning weights (68.31 and 70.68 kg per calf), and scour treatments (0.43 and 0.43 per calf) were similar for the control and DFM groups, respectively. However, DFM supplementation increased ($P<0.05$) average daily gain (0.63 vs 0.55 kg) over the control group. In Trial 3, 36 Holstein bull calves (1 to 3 d of age) were randomly assigned at arrival to either the control or DFM treatments for 42 d and fed milk replacer and starter feed. The test groups were similar for starting weight (43.98 and 45.22 kg), total starter feed intake (29.81 and 33.77 kg per calf), and health treatments (2.72 and 2.33 per calf). However, DFM supplementation increased ($P<0.0001$) daily gain (0.55 vs 0.44 kg) and enhanced ($P<0.05$) final weight (67.89 vs 62.21 kg) over the control calves. In summary, DFM supplementation increased the weight gain of young Holstein calves in three trials.

Key Words: Direct-fed microbials, Calves, Probiotics

1435 Performance of lactating dairy cows fed glyphosate-tolerant corn (event NK603). I. R. Ipharraguerre*, R. S. Younker¹, J. H. Clark¹, E. P. Stanisiewski², and G. F. Hartnell², ¹University of Illinois, Urbana, ²Monsanto Company, St. Louis, MO.

Sixteen multiparous Holstein cows averaging 74 days in milk were used in a replicated 4 x 4 Latin square to compare the effects on animal performance of feeding whole plant silage and grain from a glyphosate-tolerant corn hybrid (event NK603), the non-transgenic control line, and two commercial non-transgenic hybrids (DK647 and RX740). The grain and silage from the four corn hybrids were produced using the same procedures and under similar agronomic conditions at the University of Illinois. Diets contained 30% corn silage and 27.34% corn grain (DM basis) produced either from the glyphosate-tolerant, non-transgenic control, or commercial hybrids. Apart from the DM content of silages, the chemical composition of both grain and silage produced from the four corn hybrids were substantially equivalent. Feeding diets that contained event NK603 (24.6 kg/d) and DK647 (24.5 kg/d) hybrids tended ($P<.06$) to decrease DMI compared with the control line (25.5 kg/d) and the RX740 (26.1 kg/d). Intakes of CP, ADF, NDF, and NFC were similar ($P>.05$) for cows fed event NK603 and control diets. The RX740 diet

resulted in the highest ($P<.03$) intakes of fiber and CP whereas the DK647 diet resulted in the lowest intake of CP ($P<.01$). These differences in nutrient intake arose from small variations in both the DMI and the chemical composition of feed ingredients and experimental diets. Production of milk, 3.5% fat-corrected milk, fat, CP, true protein, and total solids (mean = 32.1, 33.0, 1.2, 1.1, 1.0, 4.0 kg/d, respectively), and the percentages of milk fat, CP, true protein, and total solids (mean = 3.68, 3.27, 3.08, 12.39, respectively), as well as milk urea N (mean = 15.2 mg/dl) and somatic cell count (mean = 167 (10^3 /ml)) were not affected by treatments ($P>.05$). These data indicate that the stable insertion of the gene that confers tolerance to glyphosate in the corn line (event NK603) used in this experiment does not affect its chemical composition and nutritional value for lactating dairy cows when compared with conventional corn.

Key Words: genetically enhanced crops, glyphosate-tolerant corn, dairy cattle production

1436 Effects of *Propionibacterium acidipropionici*, strain DH42, as a direct-fed microbial on the performance and carcass characteristics of feedlot steers. S.-W. Kim*, S. R. Rust, and M. T. Yokoyama, Michigan State University, East Lansing, MI.

A study was conducted to evaluate the effects of feeding propionic acid-producing bacteria, *P. acidipropionici*, strain DH42, to cattle fed a high concentrate diet. One hundred and twelve steers were randomly allotted to 14 pens of 8 animals each. Seven pens were randomly assigned to one of two treatments: control (C) or *P. acidipropionici*, strain DH42 (DH42). The diet included 17% corn silage, 78% high moisture corn, and 5% protein-mineral supplement. Ten mL of DH42 culture in Na-lactate broth (NLB) medium was diluted to 1 L with tap water and top-dressed on the feed of each pen assigned to the DH42 treatment. The dosage was 3.1×10^9 cfu/head/d. For C, 10 mL of pure NLB medium was diluted to 1 L with tap water and poured on the top of feed. After harvest, quality grade and yield grade were assigned by USDA personnel resident in the plant. Cattle receiving DH42 tended to gain slower than C from d 28-55 ($P=0.075$) and d 56-84 ($P<0.05$). However, DH42 treated cattle tended to grow faster ($P=0.098$) during d 112-123. Over the entire study, cattle receiving DH42 (1.40 kg/d) tended to gain slower than C (1.50 kg/d; $P=0.075$). Dry matter intakes were similar among treatments for the first 55 d, but DH42 treated cattle consumed less feed from d 56 to 111 ($P<0.05$). Over the 123 d, DMI and feed conversion efficiency was similar for cattle on the DH42 and C. Dressing percentage and quality grade were similar among treatments, but yield grade was lower in DH42 (2.39) versus C (2.60; $P<0.05$). DH42 treatment at 3×10^9 cfu/head/d level tended to decrease ADG and DMI of growing-finishing cattle.

	Control	DH42	SEM	Prob.
No. of pens	7	7		
No. of cattle	56	56		
Initial wt., kg	414	413	4.3	0.96
Final wt., kg	577	568	5.8	0.30
ADG, kg	1.50	1.41	0.03	0.08
DMI, kg/d	10.59	10.25	0.16	0.17
Feed/gain, kg feed/ kg gain	7.08	7.31	0.15	0.32

Key Words: Propionibacteria, DFM, Beef cattle

1437 Impact of ethoxyquin on productivity of dairy cattle. J.L. Smith*, L.G. Sheffield¹, and D. Saylor², ¹University of Wisconsin, Madison, ²Solutia, Inc., St. Louis, MO.

Ethoxyquin is a synthetic antioxidant used in animal rations to improve storage qualities. Ethoxyquin has also been implicated in improved animal performance, but this has not been evaluated in dairy cattle. For these studies, 24 fistulated, multiparous, mid-lactation Holstein cattle were randomly assigned to one of 4 diets (n=6 per group). These groups were fed ethoxyquin at 0, 50, 100 or 150 ppm in a standard total mixed ration (as fed-basis) for 2 weeks. 50 ppm ethoxyquin decreased dry matter intake from 24.4 kg/day in controls to 21.8 kg/day with 50 ppm ethoxyquin, pooled SEM = 1.4, $P<0.05$. Higher levels of ethoxyquin appeared similar to 50 ppm (22.2 and 22.4 kg/day with 100 or 150 ppm). Dry matter digestibility was measured by an in situ nylon bag technique. Digestibility was enhanced by 50 ppm ethoxyquin (-.037 h^{-1} in controls vs -.042 h^{-1} with 50 ppm ethoxyquin, SEM = .002),

but not by higher levels (-0.038 and -0.036 h⁻¹ for 100 and 150 ppm ethoxyquin, respectively). Similarly, 50 ppm ethoxyquin increased milk yield (32.3 kg/day in controls vs 38.5 kg/day with 50 ppm ethoxyquin, pooled SEM = 1.4; $P < 0.05$), whereas higher levels of ethoxyquin had no significant effect on milk yield (34.8 and 35.0 kg/day with 100 or 150 ppm ethoxyquin, respectively). Milk fat was numerically lower with 50 ppm ethoxyquin (3.6 % in control vs 3.2, 3.5 and 3.4 % with 50, 100 or 150 ppm ethoxyquin), but this difference did not approach significance (SEM = 0.29, $P > 0.10$). Similarly, ethoxyquin had no significant effect on milk protein content (2.92, 2.71, 2.89 and 2.70% with 0, 50 100 or 150 ppm ethoxyquin, SEM = 0.11). Interestingly, milk lactose was elevated in ethoxyquin-fed cows (4.52% in controls vs 4.67, 4.74 and 4.68 % with 50, 100 and 150 ppm ethoxyquin, respectively, SEM = 0.05; $P < 0.05$ for each treatment vs control comparison by Dunnett's test). These results indicate that ethoxyquin may increase the efficiency of lactating dairy cattle. The observed alterations in diet digestibility suggest that ethoxyquin may improve efficiency by altering rumen fermentation.

Key Words: Ethoxyquin, Antioxidant, Milk Yield

1438 Effect of live yeast culture supplementation on nitrogen digestion and ruminal liquid kinetics in cattle. M. Murillo*¹, M.S. Vazquez¹, A. Quiñones¹, J.F. Sanchez¹, F.G. Rios², and R. Barajas², ¹FMVZ-Universidad Juarez del Estado de Durango (Mexico), ²FMVZ-Universidad Autonoma de Sinaloa.

To determinate the effect of live yeast culture supplementation on nitrogen digestion and ruminal liquid kinetics in cattle, four Holstein bulls (350 kg) fitted with T-type cannulas in rumen and duodenum were used in a Crossover design experiment. The treatments were: 1) Diet 50:50 roughage:concentrate, containing 12% CP and 2.8 Mcal ME/kg (control); and 2) Diet similar to control but supplemented with a live yeast culture (Yea-Sacc 1026 TM) in amount enough to provide 10 g per animal per day (YS). Animals were fed twice a day (800 and 1600). After a 10 day adaptation period, ruminal, duodenal and fecal samples were collected for 4 days. Rumen pH and N-NH₃ concentration was measured at 0, 4, 8, 12, 16, 20, and 24 after feeding. Chromium oxide was used as solid phase marker and EDTA as liquid phase marker. Treatments had no effect ($P > 0.05$) on rumen N digestion (62.7 vs. 62.4%), flow of microbial N to the duodenum (86.5 vs. 93.8 g/d), N in feces (51.0 vs. 54 g/d), and apparent digestibility of N (70.3 vs. 68.7%). Live yeast culture supplementation increased ($P < 0.05$) rumen microbial efficiency by 11% (20.9 vs. 23.3 gMN/kg OMFR), and improved ($P < 0.05$) the amount of N from diet arriving in to the duodenum by 8% (86.5 vs. 93.8 g/d). Rumen N-NH₃ (mean = 11.6 mg/dL) was not affected by treatment ($P > 0.05$). The lowest ($P < 0.05$) ruminal pH was observed 4 h after feeding (6.8 vs. 6.3) and was similar between treatments. Rumen liquid volume was diminished ($P < 0.05$) in 11% with the YS treatment (71.4 vs. 63.4 L), without effect ($P > 0.05$) on dilution rate (4.07 vs. 4.05 %/h), ruminal liquid flow rate (2.9 vs. 2.5 L/h) and mean retention time in rumen (16.9 vs. 17.6 h). These results suggest that live yeast culture supplementation may improve by pass of dietary N, but this effect is not enough to produce changes in digestive metabolism of nitrogen in cattle.

Key Words: Yeast, Ruminal nitrogen digestion, Cattle

1439 Dietary inclusion of silymarin in peripartum dairy cows: Effects on milk quality and detection of silymarin residue. D. Tedesco¹, A. Tava*², and G. Varisco³, ¹Dipart. di Scienze e Tecnologie Veterinarie per la Sicurezza Alimentare, University of Milano, Italy, ²Ist. Sper. Colt. Foragg., Lodi, Italy, ³Ist. Zoopr. Sper. Lomb. Em. Rom., Brescia, Italy.

Silymarin, a natural hepatoprotector constituted of a mixture of flavonolignans, has shown to increase milk production if administered to dairy cows in the peripartum period. The aim of this study was to evaluate its effect on milk quality parameters and the possible presence of silymarin residues in milk. A total of 30 dairy cows has divided into two groups. Fifteen were administered 10 g/day of silymarin as an oral drench from 7 d before expected calving to 15 d after calving. Colostrum and milk samples were withdrawn on calving day and on d 7, 21, and 30 after parturition. Milk quality was evaluated according to fat, protein, lactose content, urea, inhibent activity, and cell somatic count. Fatty acid composition was evaluated in colostrum and milk at d 7 and 14 of lactation. Silymarin in milk was evaluated at 7 d of lactation. The milk quality parameters are not significantly different for treated and untreated

dairy cows, even if treated animals showed a lower fat content (3.58% - 3.22% and 3.81% - 3.43% at 21 and 30 d, respectively). Fatty acids were identified and quantified as their methyl esters by capillary GC, and no differences were observed in milk and colostrum from treated and untreated animals. No inhibent activity was detected in all milk samples. To evaluate the presence of silymarin residue in the milk, HPLC analyses were performed. The starting silymarin extract was composed of: silybin 49.8%, isosilybin 14.7%, silydianin 20.1%, silycristin 6.1%, and taxifolin 4.5%. The major bioactive compound, silybin, was purified, identified by NMR, and used as a standard reference. HPLC analyses of milk from treated animals gave no evidence of the presence of free silybin residues. Since silybin is metabolized into its glucuronic and(or) sulfonic derivatives, a further analysis was conducted after enzymatic hydrolysis with glucuronidase-arilsulfatase from *Helix pomatia*, but no silybin residues were recorded (detection limit 10 ppb). These results showed no differences in milk from animals receiving silymarin extract and the control animals; the milk safety parameters were maintained. Silymarin was kindly granted by I.D.B. Holding Indena S.p.a.

Key Words: Silymarin, Natural hepatoprotector, Milk quality

1440 The effects of prepartum diet composition and supplemental yeast culture on rumen fermentation. D. Chatman, J. Spain*, R. Belyea, M. Ellerseick, and M. Kerley, University of Missouri-Columbia/USA.

A continuous culture system was utilized to evaluate the effects of prepartum diet composition and supplemental yeast culture (*Saccharomyces cerevisiae*) on rumen fermentation. The treatments were arranged as a 2 by 4 factorial and consisted of two levels of yeast (without; Y- or with; Y+) and four diets varying in level and source of carbohydrate. Dietary carbohydrate balance was altered by utilizing different proportions of orchardgrass hay, soybean hulls and cracked corn. The standard diet contained 24% NSC; STD. The remaining diets were formulated by altering carbohydrate sources compared to the standard diet as described: cracked corn replaced with soy hulls (15% NSC; LNSC), orchardgrass hay replaced with soy hulls (24% NSC; SH) and soy hulls replaced with cracked corn (32% NSC; HNSC). Fermentors fed the SOY HULL diet had higher NAN flow/d compared to the STANDARD and HIGH NSC diets. Fermentors fed the HIGH NSC diet possessed significantly lower ammonia N flow/d compared to all other dietary treatments. Fermentors fed the LOW NSC diet had higher acetate production and a higher acetate to propionate ratio. Fermentors fed the HIGH NSC diet had higher isobutyrate production versus the LOW NSC and the STANDARD diets. Fermentors fed the SOY HULL diet supported a lower pH compared to fermentors fed the LOW NSC and STANDARD diets. Fermentor pH was similar for the SOY HULL and the HIGH NSC diets. Supplemental yeast culture decreased fermentor effluent ammonia N flow/d but had no effect on fermentor pH or VFA production. Fermentors fed the SOY HULL Y+ diet supported higher DM, OM and NDF digested/d versus the SOY HULL Y- diet. Percent NDF and ADF digested/d was increased for fermentors fed the HIGH NSC Y+ diet versus the HIGH NSC Y- diet. Percent ADF digested/d was significantly increased for the STANDARD Y+ diet compared to the STANDARD Y- diet. These results suggest that supplemental yeast culture is most effective in diets greater than 15% NSC. Diets containing 24% NSC with soybean hull NDF benefited from yeast culture supplementation compared to diets containing 24% NSC with orchardgrass hay NDF.

Key Words: Continuous Culture, Supplemental Yeast

1441 The effects of prepartum diet composition and supplemental yeast culture on rumen fermentation during the transition to a typical lactation diet. D. Chatman, J. Spain*, R. Belyea, M. Ellerseick, and M. Kerley, University of Missouri-Columbia/USA.

A continuous culture system was utilized to evaluate the effects of prepartum diet composition and supplemental yeast culture (*Saccharomyces cerevisiae*) on rumen fermentation during the transition to a typical lactation diet. The treatments were arranged as a 2 x 4 factorial and consisted of two levels of yeast (without; Y- or with; Y+) and four diets varying in level and source of carbohydrate. Dietary carbohydrate balance was altered by utilizing different proportions of orchardgrass hay, soybean hulls and cracked corn. The standard diet contained 24% NSC (STD). The remaining diets were formulated by altering carbohydrate sources compared to the standard diet as described: cracked corn

replaced with soy hulls (15% NSC; LNSC), orchardgrass hay replaced with soy hulls (24% NSC; SH) and soy hulls replaced with cracked corn (32% NSC; HNSC). The experiment consisted of three 10 d replicates. Each replicate consisted of an adaptation period (d 1 through 4), a prepartum phase (d 5 through 7) followed by a transition phase (d 8 through 10). Fermentors were fed prepartum diets (30 g DM/d) with or without supplemental yeast culture during the adaptation period and prepartum phase and a typical lactation diet (50 g DM/d) with or without yeast culture during the transition phase. Day of transition significantly affected fermentor VFA production, ammonia production and pH measurements. Fermentor VFA and ammonia production increased and fermentor pH decreased during the transition phase. Prepartum diet composition and supplemental yeast culture had no effect on DM, OM and fiber digestion, or effluent N flow on the last day of transition. These results suggest that adapting the rumen microflora with prepartum diets varying in level and source of carbohydrate and supplemental yeast culture does not moderate pH changes, or alter fermentation during the transition to a typical lactation diet.

Key Words: Continuous Culture, Supplemental Yeast

1442 The effect of monensin controlled release capsule at dry-off on calving-related disorders and milk yield in Holstein cows. P. Melendez*, C. Risco, and A. Donovan, *University of Florida, Gainesville, FL, USA.*

The objective was to evaluate the effect of a monesin slow-release capsule given at dry-off on the incidence of calving-related disorders and milk yield on Holstein dairy cows. The study was conducted in a 3000-cow commercial Holstein dairy farm (milk RHA of 10,500 kg). Cows were housed in a dry-lot system, fed a total mixed ration and milked 3 times a day. Between July and August 2001, 580 cows dried-off 50 to 70 d before expected parturition were randomly assigned either a treatment or a control group. Treated group (n=290) received orally a capsule of monensin (releasing 300 mg of monesin daily for 95 days). Control cows (no capsule, n=290) were randomly matched by parity. The outcome variables were incidence of dystocia, retained fetal membranes, metritis, digestive disorders, displacement of abomasum, clinical ketosis and daily milk yield up to 20 d pp. Milk yield was analyzed by repeated measure ANOVA developing a mixed model. Each calving-related disorder was analyzed by logistic regression. Cows treated with monensin were 2.1 times more likely to develop dystocia than control cows ($p \leq 0.01$). Treated cows correcting by dystocia were 0.2 times less likely to develop metritis ($p \leq 0.01$). There was no treatment effect for retained fetal membranes, displacement of abomasum, digestive disorders and clinical ketosis. For milk yield, within parity 1, treated cows without dystocia produced more milk than control cows without dystocia at d 5, 6, 10, 13, 14 and 19 ($p \leq 0.05$). However treated cows with dystocia produced less milk than control cows with dystocia at d 13 and 15 pp ($p \leq 0.05$). Within parity 2, treated cows produced more milk than control cows at d 3, 12 and 15 ($p \leq 0.05$). Within parity 3 or greater there was no interaction treatment by day effect ($p > 0.05$). It is concluded that although monensin increased milk production in certain days within parity 1 and 2, monensin also increased the incidence of dystocia and indirectly negatively might have affected milk yield within the first 20 d pp.

Key Words: Monensin, Milk yield, Calving-related disorders

1443 Effect of urea and/or fibrozyme supplementation on intake, degradability, digestibility and kinetics of oat hulls included in a basal ration for dairy steers. J.I. Aguilera*¹, J. Jimenez-Castro¹, M.A. Castillo-Pecina², C.F. Arechiga², and O. Ruiz-Barrera¹, ¹*Universidad Autonoma de Chihuahua*, ²*Universidad Autonoma de Zacatecas.*

Present study try to determine the effect of urea and enzymatic additives (Fibrozyme® Alltech, Inc) on intake, degradability, digestibility and kinetics of oat hulls included in a ration for dairy steers. Holstein steers (n=4) were cannulated and allotted in a 2x2 factorial design repeated 4 times, testing effects of urea and Fibrozyme addition and their interaction. Rations were composed of oat hulls (33%) supplemented with either 0 or 4% of urea, flaked corn (29%), alfalfa hay (20%), cottonseed meal (16%), salts and mineral premix (1%). When required, 15g/d Fibrozyme was added to the ration. Experimental treatments were: 1) C, control diet without urea and Fibrozyme). 2) CF, control diet supplemented with Fibrozyme); 3)CU, control diet enriched with 4%

urea on oat hulls); 4) CUF, control diet enriched with 4% urea on oat hulls and Fibrozyme). Urea treatment increased total tract digestion of dry matter (DM) and organic matter by at least 6%. DM intakes were: C=9.53; CF=9.68; CU=10.52; and CUF=10.65 kg/d. BW^{0.75} intakes were: C=110.66; CF=112.34; CU=121.97; CUF=123.62 g/kg. ($P<0.05$). In situ DM digestibility differed from 12 to 96 h of incubation. Values at 48 h post incubation were C=33.4%; CF=33.39%; CU=44.24%; and CUF=44.08%. Potential degradability was: C=66.4%; CF=66.7%; CU=83.9%; CUF=78.2%; while Effective degradability at 5% passage rate was: C=38.7%; CF=39.8%; CU=47.5%; CUF=46.6%. Digestive kinetics were similar for all treatments ($P>0.05$). In a solid phase values were: ruminal passage rate (k1)=3.55%/h, post-ruminal passage rate (k2)=6.07%/h; transit time=11.1 h. Whereas, in liquid phase the dilution fractionation rate (kdf) was 10.31%/h and the ruminal volume=46.8 L. In conclusion, 4% of urea on oat hulls improved intake, digestion, and in situ degradability of the ration, this might be due to improvement of energy status and performance of steers on the feedlot. In contrast, Fibrozyme supplementation did not show a positive effect on the variables evaluated, probably, due to the low nutritional level of the diet formulated to obtain only a 0.5 kg of daily weight gain in dairy steers.

Key Words: Oat hulls, Urea, Additives

1444 Effects of administration of Rumensin either as a controlled-release capsule or a premix on attenuation of sub-acute ruminal acidosis in lactating Holstein dairy cows. T. Mutsvangwa*¹, J. P. Walton¹, J. C. Plaizier², T. Duffield¹, G. Vessie³, R. Bagg³, and B. W. McBride¹, ¹*University of Guelph, Guelph, ON, Canada*, ²*University of Manitoba, Winnipeg, MB, Canada*, ³*Provel Division, Eli Lilly Inc., Guelph, ON, Canada.*

The efficacy of Rumensin® (monensin) administered either as a controlled-release capsule (CRC) or a premix in attenuating grain-induced sub-acute ruminal acidosis (SARA) in dairy cows was investigated in two experiments. In both experiments, six multiparous, ruminally-cannulated Holstein cows were used in a crossover design with 6-wk periods. Treatments were a monensin CRC or a placebo (Expt 1) and a monensin premix or a placebo (Expt 2). At the beginning of wk 3, SARA was induced in cows for a 10-d period using a previously developed nutritional model and ruminal pH was measured continuously. The administration of monensin CRC or premix had no effect on ruminal pH characteristics (see Table below). Under the conditions of this study, monensin had no impact on attenuating SARA.

Item	Control	Monensin	SE	P
CRC				
Mean pH	6.17	6.20	0.03	0.68
Time pH<6, min/d	406.0	450.0	24.1	0.27
Area pH<6, min x pH/d	129.4	152.7	9.9	0.17
Time pH<5.6, min/d	128.0	161.6	13.3	0.15
Area pH<5.6, min x pH/d	30.4	34.8	3.2	0.39
Premix				
Mean pH	6.15	6.12	0.02	0.45
Time pH<6, min/d	415.0	461.0	31.1	0.36
Area pH<6, min x pH/d	126.8	144.2	15.9	0.48
Time pH<5.6, min/d	123.7	154.2	22.4	0.39
Area pH<5.6, min x pH/d	25.1	29.1	4.7	0.58

Key Words: dairy cows, monensin, acidosis

1445 Influence of fibrous feed supplements on rumen morphology and production parameters in veal calves. V. Dell'Orto¹, R. Paratte, A. Di Giancamillo, C.A. Sgoifo Rossi, V. Bontempo, A. Agazzi, C.M. Domeneghini, and G. Savoini*, ¹*University of Milan, Italy.*

The aim of this study was to determine whether the nutritional regimen of two different fibrous diets, would influence the morphometric and histological development of rumen mucosa in veal calves. One hundred twenty-six Holstein calves were housed in three sheds of 42 animals each and tethered in individual crates with either exclusively liquid diet [milk replacer, control (C)], or dried corn silage supplementation (DCS), or pelleted feed supplementation (PF). Individual live weight and morphometric measurements were recorded at d 0, 52, 102, and 158. At slaughter, meat color and drip loss were measured. The effects of the

fiber-containing diet were also studied on histological characteristics of ruminal mucosa. Average daily gain was significantly higher for calves on DCS between day 52 and day 102 ($C = 1.19$ Kg; $DCS = 1.45$ Kg; $PF = 1.29$ Kg; $P < 0.01$). Over the 158-d experimental period, the DCS group had greater ADG ($C = 0.92$ Kg; $DCS = 1.03$ Kg; $PF = 0.99$ Kg), although no significant difference was observed. Meat samples from the control animals had significantly greater lightness values than samples from the other groups ($C = 53.89$; $DCS = 50.48$; $PF = 49.60$; $P < 0.05$). There were histological abnormalities in the rumen of all animals examined, but particularly in those given pelleted feed. Papillae length ($C = 1,765$ μ m; $DCS = 1,386$ μ m; $PF = 1,411$ μ m) and epithelial thickness ($C = 77.58$ μ m; $DCS = 76.2$ μ m; $PF = 72.2$ μ m) of ruminal papillae were greater in controls than fiber-supplemented animals. The dried corn silage supplement resulted in a good compromise between rumen characteristics, health, growth performance and meat quality. This fact is in accordance to a recent European Union regulations, which stipulate that the traditional liquid diet of veal calves must be supplemented with a certain daily quantity of dietary fiber to improve rumination.

Key Words: calves, rumen, fiber diets

1446 Comparison of three sieving methods to measure particle size distribution of forages. Paolo Berzaghi^{*1,2} and Dave Mertens², ¹University of Padova, Italy, ²US Dairy Forage Research Center, Madison, WI.

Methods of measuring particle size of forages differ in the number and aperture of sieves, shaking motion (horizontal or vertical), and status of the sample (undried or dried). These differences alter the particle size distribution of feeds depending on the method used. We evaluated relationships among particle size distributions of hays, corn silages, grass silages and TMR's using three methods: method S424 of American Society of Agricultural Engineers (ASAE), Penn State particle separator (PSPS), and the vertical shaking method (VERT) used to estimate peNDF. Both ASAE and PSPS use wet samples and shake horizontally. In contrast, VERT requires dry samples and shakes vertically. For all of the three methods, the largest sieve aperture was 19 mm. The smallest sieve aperture was 1.17, 8.00, and 1.18 mm, respectively for ASAE, PSPS and VERT. Materials were separated in duplicate according to each procedure. For a subset of corn silage samples, methods ASAE and PSPS were repeated using dried samples. Dry matter also was measured on all fractions obtained with the ASAE and PSPS methods when the initial sample was undried. Across all feeds, PSPS had the largest proportion of DM retained in the top screen and pan. Largest differences among methods were observed for the pan fraction that averaged 10, 54, and 15% of DM for ASAE, PSPS, and VERT, respectively, due in part to the difference in aperture. When dried corn silages were sieved, top and pan fractions obtained with ASAE were similar to VERT, but fractions separated with PSPS remained significantly different from VERT. Using undried material, the distribution of particles for ASAE and PSPS was not different when expressed on a wet or DM basis. In conclusion, sieving methods did not provide the same description of particle size distribution. Due to differences in aperture and technique, PSPS did not provide estimates of peNDF similar to VERT. Drying corn silage prior to sieving decreased retention on sieves with larger apertures, indicating improved separation efficiency.

Key Words: particle size, peNDF, silage

1447 Gas production kinetics and fermentation end product formation from neutral detergent fiber and sucrose by mixed ruminal microorganisms in vitro. P. J. Weimer^{*1} and M. B. Hall², ¹USDA-Agricultural Research Service, Madison, WI, ²University of Florida, Gainesville, FL.

The effect of sucrose on neutral detergent fiber (NDF) digestion by mixed ruminal microorganisms was determined using an in vitro 40-channel gas pressure measurement system with computerized data acquisition. Isolated bermudagrass (*Cynodon dactylon*) NDF (4 mg/mL) was incubated in 8.5 mL of Goering/Van Soest (pH 6.8) buffer amended with 1.5 mL of blended and squeezed ruminal fluid and varying amounts of sucrose (0, 2, 4, or 6 mg/mL, six replicates per treatment). Additional sets of vials contained no added substrate (blanks), or 6 mg sucrose/mL without NDF. Gas production data from 153 to 178 data points collected over a 48-h period were blank-corrected and fitted to single-pool (NDF or sucrose alone) or dual-pool (NDF + sucrose) exponential models that

incorporated one or two discrete lag terms, respectively. Sucrose concentration had no effect on the rate constant of gas release from either sucrose (0.29-0.30/h) or NDF (0.053/h). However, lag times for gas release from NDF digestion increased markedly with sucrose concentration (4.3, 8.0, 10.4, and 13.0 h at 0, 2, 4 and 6 mg sucrose/mL, respectively; $P < 0.05$). Acetate represented a smaller proportion of total VFA as sucrose increased (0.66 and 0.59 at 0 and 6 mg sucrose/mL, respectively; $P < 0.05$), whereas the proportion of butyrate increased (0.07 and 0.12 at 0 and 6 mg sucrose/mL, respectively; $P < 0.05$). Fermentation product ratios from 6 mg sucrose/mL alone were similar to those from 6 mg sucrose + 4 mg NDF/mL, but differed from those samples in which lower concentrations of sucrose were incubated with NDF. Values for pH at 48 h decreased ($P < 0.01$) with increasing sucrose (6.65, 6.46, 6.25 and 6.04 at 0, 2, 4 and 6 mg sucrose/mL, respectively). The data support the hypothesis that the rate constant of fiber digestion is dependent on the pH at which the fermentation is initiated.

Key Words: Ruminal Microorganisms, Digestion Kinetics, Neutral Detergent Fiber

1448 Relationship of forage fiber content and mechanical strength to particle size reduction during ingestive mastication by steers. H. G. Jung^{*1} and S. K. Baker², ¹USDA-ARS, St. Paul, MN, ²CSIRO, Perth, Australia.

Forage fiber content and mechanical toughness have been proposed as factors that limit particle size reduction and feed intake of ruminants. Three coarsely chopped forages were available ad lib to six mature rumen-fistulated Murray Grey steers (794 \pm 27 kg). The oaten and mature alfalfa hays were similar in NDF concentration (42.4 and 41.5 % DM, respectively), while the immature alfalfa hay contained less NDF (34.2 % DM). However, the acid detergent lignin content of the NDF fraction was much higher for both the immature and mature alfalfa hays (12.3 and 12.8 % NDF, respectively) than the oaten hay (2.1 % NDF). Compression energy was higher for the mature alfalfa hay (3.86 kJ/kg DM) than for the oaten and immature alfalfa hays (3.64 and 3.57 kJ/kg DM, respectively). Shear energies were similar among the hays (7.34 kJ/m²). Each hay was fed to two steers during two periods in a cross-over design. Periods consisted of 7 d for adaptation followed by 5 d of data collection. Ingestive boli were collected from each steer by catching the swallowed boli as they entered the rumen. Hay intake did not differ among the oaten and immature and mature alfalfa hays (9.4, 11.1, and 12.4 kg DM/d, respectively). Hay and boli samples were sieved into large (retained on 2.75 mm screen), medium (retained on 1.18 mm screen), and small (passed 1.18 mm screen) particle fractions. The percentage of particles in the large particle size fraction in the ingestive boli compared to the hays declined more for the mature alfalfa and oaten hays (-31.3 and -37.7 %, respectively) than for the immature alfalfa (-11.6 %). No differences for boli compared to hays were observed for the medium size particle fraction (+4.2 % change), but the change in percentage of small particles in the boli of mature alfalfa and oaten hays (+52.4 and +54.4 %, respectively) increased more than was observed for the immature alfalfa (+13.4 %). Lower compression energy and reduced fiber concentration of immature alfalfa, but not fiber lignification, were associated with greater particle size reduction during ingestive mastication.

Key Words: Forage, Intake, Mastication

1449 Effects of feeding corn silage that was allowed to spoil for five days with or without yeast cell walls on production parameters in early lactation Holstein cows. S.M. Bolt^{*}, D.E. Diaz, S. Davidson, S.R. Hill, B.A. Hopkins, V. Fellner, C. Brownie, and L.W. Whitlow, North Carolina State University, Raleigh, NC.

Proper silage management is important to reduce excessive spoilage due to air exposure. The objective of this study was to compare the effects on production of feeding spoiled silage and yeast cell walls (YCW) to Holstein cows. Forty-eight early lactation cows were randomly assigned to one of four treatment diets within parity. Diets included: 1) corn silage blended into a TMR (CON), 2) CON with added YCW (CON+YCW), 3) spoiled silage blended into a TMR (SP), 4) SP with added YCW (SP+YCW). Cows were started on trial at 21 DIM. Cows received the same silage type for the duration of the experiment, but switched to or from YCW treatment at the experimental midpoint (45 days). CON silage was stored in a covered trench silo. SP silage was taken from the same trench silo and piled under a covered shelter for 5 days before being

fed and then blended into the TMR based on prior DM change. There were no significant differences in %CP, %ADF, and calculated Mcal/kg NE_L for treatment diets (P > 0.10). Milk yield (35.36, 37.02, 36.74 and 37.44 kg/d), DMI (22.1, 22.3, 22.9, and 23.3 kg DM), % fat (3.24, 3.29, 3.29, and 3.32%), fat yield (1.14, 1.19, 1.16, 1.23 kg), %CP (2.87, 2.88, 2.80, and 2.80%), and protein yield (1.01, 1.05, 0.99, and 1.02 kg) were not significantly different among CON, CON+YCW, SP, and SP+YCW, respectively (P > 0.10). Acetate: propionate ratio was not significantly different among CON, CON+YCW, SP, and SP+YCW (2.4, 2.3, 2.4, and 2.3; P > 0.10), respectively. Concentrations of BUN (19.8, 20.0, 21.8, and 22.7 mg/dl), and rumen ammonia (10.7, 10.8, 10.0, and 9.7 mg/dl), as well as rumen pH (6.9, 6.8, 6.8, and 6.8) were not significantly different among treatments CON, CON+YCW, SP, and SP+YCW, respectively (P > 0.10). Milk %CP (P < .08) was significantly lower for the cows fed the SP silage. Concentrations of BUN (19.9 vs 21.5 mg/dl; P < 0.01) were significantly different for cows fed CON and SP silage, respectively.

Key Words: silage, yeast cell walls, spoilage

1450 Peak strains and strain energy transferred through the jaws and skull of sheep eating roughage and concentrate diets. W.L. Grovum^{*1}, J.J. Thomason¹, W.W. Bignell¹, and A.G. Deswysen², ¹*University of Guelph, Ontario, Canada*, ²*Universite Catholique Louvain, Belgium*.

Five sheep were used to study the strain energy developed during chewing and how this was transmitted through the jaws and skull to fragment food. With the sheep under sodium pentobarbital anesthesia, 3 simple strain-gauges were glued to the underside of each jaw bone and 4 rosette gauges to the maxilla and the frontal bones on each side of the skull. Upon recovery, each sheep was fed randomly alfalfa hay (Medicago sativa; 53% NDF), bromegrass hay (Bromus molis; 64% NDF) or finisher pellets (31% NDF) twice while recording strains (μe) for 22.5 sec periods. The sheep chewed on either its left or right side but never on both sides together (side changed frequently). The underside of the jaw used for chewing bent down in the middle creating gauge tension under the bolus. It was bent upward at the front on this side by forces transferred from the opposite jaw whose underside was always bent upwards in the middle by unopposed masseter muscle action (no bolus here). The mean peak strains recorded in the mandibular gauges during chewing were not different for the 2 hays (+476 and +485 for tensions in the middle gauges on chewing side and -524 and -607 for compressions in these gauges on the balancing side; P>0.05) but they were greater than the maximum values for the pelleted diet (+80 on the front chewing side; -145 on the front balancing side, P<0.05). Not unexpectedly then, the mean chewing effort (mean area under chewing strain curves) was similar for the hays being 61 vs 68 (P>0.05) and exceeded that for pellets (29; P<0.004). With right or left sided chews, both frontal bones were compressed since the maxillae were rotated caudally and dorsally. The compressions were once again similar for the 2 hays (-264 and -290; P>0.05) and exceeded that for pellets (-103; P<0.01). The maxillae in the nose rotated slightly toward the non chewing side due to the compression of the bolus during chewing and the unopposed downward pull by the masseter on the opposite side. Again, hay effects were similar (P>0.05) on the chewing (-124 vs -115) and non chewing sides (341 vs 399) and exceeded values for pellets (-56 vs 131; P<0.04). Since chewing frequency was similar for all diets (118-128/min; P>0.05), a tougher roughage must be chewed longer with more chews/kg dry matter eaten.

Key Words: Chewing, Strains, sheep

1451 Effects of buffer selection and level of digestible dry datter on *in vitro* NDF digestion. P.H. Doane, M.L. Henry^{*}, and J.L. Adcock, *ADM Alliance Nutrition, Inc., Decatur, IN*.

The objective of these studies were to evaluate the effect of *in vitro* buffer systems on fiber digestion. Three common buffers were evaluated based on the level of digestible DM associated with a depression in fiber digestion. Fermentations using the recommended buffer for the ANKOM Daisy fermenter system (Kansas State Buffer, KS), the Goring and Van Soest buffer (GVS), and the Marten and Barnes buffer (MB) were performed in duplicate using 150 ml serum bottles. A corn silage of known DM digestibility was added to deliver 3.6, 6, 10, and 14 mg/ml of digestible DM to assess the ability of each buffering system to support increasing fermentable substrate. *In vitro* frementations were

performed as a balanced incomplete block design with two buffer treatments per block. Increasing the level of digestible DM above 6mg/ml progressively decreased final pH and 48 h NDF digestion for each buffer. The depression in NDF digestion was more pronounced in the Kansas State buffer than with the other buffer systems (P<. 05). To evaluate whether the depression in NDF digestion with the Kansas State buffer was of practical importance, 8 feed samples, including 4 corn silages, 2 alfalfa samples, soyhulls and wheat straw, were fermented in triplicate on 3 separate days using the Daisy Fermentation System with each buffer represented. Average NDF digestion for these samples was significantly lower using the KS buffer, differences between the GVS and MB buffers were not significant. Based on these results the GVS and MB buffer systems appear more robust when evaluating highly digestible substrates.

Treatment	1	2	3	SEM	SE DIFF. ²	P =	
Item	KS	MB	GVS			1 vs. 3	2 vs. 3
DMD	56.8	59.8	61.2	5.7	1.2	.002	.26
NDFd	42.0	46.2	48.2	6.0	1.4	.0005	.18
IVTD	71.2	73.7	74.4	5.8	0.8	.0009	.35

²Standard error of the differences among treatments.

Key Words: Buffer, Fiber digestion, *In vitro*

1452 Fiber hydrolysis in the rumen: effects of pH and forage type. C. Spackman^{*}, R.L. Baldwin, R.D. Sainz, and M.L. Sweany, *University of California, Davis, CA*.

The objectives of this study were to determine the effects of rumen pH and forage type on fiber hydrolysis in the rumens of Holstein heifers. Rumen and duodenal cannulated pregnant heifers (n=8) were sequentially fed eight unbuffered diets containing 100, 80, 60 and 40% oat or alfalfa hay. The remaining portion of each diet was a concentrate mix. All oat hay diets contained 10% crude protein (CP) and all alfalfa hay diets contained 20% CP. All animals were housed individually and fed twice a day at 8am and 6pm. After a 14d adjustment period to each diet, filter bags (ANKOM F57) containing samples of ground hay to match the forage in that diet were incubated in the rumen for 2, 4, 6, 8, 10 or 12h beginning at the morning feeding. After removal, bags were washed with tap water 6 times for 1 min in an ANKOM 200 Fiber Analyzer at room temperature. Bags were then frozen until further analysis of NDF using the ANKOM system. Rumen pH was recorded every 15 min during the incubation period by an indwelling pH probe (Model 450CD, Sensesorex, Garden Grove, CA) inserted through the rumen cannula. A 96h incubation was also carried out to ascertain the potentially digestible NDF (pdNDF) fraction of each hay. Rate of degradation was expressed as the proportion of pdNDF disappearance in each 2h interval. pH data were grouped into classes from pH 5.25-7.25 in increments of 0.5 pH units. Forage type had no effect on rate of pdNDF digestion. Above pH 6.5 the rate of degradation of pdNDF was constant (2.993%/h). Below pH 6.5 there was a linear decline in the rate of digestion, decreasing by 0.12% for each 0.1 unit of pH. These data improve our understanding of the depression in fiber digestibility on high concentrate diets.

Key Words: pH, rumen, fiber digestion

1453 Vitamin A administration as a means of udder protection in lactating cows. F.T. Sleiman^{*}, L.S. Jaber, M.Z. Habbal, M.T. Farran, M.G. Uwayjan, and E.K. Barbour, *American University of Beirut*.

A study was conducted to determine the effect of vitamin A administration on teat canal keratin (TCK) composition as an indication of udder protection. Eight Holstein cows of different parity in early and mid lactation were randomly allocated into two groups. Cows of the first group (A) were injected with 700,000 IU of vitamin A/wk.The control group (C) received no supplemental vitamin A. Feed provided to both groups supplied about 400,000 IU of vitamin A/h/d during the 9 wk trial period. Data collection included daily milk yield, weekly measurements of electric conductivity(EC) of milk as an indicator of sub clinical mastitis and TCK content of every teat. Results showed that milk yield and TCK weight were not significantly different (p>0.05), 24.5 Vs 24.3 kg/d and 5.87 Vs 5.78 mg/teat, between treatments A and C, respectively. The TCK fatty acid profile of group A had a significantly (p<0.05) higher level of Palmitic acid only during week 5 of the study (56.83 Vs 48.46%).

The incidence of sub clinical mastitis in teats of the A group was significantly ($p < 0.01$) lower than that of the control (8.5 Vs 20.7%). The latter results lead to the conclusion that although cows had adequate daily intake of vitamin A, additional supplementation had favorable response on mammary gland protection.

Key Words: Vitamin A, Teat Canal Keratin, Mammary Gland

1454 Effects of dietary supplements of vitamin B₁₂ and biotin (B₈) on the net flux of nutrients across the splanchnic tissues of lactating dairy cows. C.L. Girard^{*1}, J.J. Matte¹, and A. Desrochers², ¹*Agriculture and Agri-Food Canada, Lennoxville, QC, Canada*, ²*Universite de Montreal, S-Hyacinthe, QC, Canada*.

The objective of these trials was to define the effects of dietary supplements of vitamins B₈ and B₁₂ on the flux of nutrients across portal-drained viscera (PDV) and liver. Four lactating cows equipped with catheters in the portal and a hepatic veins and a mesenteric artery and an ultrasonic flow probe around the portal vein were fed twelve times per day a TMR at 95% of ad libitum DMI. Daily supplements of 0 or 500 mg B₁₂ + 20 mg B₈ (Trial 1) or 500 mg B₁₂ + 20 mg B₈ or 500 mg vitamin B₁₂ only (Trial 2) were fed according to a double 2x2 Latin Square with two 4-wk periods for each study. On the last day of each period, blood samples were collected every 30 min for 4 h. In Trial 1, B₈+B₁₂ increased milk (30.5 to 31.6 kg/d; $P=0.08$) and protein (1.04 to 1.07 kg/d; $P=0.02$) yields as compared to the control diet in cows at 1185.6 DIM and 23.10.4 kg DMI. It decreased blood arterial urea (9.4 to 8.8 mM; $P=0.03$) and portal flux (mmol/h) of B-OH-butyrate (180 to 150; $P=0.03$), acetate (2970 to 2544; $P=0.06$), propionate (1092 to 1020; $P=0.12$), n-CH₃-butyrate (36 to 30; $P=0.07$), butyrate (228 to 198; $P=0.13$) and ammonia (696 to 612; $P=0.05$). It decreased liver removal of butyrate (-223 to -206; $P=0.11$), i-valerate (-64 to -56; $P=0.15$) and lactate (-102 to -66; $P=0.14$). In Trial 2, B₈+B₁₂, compared to B₁₂ alone, had no effect on milk yield (27.7 1.2 kg/d) of cows at 1815.6 DIM and 22.5.3 kg DMI. It decreased arterial blood glucose (3.7 to 3.6 mM; $P=0.02$) and urea (10.4 to 9.3 mM; $P=0.03$) and portal flux (mmol/h) of ammonia (648 to 576; $P=0.04$). It increased liver removal of butyrate (-149 vs -178; $P=0.04$) and i-valerate (-35 to -44; $P=0.15$), release of B-OH-butyrate (213 to 313; $P=0.13$) and decreased removal of ammonia (-897 to -665; $P=0.005$). In Trial 1, B₈+B₁₂ reduced portal flux of VFA and ammonia. Comparisons with Trial 2 give an indication that most of the effects are due to B₁₂ alone, except for the effects on nitrogen metabolism, butyrate and i-valerate.

Key Words: Cow, Biotin, Vitamin B₁₂

1455 The effect of feeding complexed trace minerals to pregravid Holstein heifers on the incidence of prepartum and postpartum claw diseases. T.R. Drendel^{*1}, P.C. Hoffman¹, and M.T. Socha², ¹*University of Wisconsin, Madison*, ²*Zinpro Corp., Eden Prairie, MN*.

In a field study pregravid (12 mo) Holstein heifers ($n = 421$) were alternately assigned by age to either diets without (Control) or with 7 g/d of complexed trace minerals (CTM) (Availa-4, Zinpro Corp.) Diets were formulated bi-weekly and fed for approximately 335d. Heifers were housed at a commercial heifer rearing facility in open mounded lots. Claws were evaluated for incidence and severity of 12 claw diseases prior to treatment assignment, at end of treatment period, and 60d postpartum. Evaluations were conducted using a clean, light grind evaluation system. Claw diseases were scored on a severity scale of 1=milk, 2=moderate, or 3=severe. Severity of disease per heifer was expressed as [Sum (maximum claw severity codes)]/12. Data were statistically analyzed by CATMOD and GLM procedures of SAS. Incidence of dorsal wall ridges, abaxial wall lesions, double soling, sole abscess, sole ulceration, interdigital dermatitis, and foot rot was low ($< 1\%$) and not statistically analyzed. Incidence of digital dermatitis, sole hemorrhage, white line separation, and abaxial wall fissure was higher ($P < 0.03$) postpartum (20.0, 59.7, 55.0, 31.9%) as compared to prepartum (14.3, 40.1, 22.4, 3.8%), respectively. The number of claws with heel erosions (3.4 vs 3.8) and digital dermatitis (1.2 vs 1.3) was lower ($P < 0.04$) postpartum, but claws/heifer with white line separation (1.8 vs 1.5) and abaxial wall fissures (2.1 vs 1.2) were higher ($P < 0.04$) postpartum as compared to prepartum. Feeding CTM decreased ($P < 0.04$) the incidence, claws affected/heifer, and severity of sole hemorrhages postpartum but not prepartum. Also, feeding CTM decreased ($P < 0.05$) the incidence of

heel erosions postpartum but not prepartum. Feeding CTM tended to ($P < 0.10$) decrease claws affected with white line separation and the severity of abaxial wall fissures postpartum but not prepartum. Mechanisms by which CTM decreased selected claw disease indicators postpartum but not prepartum are unclear.

Key Words: Dairy Heifers, Complexed Trace Minerals, Claw Diseases

1456 Characterization of prepartum and postpartum serum mineral concentrations in periparturient Holstein dairy cows. A. B. Todd^{*} and G. A. Varga, *The Pennsylvania State University, University Park, PA*.

The relationships between mineral intakes, serum mineral levels, absorbable mineral intakes (NRC 2001), and postpartum health in the periparturient cow were investigated. This study also evaluated the effects of feeding a traditional dry cow diet (A) vs one formulated to contain 25% of the ration DM as non-forage fiber sources (B) on serum mineral levels prepartum and postpartum. The blood serum from thirty cows randomly chosen from each trial was analyzed from the period 4 wk prepartum to 4 wk postpartum. Some of the data is presented in the table below. Cows fed diet B had significantly greater prepartum DMI than cows fed diet A (16.8 vs 13.3 \pm 0.30 kg/d). DMI did not differ postpartum and the average milk yields for diets A and B were 45.3 kg/d and 47.3 kg/d, respectively. A significant finding in this study was an increase in serum Ca ($P \leq 0.001$) and Mg levels ($P \leq 0.001$) and a decrease in serum Cl levels ($P \leq 0.001$) in healthy cows during the postpartum period.

Diet	Mineral	Prepartum			Postpartum		
		Mean Absorbable Intake (g)	Mean Serum	Std Error	Mean Absorbable Intake (g)	Mean Serum	r Std Error
A	Ca (mg%)	38.15	8.12	0.09	93.25	8.53	0.12
	Mg (mg%)	7.70	2.24	0.03	12.51	2.52	0.03
	K (mEq/L)	239.05	4.79	0.04	276.45	4.80	0.04
	Na (mEq/L)	12.10	140.68	1.19	62.72	142.24	1.76
	Pi (mg%)	35.88	5.83	0.08	54.99	5.57	0.09
	Cl (mEq/L)	27.52	102.6	0.30	70.43	99.12	0.36
	Zn (ppm)	0.107	1.02	0.02	0.192	0.99	0.02
	Fe (ppm)	0.664	1.85	0.06	0.639	1.54	0.05
	Cu (ppm)	0.005	0.60	0.02	0.012	0.61	0.01
B	Ca (mg%)	49.82	8.38	0.09	95.71	8.34	0.08
	Mg (mg%)	12.72	2.28	0.03	11.09	2.22	0.03
	K (mEq/L)	231.09	4.70	0.04	279.00	5.03	0.04
	Na (mEq/L)	36.57	134.19	0.96	71.04	130.44	0.78
	Pi (mg%)	45.91	6.18	0.08	54.61	5.51	0.10
	Cl (mEq/L)	39.25	102.13	0.24	96.56	99.00	0.25
	Zn (ppm)	0.263	1.16	0.02	0.218	1.01	0.02
	Fe (ppm)	0.826	2.02	0.06	0.395	1.51	0.05
	Cu (ppm)	0.020	0.53	0.01	0.015	0.62	0.01

Key Words: Minerals, Dairy Cow, Metabolic Profile

1457 Effect of chromium methionine and zinc methionine supplementation on blood concentrations of immunoglobulin G and M and inflammatory response to a phytohemagglutinin in stressed fedlot calves. L. Almeida^{*1} and R. Barajas¹, ¹*FMVZ-Universidad Autonoma de Sinaloa (Mexico)*.

To determine the effect of chromium methionine and zinc methionine supplementation on immunoglobulin levels in stressed feedlot calves, one experiment was conducted. Twenty bull calves (Brahman cross-breed; BW = 198 2.2 kg), just arrived at the feedlot, were allotted in groups of five and used in a randomized design experiment with a 2 x 2 factorial arrangement, with Zn supplementation of 0 or 60 ppm from zinc-methionine (Zn-met) and Cr levels of 0 or 1 ppm from chromium-methionine (Cr-met). The basal diet was 35:65 roughage:concentrate, with 14.3% CP, 1.37 Mcal of NEm/kg of DM, and 55 ppm of Zn (from Zn sulfate). Blood samples were taken from the jugular vein on d 0, 7, 14, and 28. Globulins G (IgG) and M (IgM) were determined in serum samples. On d 28, an intradermal injection of phytohemagglutinin (PHA) was applied in the base of tail, and the inflammatory response was measured at 0, 12, 24, and 36 h after injection. IgG values were increased ($P < 0.01$) by Zn-met on d 7 (1,973 vs 2,230 mg/dL), 14 (2,072

vs 2,935 mg/dL) and 28 (2,327 vs 2,939 mg/dL). IgG concentration was increased ($P < 0.01$) by Cr-met in d 7 (1,957 vs 2,198 mg/dL), 14 (2,167 vs 2,840 mg/dL) and 28 (2,312 vs 2,955 mg/dL). IgM concentration was enhanced ($P < 0.01$) by Zn-met supplementation on d 7 (255 vs 326 mg/dL), 14 (316 vs 410 mg/dL), and 28 (334 vs 468 mg/dL). Cr-met increased IgM values on d 7 (250 vs 330 mg/dL), 14 (229 vs 428 mg/dL), and 28 (320 vs 482 mg/dL). Inflammatory response to PHA was increased ($P < 0.01$) by Zn-met at 24 h (1.28 vs 1.44 cm), whereas Cr-met increased the response ($P < 0.01$) both at 24 h (1.23 vs 1.49 cm) and 36 h (1.11 vs 1.23 cm) after PHA injection. It is concluded that both zinc-methionine and chromium-methionine supplementation can reduce the impact of stress in calves recently arrived to feedlot.

Key Words: Immunoglobulins, Zinc, Chromium

1458 Effect of chromium methionine and zinc methionine supplementation on cortisol, glucose, aspartate amino transferase, and creatinin in blood of stressed feedlot calves. L. Almeida^{*1} and R. Barajas¹, ¹FMVZ- Universidad Autonoma de Sinaloa (Mexico).

With the objective of determinate the effect of chromium methionine and zinc methionine supplementation on cortisol, glucose, aspartate amino transferase, and creatinin levels in blood of stressed feedlot calves, one experiment was conducted. Twenty just arrived to feedlot bull calves, males, Brahman crossbreed (BW = 198 ± 2.2 kg), allotted in groups of five, were used in an randomized design experiment with a factorial arrangement 2 x 2 where levels of zinc supplementation 0 or 60 ppm from zinc-methionine (Zn-met), and two chromium levels 0 or 1 ppm from chromium-methionine (Cr-met) were tested. Basal diet was 35:65 roughage:concentrate, with 14.3 % CP, 1.37 Mcal of NEm/kg of DM, and 55 ppm of zinc (from Zn sulfate). Blood samples were taken from jugular vein at days 0, 7, 14 and 28. Blood cortisol, glucose, aspartate amino transferase enzyme (ATT), and creatinin were assayed in blood samples. Zn-met decreased ($P < 0.01$) cortisol level in days 7 (2.77 vs. 0.34 µg/dL) and 14 (2.13 vs. 0.29 µg/dL). Cr-met diminished ($P < 0.01$) cortisol serum values in days 7 (2.73 vs. 0.38 µg/dL), 14 (2.04 vs 0.38 µg/dL), and 28 (2.82 vs. 1.98 µg/dL). Glucose levels in blood was diminished ($P < 0.01$) in day 14 both by Zn-met (70.72 vs 61.26 mg/dL) as by Cr-met (70.27 vs 61.71 mg/dL) diminished blood glucose ($P < 0.01$). An additive effect ($P < 0.01$) Zn + Cr supplementation was detected. ATT blood concentration was diminished ($P < 0.05$) by Zn-met in days 7 (72.20 vs. 61.36 IU/L), 14 (44.81 vs. 40.05 IU/L). Cr-met decreased ($P < 0.05$) ATT values in days 7 (73.62 vs. 59.99 IU/L), 14 (46.03 vs. 39.50 IU/L) and 28 (34.04 vs. 31.86 IU/L). Creatinin in blood was reduced ($P < 0.01$) by Zn-met in days 14 (1.62 vs. 0.94 mg/dL) and 28 (1.25 vs. 0.74 mg/dL), and by Cr-met in days 14 (1.65 vs 0.90 mg/dL) and 28 (1.29 vs. 0.70 mg/dL). It is concluded, tan both zinc-methionine and chromium-methionine supplementation are able to reduce the impact of stress in calves recently arrived to feedlot.

Key Words: Cortisol, Glucose, Zinc, Chromium, Calves

1459 Release of phosphorus from feedstuffs for cattle. J. Sehested^{*} and M.R. Weisbjerg, *Danish Institute of Agricultural Sciences, Denmark.*

Besides the nutritious effects of phosphorus (P), there is an increasing concern regarding the environmental and economical impact of surplus P from animal production. The utilisation of dietary P in cattle is estimated to be less than 30%, and there seems to be a significant potential for improvement. In this study, release of P from 21 feedstuffs including minerals, roughages and concentrates was measured by the nylon bag techniques. For each feedstuff six replicate sets of mobile nylon bags (pore size 11 µm) were incubated in three fistulated cows (Hvelplund & Weisbjerg, 2000): in the rumen for 16 hours; then in pepsin-HCl solution (pH 2.4) for 24 hours; finally through the intestine and collected from the feces. Six *in situ* nylon bags (pore size 36×36 µm) were incubated in the rumen for 0, 2, 4, 8, 16, 24 or 48 hours in three fistulated cows (Madsen & Hvelplund, 1994). P-content of the samples and bag residues were analysed by colorimetri and availability of P was calculated from the disappearance of P from the bags. Effective ruminal availability of P was calculated as described by Hvelplund & Weisbjerg (2000), using a 4% fractional outflow rate from the rumen. The effective ruminal availabilities, as measured by the *in situ* bags, varied significantly between feedstuffs (roughages: 35% to 95%; concentrates and by-products: 38% to 93%). Low digestibility of roughages and expanding of concentrates

reduced ruminal availability. The total release of P (mobile bags: rumen + intestine) from concentrates and by-products was high (94% to 99%), but it can not be excluded that some of the released P was bound as phytate. The total release of P from minerals varied between 29% and 100%. The total release of P (RP) from roughages was correlated to availability of dry matter (DDM): $RP(\%) = 0.25 \times DDM(\%) + 77.5$; $R^2 = 0.81$.

References: Hvelplund, T.; Weisbjerg, M. (2000): In: Forage Evaluation in Ruminant Nutrition, (eds.) D.I. Givens, E. Owen, R.F.E. Axford & H.M. Omed, CABI Publishing, p. 233-258. Madsen, J.; Hvelplund, T. (1994), *Livestock Production Science*, 39:201-212.

Key Words: Phosphorus, Cattle, Availability

1460 Effect of dietary phosphorus concentration on reproductive performance of lactating dairy cows. H. Lopez^{*1}, F. D. Kanitz², V. R. Moreira², M. C. Wiltbank¹, and L. D. Satter^{1,2}, ¹University of Wisconsin, Madison WI, ²US Dairy Forage Research Center, USDA-ARS, Madison WI.

There is a widespread notion that increasing dietary phosphorus (P) for lactating cows above NRC requirements will improve reproductive performance. The objective of this study was to determine the effect of dietary P concentrations of .37 or .54% of the TMR (DM basis) on reproductive performance. At calving (d 0) Holstein cows (n=134 for .37 and n=133 for .54%) were randomly assigned to one of the treatments. Cows received a radiotelemetric transmitter (d 50) and were bred to natural estrus from d 50 to d 100 and to synchronized estrus after d 100. The first number of paired results shown below is for the .37% and the second for the .54% treatment. Days to first estrus (701.6 and 681.2; $P=0.24$), days to first service (742.2 and 721.8; $P=0.58$), and conception rate at first service (44.4% and 55.8%; $P=0.19$) did not differ between groups. Similarly, there were no differences in overall conception rate (33.3% and 36.3%; $P=0.45$) and days open (1103.5 and 1163.8; $P=0.29$). The total number of natural ovulations was 495 (n=226 for .37 and n=269 for .54%) and the total number of natural estruses was 260 (n=116 for .37 and n=144 for .54%). These two measures are sensitive to the 100 d end point for measuring natural ovulation and natural estrus, since a 2 d delay to first service (74 and 72 d for .37 and .54%) would reduce the number of cows cycling a second time before the 100 d cut off point. Double ovulation rates were 20.3% and 19.0%, respectively ($P=0.69$). Anovulatory condition was diagnosed in 34.3% and 29.3% of the cows ($P=0.38$). Pregnancies lost from 30 d to 60 d (16.4% and 17.8%; $P=0.80$) did not differ between groups. The mean duration of estrus was 8.80.7 and 8.80.8 h ($P=0.98$). The average number of mounts per estrus was 7.40.6 and 7.70.6 ($P=0.71$) and the total mounting time was 27.42.2 and 25.31.9 s ($P=0.47$). Phosphorus treatment had no detectable effect on reproductive performance.

Key Words: Dairy Cow, Reproductive Performance, Phosphorus Requirement

1461 Effects of dietary calcium (Ca), anionic salts (AS) and vitamin D₃ (D₃) on Ca and acid-base status of steers. G. Aranda-Osorio^{*} and J.J. McKinnon, *University of Saskatchewan, Saskatoon, SK, Canada.*

The objective of this study was to evaluate the effects of dietary Ca manipulation, and supplementation with AS and D₃ on blood levels of Ca, parathyroid hormone (PTH), calcitonin, D₃, 25 hydroxyvitamin D₃ (25(OH)D₃), 1-25 dihydroxyvitamin D₃ (1-25(OH)₂D₃) and on systemic acid-base parameters. Twenty steers (448 ± 26 kg), penned individually, were fed a 90% barley-based concentrate, 10% barley silage diet (DM basis). For the first 14 d (d L1-L14), the Ca level of the diet was 0.16%. For the next 10 d (d S1-S10) the Ca level of the diet was 0.84%. During this period the cattle were fed AS at 1.5 Eq/d (56.8 g ammonium chloride (NH₄Cl) and 56.8 g magnesium sulfate (MgSO₄)/hd/d) for 3 d and then at 3 Eq/d (113.5 g NH₄Cl and 113.5 g MgSO₄/hd/d) for the next 7 d. During this period the steers were divided into 4 groups and randomly assigned to 0, 0.6, 1.2 and 2.4 million IU (MIU) D₃/hd/d. The cattle were then put on a 5 d withdrawal period (d W1-W5). Blood samples were obtained every second day by venipuncture. The data were analyzed by repeated measures analysis and single degree of freedom contrasts. Feeding the low Ca diet decreased ($P < .05$) total (TCa) and ionized (ICa) serum Ca levels on d L7 and L14; plasma D₃ on d L7 and 25(OH)D₃ on d L7 and L14. From d S1-S10, TCa and ICa levels increased ($P < .05$) in all groups, with the greatest response ($P < .05$) in the D₃ fed steers. Maximum serum Ca levels for all 3 D₃ treatments were

achieved during the withdrawal period. Plasma D₃ increased quadratically, reaching a maximum of 122.6 ng ml⁻¹ on d S5 for the 2.4 MIU D₃ treatment. In contrast, 25(OH)D₃ increased in a linear fashion. Supplementing AS at 3 Eq/d decreased ($P < .05$) blood pH. On d W1, PTH levels were decreased ($P < .05$) while 1,25(OH)₂D₃ increased ($P < .05$), responses related to the level of D₃ fed. These results show that dietary Ca manipulation along with AS and D₃ feeding, elevates plasma Ca levels, a response related to improved beef quality.

Key Words: Calcium, Anionic Salts, Vitamin D₃, Beef Quality

1462 Offering sodium bicarbonate and sodium bentonite free-choice to lactating dairy cattle. L.E. Wester*, C.C. Stallings, M.L. McGilliard, and W.S. Swecker, Jr., *Virginia Polytechnic Institute and State University, Blacksburg, Virginia.*

The objective of this trial was to evaluate the effects of free-choice intake of sodium bentonite and sodium bicarbonate on physiological and production parameters. Twenty-five cows (8 Jerseys, 17 Holsteins) were randomly assigned to two groups to equalize stage of lactation, age and production history. Each group followed a different sequence of: 1) control diet, 2) control diet with added bicarbonate at 1.2% DM, 3) diet 1 with free-choice option, and 4) diet 2 with free-choice option. Free-choice options of bentonite and bicarbonate were offered side by side in a covered feeder to breed groups. Diets were changed every 10 days to provide 8 periods with a repetition of each diet. All diets consisted of corn silage, alfalfa silage, high moisture corn, soybean meal and corn meal and adjusted to 17% ADF and 17% CP. There were no differences between diets for blood protein, blood packed cell volume, fecal pH, visual fecal consistency scores, milk composition, or daily milk yield. Urine pH was higher in Jerseys fed free-choice (8.28) versus no free-choice (8.22). Urine specific gravity was lower in cows force-fed bicarbonate [diets 1, 3 (1.029, 1.028) versus diets 2, 4 (1.025, 1.026)]. In Jerseys, MUN was higher with free-choice diets (1.2 versus 3.4). Holsteins force-fed bicarbonate consumed 1.2 kg/d more DM than Holsteins not force-fed but daily milk yield was not different. Force-fed bicarbonate intake was approximately 300 g/d for Holsteins and 240 g/d for Jerseys. Free-choice intake of bicarbonate averaged 33.6 g/d for Holsteins and 81.3 g/d for Jerseys, and free-choice intake of bentonite averaged 80.7 g/d for Holsteins and 97.9 g/d for Jerseys. Force-fed bicarbonate decreased urine specific gravity and free-choice intake of bicarbonate and bentonite increased urine pH in Jerseys.

Key Words: sodium bicarbonate, free-choice, cows

1463 The effects of sub-acute rumen acidosis on sodium bicarbonate supplemented water intake for lactating dairy cows. G. Cotte*¹, V. R. Osborne¹, I. Kyriazakis², T. M. Widowski¹, and B. W. McBride¹, ¹*University of Guelph, Guelph, Ontario, Canada*, ²*Scottish Agricultural College, Edinburgh, UK.*

Sub-acute rumen acidosis (SARA) is common in dairy cows. An experiment was conducted to evaluate if cows subjected to SARA would select for drinking water supplemented with sodium bicarbonate. Four ruminally fistulated Holstein dairy cows (142 ± 20 DIM) were used in a repeated block design. Each cow was presented with a choice from two opposite positioned lateral water bowls. Sodium bicarbonate was supplemented into one of the water bowls via an in-line water medicator delivery system at 2.5 g/L. The other bowl contained normal water. SARA was induced by replacing 25% (DM basis) of a total mixed ration with 50:50 wheat:barley pellets. The average daily water intake was 85.7 ± 3.1 L/d during the control period and 80.5 ± 3.1 L/d during the SARA period ($P = 0.24$). Individual preference ratios [PR = treatment bowl intake / (treatment bowl intake + control bowl intake)] for sodium bicarbonate supplemented drinking water during the control and SARA periods were not different ($P = 0.97$). The PR for sodium bicarbonate supplemented water was 0.41 and 0.41 ± 0.07 during the SARA and control periods respectively. There was, however, a large variation in individual preference for drinking water supplemented with sodium bicarbonate.

Key Words: sub-acute rumen acidosis, sodium bicarbonate, water intake

1464 Effect of dietary cations-anions difference on physiological and productive responses in dairy goats during early lactation. F. Meschy and D. Sauvant*, *INRA-INAPG Physiologie de la Nutrition et Alimentation Paris France.*

Numerous studies have dealt with the role of manipulating the dietary cation-anion difference (DCAD) to prevent milk fever in dairy cows but much less investigated the DCAD effects on productive and physiological parameters. This experiment was designed to determine the effect of DCAD on milk production, ruminal and blood responses in lactating goats during early lactation (wk 1 to wk 8 after kidding). Twenty-four Alpine or Saanen multiparous goats including 6 rumen cannulated animals (mean BW at the beginning of the experiment 74 ± 13 kg). At 7 DIM goats were assigned to three experimental groups: D80, D200 and D320. Animals were fed TMR (pulp silage, grass hay, dehydrated alfalfa and concentrate) with a forage: concentrate ratio of 50: 50 (DM basis). Diets differed only on DCAD ([Na + K] # [Cl + S]) values, mEq/ kg : 84, 200 and 319 for D80, D200, D320 respectively (analytical basis). DMI and milk production were recorded daily, milk, rumen and blood parameters analysis were performed once a week. DMI increased ($p < 0.001$) with D320: 119 g/kg BW 0.75 vs 103 and 110 for D80 and D200 respectively. Milk production (g/BW 0.75) was higher for D200 (166.7) compared with D80 (155.6), D320 (163.5) did not show any difference with two other groups. No difference among the treatments were observed for milk composition. pH decreased linearly when DCAD increased: 7.05, 6.94 and 6.80 for D80, D200 and D320 respectively but remains in a range which is favorable for microbial activity. This could be explained by a linear increasing of total VFA production: 100.3, 127.4 and 137 mmol/L. Acetate percentage was significantly higher for D300: 66.1 % vs 64.3 and 64.7 for D80 and D200 respectively while other VFA percentages were not significantly different. NEFA (Eq/L) were higher for D200 (428) than for D80 (369) and D320 (310), a significant difference was observed between these two latter groups. Blood urea (mg/L) was lower in D200 (0.34) and D320 (0.33) compared with D80 (0.42). β -hydroxybutyrate (mg/L) was higher in D200 (46.0) and D320 (45.2) than in D80 (42.5). These results indicate that manipulating DCAD could improve performance and metabolic responses in lactating goats during early lactation. At this physiological stage a DCAD of 300 mEq/kg DM might be recommended.

Key Words: DCAD, Goat, Performances

1465 Use of organically complexed trace minerals in lactating dairy cow diets. H. Chester-Jones*¹, J. G. Linn³, G. D. Marx², W. G. Olsen³, M. C. Jacobson², D. M. Ziegler¹, K. Brokken⁴, W. Brommelsiek⁴, and D. A. Vermeire⁵, ¹*University of Minnesota, Waseca, MN*, ²*University of Minnesota, Crookston, MN*, ³*University of Minnesota, St. Paul, MN*, ⁴*Quali-Tech Inc., Chaska, MN*, ⁵*Nouriche Nutrition, St. Louis, MO.*

A 2-yr study was designed to evaluate performance, health and reproductive responses to sulfate, polysaccharide complexed or specific amino acid chelated, Cu, Mn, Zn and Fe. Thirty-nine primiparous (pp) and 62 multiparous (mp) lactating Holstein cows at the Northwest Research and Outreach Center were assigned to one of 4 trace mineral supplements. Trace mineral (Cu, Mn, Zn, and Fe) supplement sources were: 100% inorganic sulfate (SULF), 100% polysaccharide complex (SQM), 67% SULF:33% SQM (SULFSQM) and 67% SULF:33% amino acid chelates (SULFAA). Supplements were formulated to supply 40 ppm Zn, 40 ppm Mn, 20 ppm Fe and 10 ppm Cu in the total diet (DM basis). Cows were housed in a tie-stall barn, milked twice daily and fed a TMR containing their respective supplement once daily from freshening to dry off. Mean lactation length for all cows was 297 days. Cows were switched from a 'high' (18% CP, 1.73 Mcal/kg NEL, 42% NFC, 18.3% ADF, 27.9% NDF) to 'low' (15.3% CP, 1.66 Mcal/kg NEL, 42% NFC, 29.6% ADF, 31.1% NDF) TMR when milk production was < 30 kg per day. Average DMI for the lactation was 21.4 kg per day. Somatic cell counts were not affected by supplement ($P > .05$). Days to first heat and days to first service were 65 and 84 days, respectively. Days open were lower ($P < .02$) for cows fed SQM (112.9) than those fed SULF (173.2) but similar ($P > .10$) to those fed SULFSQM (135.9) and SULFAA (128.5). First service conception rate and total services per conception were lowest ($P < .03$) for cows fed SQM (71, 1.5) versus SULFAA (29, 3.4), SULFSQM (32, 3.7) and SULF (28, 4.8). Number of cows culled during the study (main criteria > 200 days open) was 11, 8, 7, and 4 for those fed SULF,

SULFAA, SULFSQM, and SQM supplements, respectively. Under conditions of this study, 100% inclusion of polysaccharide complexed Cu, Mn, Zn, and Fe improved reproductive efficiency.

Key Words: Lactating cows, Reproduction, Polysaccharide complexed minerals

1466 The effect of steam flaked or ground corn and supplemental phytic acid on ruminal phytase activity and P balance in lactating cows. A.D. Guyton*, J.M. McKinney, and K.F. Knowlton, *Virginia Polytechnic Institute and State University.*

The effect of starch source and supplemental phytic acid on P partitioning and ruminal phytase activity was evaluated in 8 lactating cows (4 ruminally cannulated; 113 DIM). Cows were assigned to one of four treatments in 2, 4x4 Latin squares with 18 d periods. Diets were 61% forage, 37% starch, 16.6% CP, and 31% NDF, and included dry ground corn (DG) or steam flaked corn (SF), with a no supplemental P (L; 0.34% P) or supplemental purified phytic acid (PA; 0.45% P) to provide additional P from an organic source. Total collection of milk, urine, feces, and feed was conducted on d 16-18 of each period. Rumen fluid (RF) was sampled and rumen pH measured every 4 h on d 16-18. Excretion of feces, urine, and P was lower in cows fed SF than in cows fed DG (7.2 kg/d, 22.9 kg/d and 50.4 g/d vs. 8.5 kg/d, 26.0 kg/d and 61.6 g/d for SF and DG). In cows fed SF, apparent P digestibility tended to be higher, and milk P as a percent of P intake increased (14.8 vs. 13.0%) when compared to cows fed DG. Milk yield was unaffected by diet (mean = 33.6 kg/d), despite lower DMI by cows fed SF (24.0 vs. 25.8 kg/d). Cows fed SF had increased DM digestibility compared to those fed DG, and tended to have higher feed efficiency (1.40 vs. 1.35 kg milk/kg DMI). Rumen pH was unaffected by diet (mean = 6.1), but milkfat content was lower for cows fed SF. Milk yield, DMI, and feed efficiency were not affected by PA. Cows fed PA had increased P intake (108.8 vs. 79.8 g/d) and excretion (67.0 g/d vs. 45.0 g/d) compared to cows fed L, but apparent P digestibility was unaffected (mean = 41.3%). P balance tended to be higher in cows fed PA (29.4 vs. 22.4 g/d), but milk P as a percent of intake was reduced (11.8 vs.16.0%). The interaction of starch source and PA affected ruminal phytase activity (2.51, 5.41, 4.14, and 3.15 umol/min/ml RF for DG-L, DG-PA, SF-L, and SF-PA). Altering dietary sources of starch and P offers opportunity to improve P availability and reduce manure nutrient excretion.

Key Words: phosphorus excretion, phytase activity, starch digestibility

1467 Comparative metabolism of calcium from calcium carbonate and calcium propionate in growing steers. J. W. Spears*, V. Fellner¹, and F. R. Valdez², ¹*North Carolina State University*, ²*Kemin Americas, Inc., Dex Moines, Iowa.*

Twenty-four Angus and Angus crossbred steers (255 kg initial BW) were used to determine the effect of calcium (Ca) source on calcium metabolism in steers fed dietary Ca below or in excess of requirements. The experiment was conducted over three trials with eight steers randomly assigned in each trial to treatments in a 2 x 2 factorial design. Treatments consisted of two dietary levels (0.25 or 0.75%) and two sources (CaCO₃ or Ca propionate, NutroCAL[®] of Ca. Steers were individually fed a corn-cottonseed hull based diet for 21 d. Following the 21-d period, steers were placed in metabolism crates. Steers were acclimated to the crates for 7 d followed by a 5-d total collection of urine and feces. Ruminal soluble Ca concentrations were much higher (P<0.01) in steers supplemented with Ca propionate. A Ca level x Ca source interaction (P<0.01) was observed with ruminal soluble Ca increasing greatly when dietary Ca was increased from Ca propionate, but increasing dietary Ca from CaCO₃ had little affect on soluble Ca concentrations. Plasma Ca was slightly higher (P<0.10) in steers fed high dietary Ca, but was not consistently affected by Ca source. Apparent absorption (%) of Ca was higher (P<0.05) for steers fed low dietary Ca. Percent Ca absorption was affected by a Ca level x Ca source and a trial x treatment interaction. Apparent absorption of Ca was higher from CaProp at the low Ca level, but not at the high level. Urinary excretion of Ca was higher (P<0.05) in steers supplemented with Ca propionate. Molar proportion of acetate was lower in steers supplemented with Ca propionate compared to those given CaCO₃ especially at the high Ca level (interaction, P<0.05). At the low Ca level, propionate was not affected by Ca source, but at the high Ca level molar proportion of propionate was higher in steers fed Ca propionate (interaction P<0.10). Calcium propionate may affect ruminal fermentation differently from CaCO₃. Calcium

from Ca propionate was absorbed more efficiently when supplied at low dietary concentrations.

Key Words: Cattle, Calcium

1468 Production and economic responses of high producing lactating dairy cows to increasing Dietary Cation Anion Difference during non-heat stress seasons. W.K. Sanchez*, M.A. DeGroot², E. Block², D.E. Weber¹, and K.R. Cummings¹, ¹*Arm & Hammer Animal Nutrition Group, Church & Dwight Co., Inc., Princeton, NJ*, ²*Fresno State University, Fresno, CA.*

Five controlled field studies were conducted in commercial Holstein herds to test the effects of increasing Dietary Cation Anion Difference (DCAD) on milk production. In each herd the high group was split into two pens (min. 85, max. 145 cows per pen) with one pen receiving a higher calculated DCAD (meq (Na + K) - (Cl + S)/100g DM) (treatment) than the other. DCAD was altered by either reducing dietary Cl or by increasing K or Na and K (see table). One trial had individual milk yields monitored daily; the others were individually recorded every other week by DHI. All but one trial had milk components assayed bi-monthly. Three of five trials showed significant (P<.05) production responses to increasing DCAD. The other two trials tended (P<.1) to produce a production response to elevated DCAD. The Fall trial revealed no milk response (P>.1) but an increased FCM yield (P<.05) to elevated DCAD. Combining trials showed that increasing DCAD improved milk and FCM yields with a positive return on investment. Because DMI was not recorded, the assumption was made that extra DM was required to achieve the milk response and was included in the economic analysis. Break-even analysis showed that a response of 0.9 lb. of milk is required to repay the cost of treatment with a 93% chance of exceeding that response (Type I and Type II error analysis). In conclusion, increasing DCAD during non-heat stress seasons improves production performance of cows in early to mid lactation in a positive economic fashion.

Early Lactation Studies		Trial Description					
		Winter	Winter	Winter	Fall	Spring	
Item	Units	-CL	+K	+K	+Ka +Na	+K	Avg.
DCAD Control	Meq/100g DM	18.9	18	38	25	33	28.78
DCAD Treatment	Meq/100g DM	25.1	26	43	35	39	35.02
% K for Control	%DM	1.38	1.20	1.52	1.63	1.50	1.45
% K Treatment	%DM	1.33	1.50	1.80	1.84	1.70	1.63
Product Cost	\$cow	0.05	0.10	0.08	0.08	0.09	0.08
Cost of extra DM(est) ^a	\$/cow/d	0.09	0.16	0.07	(0.06)	0.05	0.09
Milk Response	Lb./cow/d	3.0*	5.4*	2.4†	-2.0	1.5	2.1
Fat Response	Lb./cow/d	NA	0.14	0.04	0.40*	0.01	0.15
FCM Response	Lb./cow/d	3.0*	3.3*	2.0†	5.6*	1.9†	3.2
Revenue (est) ^b	\$/cow/d	0.36	0.39	0.25	0.67	0.23	0.38
Net Profit	\$/cow/d	0.22	0.13	0.09	0.65	0.09	0.24
Return on Investment	%	157	49	62	3260	69	719

^aEstimated intake needed for milk response; ^bRevenue estimated with milk at \$12/cwt of FCM; *P<.05; †P<.10

Key Words: DCAD, Potassium, Early Lactation

1469 Selenium status of beef calves from dams receiving different forms of selenium supplementation. G. Valle¹, L. R. McDowell¹, P. A. Davis^{*1}, D. L. Prichard², P. J. Chenoweth³, D. L. Wright², F. G. Martin⁴, W. E. Kunkle¹, and N. S. Wilkinson¹, ¹University of Florida, Department of Animal Sciences, Gainesville, ²UF-IFAS North Florida Research and Education Center, ³College of Veterinary Medicine, University of Florida, Gainesville, ⁴University of Florida, Department of Statistics, Gainesville.

Seventy-five Angus cows (150-240 d gestation) were randomly assigned to five groups and received either no selenium (Se) supplementation (control), 5 ml sodium selenite via subcutaneous injection (Mu-Se, Burns Biotech Labs, Inc. Oakland, CA) every six mo, 9 ml barium selenate via subcutaneous injection (Deposel, Grampian Pharmaceuticals Ltd, Lancashire, UK), and two groups received selenized yeast (Se-Plex, Alltech Biotech, Nicholasville, KY) via ad libitum salt-based mineral mixtures (30 ppm Se) for two yr. Calf plasma Se levels were determined at birth, 60, 120 and 180 d postpartum each yr. During yr 1, calf plasma Se concentrations at birth were at critical concentrations (0.03 mg/L) for the control, Mu-Se, and Deposel treatments. The two free-choice mineral treatments had an average Se concentration of 0.06 mg/L, which is borderline to adequate (0.07 mg/L). At 60, 120 and 180 d, the control, Mu-Se and Deposel treatments were below critical Se concentrations, whereas the averages for the free-choice mineral mixtures were at or above adequacy. During yr 2, control calves were below critical concentrations at all times, while Mu-Se and Deposel treatments were at a critical level at birth and 60 d postpartum and below the critical level thereafter. Calves from the two free-choice mineral treatments were higher in plasma Se ($P<0.05$) than calves from all other treatments with average concentrations being borderline (0.055 mg/L) at birth and near adequate (0.065 mg/L) for the remainder of the experiment. In general, the control and the two injectable inorganic treatments resulted in calf plasma Se concentrations declining with time and at no time being adequate. Calves on the two free-choice mineral mixture treatments with organic Se had adequate plasma Se during the majority of the study. Neither injectable inorganic Se source was effective for increasing and maintaining calf plasma Se concentrations during this experiment. Calves nursing dams on inorganic Se treatments had plasma Se concentrations that tended to decrease with time. Organic Se treatments were effective in attaining and maintaining near adequate plasma Se concentrations throughout the experiment.

Key Words: Beef calves, Selenium, Supplementation methods

1470 Estimating bone mineral content in dairy cows. B.E. Keene*, A.M. Rutledge, S.M. Nickols-Richardson, C. Holtaway, J.M. McKinney, and K.F. Knowlton, *Virginia Polytechnic Institute and State University, Blacksburg.*

The objectives were to evaluate non-invasive measures of bone mineral content (BMC) and bone mineral density (BMD) in dairy cows, and to evaluate effects of parity and stage of lactation on BMC and BMD using dual energy X-ray absorptiometry (DXA). DXA is an imaging technique used to assess bone strength and to predict osteoporosis fractures in humans. The tail (caudal vertebrae) and right front leg (metacarpal) were excised from 107 Holstein cull cows following slaughter. Parity and days in milk (DIM) of donor animals were obtained for 43 sets of samples. Samples were grouped by parity (1, 2, 3, 4+) and stage of lactation (0-89 DIM; 90-150; 151-250; 251+). BMC and BMD of the fused 3rd and 4th bones of the metacarpal, and of caudal vertebrae 14 and 15 were measured by DXA. In the metacarpal, increasing parity increased BMC linearly, but stage of lactation had no effect. Stage of lactation affected BMC of caudal vertebra 15, with the highest values observed in samples from cows in late lactation (151-250 DIM). Imaging techniques offer opportunity to evaluate factors affecting bone mineral metabolism of dairy cows.

1472 Effect of greenhouse housing on performance of neonatal dairy calves housed in hutches. D.R. McKnight^{*1}, P.H. Sharpe, and R.S. Rana, ¹Kemptville College, University of Guelph.

Eight studies with a total of 198 calves were conducted during 2 consecutive years and 4 seasons to evaluate the effects of providing supplemental greenhouse shelter to neonatal dairy calves housed in polyethylene

	Parity					P<			
	1	2	3	4	SEM	Parity	Lin	Quad	
Metacarpal									
BMC _{UPPER} ¹	9.47	13.06	10.70	14.58	1.77	0.07	0.07	0.92	
BMC _{MID} ²	33.41	44.04	37.83	45.49	4.07	0.06	0.07	0.67	
BMC _{TOTAL} ³	43.65	60.05	49.59	61.24	5.75	0.04	0.04	0.63	
BMD _{UPPER} ⁴	1.52	1.90	1.65	1.98	0.17	0.10	0.11	0.85	
Stage of lactation ⁵									
	1	2	3	4	SEM	Stage	Lin	Quad	
Caudal vertebrae									
BMC _{V14} ⁶	1.44	1.42	2.18	1.37	0.27	0.09	0.58	0.15	
BMC _{V15} ⁷	0.91	0.87	1.65	0.92	0.24	0.05	0.34	0.15	
BMC _{VTOTAL} ⁸	4.96	4.78	7.47	4.84	0.94	0.10	0.49	0.20	
BMD _{V15} ⁹	0.45	0.44	0.51	0.45	0.02	0.10	0.43	0.25	

¹BMC_{UPPER}= BMC of upper metacarpal, g; ²BMC_{MID}= BMC of mid-section of metacarpal, g; ³BMC_{TOTAL}= Total BMC of mid- and upper metacarpal, g; ⁴BMD_{UPPER}= BMD of upper metacarpal, g/cm²; ⁵Stage of lactation defined by DIM. Stage 1 = 0-89; Stage 2 = 90-150; Stage 3 = 151-250; Stage 4 >250; ⁶BMC_{V14}= BMC of caudal vertebra 14, g; ⁷BMC_{V15}= BMC of caudal vertebra 15, g; ⁸BMC_{VTOTAL} = Total BMC of caudal vertebrae 14 and 15, g; ⁹BMD_{V15} = BMD of caudal vertebra 15, g/cm²

Key Words: Bone mineral content, Bone mineral density, DXA

1471 Organic chromium and selenium effects on immunoglobulins concentration, and carcass composition of finishing lambs. I. Dominguez-Vara¹, S. Gonzalez^{*2}, R. Barcena², M. Cobos², and G. Mendoza², ¹Universidad Autónoma del Estado de México, ²Colegio de Postgraduados.

Fifty four lambs (27.0 kg BW) were fed 95 d and assigned to a completely randomized experiment (2x3 factorial arrangement) using organic Se (0, 0.3 ppm, as Sel-Plex-50) or Cr (0, 0.250, 0.350 ppm, as Biochromium). Sel-Plex-50 (0.0, 3.0 g/lamb/d) and (Biochromium, 0.0, 2.5, 3.5 g/lamb/d) were offered with the morning feeding. Basal diet (%DM) had shorgum 65.0, corn stover 13.0 and DPW 12.0, as main ingredients. Jugular blood samples were taken at the beginning and weeks two, seven and eleven. Plasma metabolites, tryglicerides, cholesterol, glucose and urea-N were analyzed using enzymatic methods, and serum immunoglobulins IgG by ELISA. At the beginning of the experiment four lambs were slaughtered and 30 at the end, to measure carcass composition by specific gravity. Three days before slaughter, backfat depth was measured in vivo on 6th and 10th ribs by ultrasound and in situ with a metallic rule. Means were analyzed by ortogonal contrasts (C): C-1, 0 Se vs 0.3 ppm Se; C-2, 0 Cr 0 Se vs 0.250+0.350 ppm Cr+0 Se; C-3, 0 Cr+0.3 ppm Se vs 0.250+0.350 ppm Cr+0.3 ppm Se; C-4, 0.250 ppm Cr+0 Se vs 0.350 ppm Cr+0.3 ppm Se; C-5, 0.250 ppm Cr+0.3 ppm Se vs 0.350 ppm Cr+0.3 ppm Se. Among weeks there were differences for tryglicerides and cholesterol at 0 h ($P<0.0008$ and $P<0.0001$) and 3 h ($P<0.04$ and $P<0.0002$); for glucose and urea-N concentration at 0 h ($P<0.074$ and $P<0.021$); and for IgG ($P<0.0001$). Carcass in situ measurements at the 10th rib and in vivo at the 6th rib were significant for C-2 ($P<0.01$, $P<0.07$). Body fat was reduced by Cr (C-2, $P<0.01$; C-4, $P<0.02$) and total carcass energy was higher for lambs without Cr or Se. Weight of heart, lung, liver and spleen was increased ($P<0.04$; C-3) by Cr and Se. Addition of organic Cr improved carcass composition of finishing lambs; however, tryglicerides, cholesterol, glucose and urea-N, and immunoglobulins IgG levels were not affected by treatments.

Key Words: Organic chromium and selenium, Immunoglobulins and carcass composition, Finishing lambs

Animal Behavior and Well-Being

1472 Effect of greenhouse housing on performance of neonatal dairy calves housed in hutches. D.R. McKnight^{*1}, P.H. Sharpe, and R.S. Rana, ¹Kemptville College, University of Guelph.

Eight studies with a total of 198 calves were conducted during 2 consecutive years and 4 seasons to evaluate the effects of providing supplemental greenhouse shelter to neonatal dairy calves housed in polyethylene

hutches. Purchased Holstein bull calves from 3 to 7 days of age weighing 40 to 45 kg. were randomized by weight to 12 hutches in an open control area or 12 hutches under a greenhouse shelter. The greenhouse shelter had an open ridge vent, removable side curtains and end walls, and a translucent grey cover rated to prevent 60% of sunlight penetration. Side curtains and end walls were removed during summer and fall trials. The

south end wall was always left open. Each seasonal replicate ran for 56 d. Calves were fed 2 L of whole milk twice daily, except during winter trials when it increased to 2.5 L. Weaning occurred after 4 wk on trial when a calf had consumed 750 g calf starter for 3 consecutive d. Water and calf starter were provided ad libitum. Milk, water, calf starter, fecal scores, respiration rates and health treatments were recorded daily. Environmental temperatures and humidity were recorded daily inside and outside selected hutch using maximum-minimum digital recorders. Data were analyzed as a factorial design using SAS procedures. No interaction ($P>0.05$) was detected between housing and season. Greenhouse shelter had no significant ($P>0.05$) effect on performance of neonatal calves. Maximum and minimum temperatures were moderated ($P<0.05$) by greenhouse housing. It is suggested that summer shade of hutch is still desirable from a humane aspect. Evaluation of less costly, more easily sanitized shade options are recommended. There were significant ($P<0.05$) seasonal differences. Calves grew significantly ($P<0.05$) faster in winter and fall than spring and summer trials (.61, .69, .74, .58 kg/d for summer, fall, winter, spring resp.). Alternatives to hutch housing is recommended for newborn calves when environmental temperatures drop below -25°C for any prolonged period. In conclusion, greenhouse shelter for neonatal calves housed in hutch did not effect performance or health.

Key Words: Greenhouse, Hutch, Neonatal dairy calves

1473 Rearing calves outdoors compared with indoor housing on calf health, immunity, behaviour and performance. B Earley^{*1}, ¹*Teagasc, Grange Research Centre, Dunsany, Co. Meath, Ireland.*

The objective of this study was to compare the effects of rearing calves outdoors with and without calf jackets with calves reared indoors on calf health, immunity, behaviour and performance. Ninety male Holstein calves (55 ± 2.0 kg) were randomly assigned to each of 3 treatments ($n=30$ per treatment): 1). Outdoor with Jacket (J); 2). Outdoor No Jacket (NJ); or 3). Indoors (I) housed on straw. Calves received an individual allowance of 25 kg of milk replacer during the first 42 d with ad libitum access to a concentrate ration from d 1 to 63. No significant difference among treatments was found in liveweight gain from d 1 to 63 of the study (Jackets; 0.79: No Jackets; 0.80: I; 0.80 mean kg/d). Thirteen percent of the J calves and 13% of the NJ calves required 4 or more antibiotic treatments for respiratory disease while corresponding treatments for the Indoor calves was 60%. The incidences of diarrhoea was significantly higher ($P < 0.05$) in the outdoor treatments, irrespective of calf jackets. Concanavalin-A (Con-A) and Keyhole limpet haemocyanin (KLH) induced interferon- γ were significantly reduced ($P < 0.05$) in calves treated for respiratory disease. Calves reared outdoors spent significantly ($P < 0.05$) longer periods standing than calves reared indoors. There was no significant difference in Ig serum levels or white cell counts among treatments on days 1, 7, 14, 21, 28, 42, 49, 56 and 63. It is concluded that rearing calves outdoors using calf jackets had no beneficial effect on calf performance. The incidence of respiratory disease was higher in calves reared indoors compared with calves reared outdoors with and without jackets and cell mediated immune function was lower in calves treated with antibiotics for respiratory disease.

Key Words: Immunity, Respiratory disease, Behaviour

1474 Preference of dairy cows for four commercial free stall mattresses. J. K. Bernard^{*}, B. G. Mullinix, J. W. West, and H. Cross, *University of Georgia, Tifton, GA/USA.*

Four commercially available free stall mattresses were used in a 5-mo study to compare cow usage. The mattresses were 1) Pasture Mat, Promat Ltd; 2) Comfy Mat, Sikkema's Equipment; 3) Alanta water bed, Georgia Duck and Cordage; and 4) System 2000, Don Themm Enterprises, Inc. Mattresses were installed in blocks of four in a section of 32 stalls on the north side of a 4-row open sided barn and populated at 75% capacity with Holstein cows. Free stalls were 1.2 m wide and 2.3 m long. Neck rails were set at 1.6 m from the back of the curb and 1.1 m above the free stall floor. Observations were made once daily Monday through Friday of each week from February 14 through June 29, 2001 approximately 2 to 4 h after the AM feeding. The position of cows was recorded as laying, standing or partially in free stalls. Data were analyzed using PROC MIXED procedures of SAS for differences due to mattress and usage (laying, standing, or partially in the stall). The proportion of cows using stalls fitted with the Comfy Mat was highest ($P < 0.001$)

and least for the Alanta water bed. The proportion of cows using stalls fitted with Pasture Mat and System 2000 were similar. The proportion of cows laying in stalls (54.1, 30.0, 41.5, and 3.8%), partially standing in the stall (18.2, 16.7, 14.7, and 4.5%) or standing in a stall (6.7, 6.6, 6.4, and 3.5% for Comfy Mat, Pasture Mat, System 2000, and Alanta water bed, respectively) differed ($P < 0.01$) among mattresses. Results of this study indicate that cows differ in their preference to mattress type when allowed a choice.

Key Words: Free stall bedding, Mattresses, Cow preference

1475 Effect of recycling sand and sand retaining devices on bacterial counts in free stalls. J. K. Bernard^{*1}, D. R. Bray², J. W. West¹, and D. S. Trammell¹, ¹*University of Georgia, Tifton, GA/USA,* ²*University of Florida, Gainesville, FL/USA.*

A year long trial was conducted to determine the effect of sand source and sand retaining devices on bacterial concentrations in free stalls. Two sections of free stalls were bedded with either fresh sand from a pit or recycled sand. The recycled sand was collected from a settling basin and stacked outside until reused for bedding. Within each section of stalls, groups of four stalls were fitted with either Pack Mat, Sand Trap, or Sand Mizer plus one control group. Samples of sand were randomly collected from stall surfaces before rebedding each week. Samples of sand used for bedding were collected and amount of sand required to maintain each group of stalls recorded. Weekly samples were analyzed for DM and ash and one set of samples per month were submitted to All Florida Veterinary Laboratory, Inc. (Archer, FL) for analysis of bacterial concentrations. The amount of sand required to maintain free stalls in our study ranged from 12.7 to 18.8 kg/d. The DM of sand used for bedding was similar for fresh (96.7%) and recycled (96.5%) sand, but the OM content was higher ($P < 0.001$) for recycled sand (1.1% of DM) compared with fresh sand (0.6% of DM). There was no difference in DM and OM concentrations among sand retaining devices, but DM ($P < 0.03$) and OM ($P < 0.01$) concentrations in fresh sand collected from free stall surfaces (97.8% and 1.2% of DM) was lower than recycled sand (98.2% and 2.1% of DM). Concentrations of *Bacillus* gram negative, coliform and *Coryne* sp. were higher ($P < 0.05$) in recycled sand used for bedding compared with fresh sand. No differences were observed in bacterial concentrations among sand retaining devices except for *Streptococcus dysgalactiae* which was highest ($P < 0.01$) for stalls fitted with Pack Mat and Sandmizer and lowest for Stand Trap. Concentrations of *Bacillus cereus*, *Bacillus subtilis*, and *Bacillus* gram negative were higher ($P < 0.05$) and *Streptococcus dysgalactiae* in the stalls were lower ($P < 0.05$) for recycled sand compared with fresh sand. Concentrations of coliform were similar for both fresh and recycled sand and sand retaining devices. Results indicate that recycled sand has higher concentrations of certain bacteria.

Key Words: Free stall bedding, Sand, Bacteria concentrations

1476 Circadian activity profiles of loose housed dairy cows. B.L. Nielsen^{*1,2} and P. Lovendahl², ¹*Scottish Agricultural College (SAC),* ²*Danish Institute of Agricultural Sciences (DIAS).*

In the present study activity levels of loose housed dairy cows were measured in relation to genotype, feeding level and stage of lactation using electronic pedometers. Sixteen cows of either high or low genetic merit were fed one of two total mixed rations (TMRs) with two levels of concentrate inclusion (High: 450 g concentrate DM/kg total DM, 376 g DM/kg fresh, 12.4 MJ ME/kg DM; and Low: 200 g concentrate DM/kg total DM; 314 g DM/kg fresh; 12.2 MJ ME/kg DM) in a two by two factorial experimental design. Electronic pedometers were fitted during six periods of 7 d across the duration of lactation (periods 1 through 6: median 74, 122, 164, 220, 248, and 304 d from calving). During the last period the cows were on pasture. The pedometers logged activity (an estimate of leg movements) in 2-h counts. The circadian activity patterns of the housed cows was similar across lactation with two activity peaks immediately following the morning and afternoon milkings. Cows were significantly more active when on pasture (mean log activity/hour in periods 1-5 vs. 6 (SD): 3.25 (0.07) vs. 4.05 (0.06); $P<0.001$). When housed (periods 1 through 5) the selection line cows in the HC feeding group were more active during the afternoon than the other cows (mean log activity/h from 1200 through 1800 h for HC-sel vs. the others (SD): 3.12 (0.2) vs. 2.55 (0.3); $P<0.05$). These cows also had the highest dry matter intake (HC-sel vs. the others (SD): 19.9 (0.7) vs. 16.2 (1.5) kg/d; $P<0.01$) and highest milk yield (HC-sel vs. the others (SD): 29.8

(2.6) vs. 24.4 (3.3) kg/d; $P < 0.05$). The increased activity of the highest yielding group of cows may reflect increased restlessness in these animals. We conclude that pedometer measured activity of dairy cows is useful in describing changes in the circadian activity profiles related to feed intake or selection for milk yield.

Key Words: Circadian Activity, Dairy Cows, Production Level

1477 Behavioral comparisons of cloned and non-cloned pigs during maintenance, dominance and intelligence testing, and in the peripartum period. F.C. Gwazdauskas¹, A.H. Walters¹, M.L. McGilliard¹, S.F. Ball², S.S. Flesher¹, W.F. Nicholson¹, K.S. Rosoff¹, L.L. Keyes¹, M.R. Wheeler¹, and D.L. Ayares², ¹Virginia Tech, Blacksburg, VA, ²PPL Therapeutics, Blacksburg, VA.

Genetic manipulation and use of assisted reproductive technologies, including somatic cell nuclear transfer (cloning), have engendered concern of the general public for the welfare of the animals produced with these laboratory procedures. The goal of this study was to evaluate whether there were differences in innate behaviors of cloned and non-cloned pigs. The specific objectives of this project were: 1) to evaluate maintenance behaviors; 2) to determine the establishment of dominance; 3) to assess intelligence; and 4) to evaluate farrowing and mothering abilities of cloned and non-cloned gilts. The cloned pigs were derived from cultured adult somatic cells (granulosa) using nuclear transfer procedures. Maintenance behaviors were recorded at 15-min intervals over a 12-h period. There were no significant differences in the frequencies of lying, standing, feeding, and rooting behaviors between groups (clone vs. non-clone). The analysis of aggressive encounters revealed a significant group by time interaction ($P < 0.05$), with cloned gilts more active in late morning. Short term paired feeding tests used to establish social order and dominance found no significant effects of group on attempts to chase away, fleeing activity, or attempts to eat. However, there was a significant difference ($P < 0.01$) in the amount of time spent eating by each gilt during the dominance testing. Intelligence evaluated using a problem-solving maze with a feed reward found no difference between the groups going through the maze. The ease of farrowing, mothering ability score, and the suckling order were assessed and recorded. Average piglet birth weight was affected ($P < 0.05$) by the number of piglets born, but not by the other independent variables. Farrowing score was not different across groups. Mothering scores were not affected by group, dominance or intelligence scores. In general, the behavior of cloned gilts was not different from that of non-cloned gilts.

Key Words: Cloned pig behavior, Dominance, Intelligence

1478 Cross-sucking before and after weaning by calves fed with a computerized milk feeding system. A. M. de Passille* and J. Rushen, *Agriculture and Agri-Food Canada, Lennoxville, QC, Canada.*

There is interest in group rearing of young calves because of reduced labor requirements and animal welfare concerns. However, dairy producers are concerned about the incidence of cross-sucking, which some believe will lead to milk stealing or udder malformation. We examined the behavior of 11 groups of younger calves (4-d to 25-d of age) and 10 groups of older calves (25-d to 50-d of age) fed with a computerized milk replacer feeding system on a commercial farm. The milk feeder had been fitted with a special door to allow each calf to suck without interference from other calves. Calves were allowed a maximum of 4L/d in four portions. Milk was diluted two-fold and milk flow regulated to increase sucking time. Group size ranged from 3 to 16 (median = 8). Calves were videotaped for 2, 24-h periods each wk in each of the two group pens. Calves visited the milk feeder on average 17 times a d. Each video was scanned to search for all cross-sucking events. We calculated the rate of cross-sucking as the number of cross-sucking events/calf-day. We observed a total of 238 cross-sucking events over 2145 calf days. Rates of cross-sucking were 0.08 and 0.09 cross-sucking events/calf-day for the young calves and older calves respectively ($P > 0.10$). Cross-sucking events did not last very long. For the younger calves, a cross-sucking lasted on average 90 s with a range from 21 s to 193 s. For the older calves, the average cross-sucking lasted 77 s (range 19 s to 391 s). We also observed the group reared calves ($n = 134$) after weaning when they were mixed with calves that had been reared individually and bucket fed during the milk feeding period ($n = 176$). Cross-sucking rates were

0.12-events/calf-day for the group-reared calves and 0.15 events/calf-day for individually reared calves ($P > 0.10$). Overall, cross-sucking rates were extremely low. The computerized milk feeder did not cause cross-sucking behaviour to develop during the milk feeding period nor did it lead to an increase in cross-sucking following weaning. However, it is important that the feeder be operated in a way as to allow adequate sucking time for the calves.

Key Words: Cross-sucking, Calf feeding, Group housing

1479 Behavior and meat quality of veal calves provided with drinking water for welfare purpose. G. Cozzi^{*1}, F. Gottardo¹, S. Mattiello², E. Canali², S. Segato¹, and I. Andrighetto¹, ¹Dipartimento di Scienze Zootecniche, University of Padova, Italy, ²Istituto di Zootecnica, University of Milano, Italy.

Growth performance, behavior, forestomach development, abomasal lesions and meat quality of veal calves fed a milk replacer diet (No Water) were compared to those obtained from calves fed the same diet and provided with increasing amounts of drinking water (Water) during the fattening period. Two groups of 69 Polish Friesian calves, balanced according to initial BW, were assigned to the two water treatments in a $3 \times 2 \times 2$ factorial arrangement which considered the provision of solid feed and the adoption of two housing systems. Drinking water was offered to the calves starting from the wk 2 of the study and its amount was progressively increased from 3 to 8 L/d per calf. Calves were not dehydrated, as shown by hematocrit, Na, and K concentration, however when drinking water was available they drank it. Therefore, the water provided by the milk replacer (from 6 to 16 L/d per calf) was not sufficient to fully satisfy the needs of the animals. Drinking water did not affect the calves' growth performance but it reduced their abnormal oral behavior throughout the fattening period (9.6 vs 11.6%, $P < 0.05$). Based on these results, it seems that drinking water did not cover a shortage in calves water requirement but it played a role of an environmental enrichment. Health status was similar between treatments (No Water: 1.76%, Water: 1.44%), although water provision reduced the episodes of feed refusal (0.19 vs 0.89%, $P < 0.05$). Chronic stress measurement by cortisol levels showed that the provision of water should be advisable (12.8 vs 22.1 ng/mL, $P < 0.01$). Feces consistency and animal cleanliness were not affected by drinking water. At slaughter, forestomach development was similar between treatments (No Water: 2548 g, Water: 2500 g) and drinking water did not affect the number of calves showing rumen hairballs and abomasal lesions. No differences in color and other meat quality traits were observed between Water and No Water calves. Despite the lack of direct effects on productive traits, when water was available, the calves drank it and an improvement on some welfare indicators were noticed.

Key Words: veal-calves, drinking water, animal welfare

1480 Head coloration is related to Holstein cow temperament. S. Rose*, T. Grandin, and W.R. Wailes, *Colorado State University, Fort Collins, Colorado, U.S.A.*

Studies with mice indicate that animals with a yellow coat color are more prone to stress when subjected to the same stress as animals with a wild-type coat color. Mice with a yellow coat color experienced greater weight loss, higher levels of corticosterone, and an increase in norepinephrine turnover when restrained in a tube for thirty minutes. In this study, temperament and the amount of dark pigmentation on the head was evaluated in Holstein cows ($n = 219$). All animals were restrained in a fenceline headlock system for scoring. While standing about one meter from the stanchion, the experimenter stood sideways towards the front of the cow. The experimenter leaned towards the animal's head while maintaining position, then observed and recorded the temperament score. The criteria was 1) Extends head forward ($f = 20$), 2) No reaction ($f = 16$), 3) Pulled away, did not pull against headlock ($f = 107$), and 4) Pulled against headlock when a person moved towards the animal ($f = 76$). After animals were scored for temperament, pigmentation scores were given based on the amount of black and white hair covering their head. Pigmentation scores were 1) >95% black ($f = 11$), 2) >50-95% black ($f = 134$), 3) 50:50 black:white ($f = 34$), 4) >50-95% white ($f = 35$), and 5) >95% white ($f = 5$). SEM temperament scores relating to head color scores were 1) >95% black (2.64 ± 0.08), 2) >50-95% black (3.04 ± 0.06), 3) 50:50 black:white (3.06 ± 0.06), 4) >50-95% white (3.34 ± 0.06), and 5) >95% white (3.80 ± 0.03). Cows with more white head color were more likely to pull back against the

stanchion than cows with more black head color (Pearson correlation, $r^2 = 0.03$, $P < 0.01$). Visual assessment of color may help predict a Holstein dairy cow's temperament in order to identify those animals that have a tendency to be more flighty and may require gentler handling.

Key Words: Behavior, Pigment, Dairy

1481 Effect of the presence of a foraging substrate on the welfare of nutritionally satiated sows. J.A. de Leeuw^{*1,2}, E.D. Ekkel², A.W. Jongbloed¹, and M.W.A. Verstegen², ¹ID TNO Animal Nutrition, Lelystad, The Netherlands, ²Wageningen Institute of Animal Sciences, Wageningen, The Netherlands.

the aim of this study was to test whether, in addition to nutritional satiety, the presence of a foraging substrate can improve the welfare of sows. Therefore, 48 nulliparous sows were used in this experiment, divided over three batches and two rooms. Sows were individually housed in 3 m² pens with 1.8 m² solid floor. Lights were on from 0600 to 1800h. Sows had either wood-shavings on the floor as foraging substrate (S), or no substrate (NS). They had unrestricted access to feed from a feed-hopper. After 7 wk adaptation to the environment and substrate behavior was scored once per week during 5 wk in the periods 0700 to 0900h (P1), 1000 to 1200h (P2), and 1300 to 1500h (P3). The scan-sampling method was used with 4-min intervals. Data of 5 wk were pooled per animal. Saliva samples were taken in wk 11, every 2 h for 24 h for determination of cortisol levels. In weeks 2, 7, and 12, spontaneously voided morning-urine was sampled and measured for (nor)adrenaline levels. Ratio's with creatinine levels were calculated to correct for dilution of urine. Hormones were only analyzed for eight sows per treatment (only batches 1 and 2). Most effects on behavior were found in P1. S-sows stood more ($P < 0.01$) and showed more (visible) oral behavior ($P = 0.001$), which was mainly more (sham chewing (including chewing on substrate; $P < 0.05$) and floor manipulation (including substrate manipulation; $P < 0.001$). Only the latter effect was also significant in P2 and P3 ($P = 0.001$). NS-sows had higher cortisol levels during the whole 24 h period. At most times differences were significant ($P < 0.05$). Only in week 2 NS-sows had higher adrenaline levels ($P < 0.05$), whereas noradrenaline levels were higher in weeks 2, 7 ($P = 0.005$), and 12 ($P < 0.05$). Both behavior and physiology imply that nutritionally satiated sows appreciate the presence of a foraging substrate. Therefore, their welfare might be improved.

Key Words: Sows, Foraging Behavior, Welfare

1482 Importance of the activity sort level when using pedometry to detect estrus. O. A. Peralta*, R. L. Nebel, and R. E. Pearson, *Virginia Polytechnic Institute and State University, Blacksburg, VA/USA.*

A review of the literature reveals that pedometer measurements identify 70 to 80% of the cows in estrus; activity increases approximately 4 h prior to the onset of standing estrus, and the predicted optimal time of AI to be between 6 and 17 h after increased activity. The objective of this study was to determine how activity alarm setting affected pregnancy rate. Four commercial dairy herds (A, B, C, D) recorded activity measurements obtained during the four milking sessions prior to AI. For the milking prior to AI, the increase in activity, relative to a baseline activity determined by the pedometry system, was similar across herds ($P \geq 0.05$), 2.9 for A ($n = 167$), 3.6 for B ($n = 84$), 3.3 for C ($n = 166$), and 3.8 for D ($n = 308$). However, the activity for the second milking prior to AI was related to the timing of AI ($P \leq 0.05$). Herds A and D performed AI once daily and had activity increases of 3.3 and 2.5 above baseline, whereas herds B and C that inseminated cows after each milking had activity increases of 1.3 and 1.5 above baseline. Retrospectively, five activity levels (2 \times , 2.5 \times , 3 \times , 3.5 \times , and 4 \times baseline) were applied to determine the number of cows and pregnancy rate for cows in each activity level. Overall pregnancy rates ranged from 33.1% for herd C to 41.6% for herd D. Pregnancy rates increased from 38.4% when activity increase was twice baseline to 41.9% when the activity was 4 \times , the baseline. Requiring that a cow exhibit a four fold increase in activity decreased the number that would have been inseminated by 58% when compared to cows that qualified at twice the baseline activity. More importantly the number of pregnant cows decreased from 212 when using a two fold increase in activity to 98 when a four fold increase was required for insemination. The software interface of commercially available pedometer systems has improved significantly in the last few years

and thus enhances pedometry as a viable alternative for the detection of estrus.

Key Words: Dairy cows, Pedometry, Detection of estrus

1483 Reproductive performance of guinea pigs subjected to 10, 12, and 14 hour continuous and intermittent photoperiods. N.P. Johnston^{*1} and M.E. Uzcategui², ¹Brigham Young University, ²University of San Francisco-Quito, Ecuador.

The effect of 10-, 12, and 14 h continuous and intermittent photoperiods was observed for 10 months on the reproductive performance and growth of guinea pigs. Sixty, two-month old virgin female guinea pigs were equally divided into 6 identical, environmentally controlled rooms under the following photoperiods: 14L:10D, 12L:12D, 10L:14D, 1L:5.5D:1L:5.5D:1L:10D, 1L:4.5D:1L:4.5D:1L:12D, and 1L:3.5D:1L:3.5D:1L:14D. These photoperiods simulated continuous and intermittent subjective days of 14, 12 and 10h respectively. There were no differences between continuous and intermittent lighting for number of litters for 10 months (3.0 v.2.7), litter size at birth (4.18 v. 3.50 kits) and at weaning (2.85 v. 2.84 kits) and parturition interval (71.2 v. 72.8 d between litters). Prewaning mortality was higher ($P < .05$) under continuous lighting. Sows appeared less active under intermittent light which may have contributed to lower early mortality. Continuous and intermittent light had similar effects for postnatal kit daily gain (3.7 v. 3.8 g), feed consumption (83.5 v. 79.2g) and feed to gain. It was concluded that guinea pigs were not photosensitive and daily photoperiods as short as 10 hours would support normal reproductive performance and kit growth.

Key Words: guinea pig, photoperiod, reproduction

1484 Feed consumption pattern of young pigs. S. Salgado², H. Herrera^{*1}, and A.G. Borbolla¹, ¹Universidad Nacional Autonoma de Mexico, ²Universidad Autonoma Metropolitana.

Feed intake immediately after weaning is a critical factor that strongly influences future performance under intensive production systems. Information on consumption patterns can be used as a way to optimize the labor force and/or the feeding management. The objective of this study was therefore, to evaluate the feed intake pattern of young pigs. One hundred and fifty pigs weaned at 19 d of age were transported to a specialized facility located at 5 km from the sow unit. Pigs were randomly allocated to ten pens of 15 animals each. Distribution of the pigs into pens was following the rules of a randomized complete block design with weight as the blocking factor. Average weaning weight was 5.8 \pm 0.8 kg. Feed was provided ad libitum during day and night but changed every eight hours following the next schedule: 8 to 16, 16 to 24, 24 to 8 h, for the whole experimental period (28 d). Self-feeders of 25 Kg of capacity and four holes were used. After each period of 8 h, the remaining feed was weighed and subtracted from the amount previously added. Dry non-consumed feed recollected from each period was cleaned and reintroduced into the next period (to avoid the freshness factor). Data were analyzed using the GLM procedures of SAS using pens as the experimental unit. Feed intake during the first wk, between 8 to 16 h (8 h) period, was 45 and 26% greater ($P < 0.0001$) than the consumption registered at 16 to 24 hrs (16 h) and 24 to 8 h (24 h) periods (39.9 vs. 21.9 and 29.5 g, respectively). Second week consumption at 8 h period was similarly superior ($P < 0.0001$), than registered at 16 h and 24 h periods (135 vs. 110 and 105 g, respectively). Similar consumption pattern was observed during the third experimental week were 8 h and 16 h periods were greater ($P < 0.0001$) in feed intake when compare to the 24 h periods (228 and 222 vs. 196 g). Contrarily, during the four wk, feed intake during the 16 h period was slightly larger than at 8 h period (276.6 vs. 267.8 g, respectively), however, both periods were considerably better than the 24 h period (222.9 g). The present study suggest that feed intake in young pigs is larger between 0800 to 1600 h; therefore, strategies to stimulate this trait and the labor involved would be more successful around this time.

Key Words: Young Pigs, Feeding Management

1485 Defining feeding bouts for lactating dairy cows housed in a free stall barn. M.A.G. von Keyserlingk^{*1}, L.G. Baird¹, D.M. Weary¹, and K.A. Beauchemin², ¹The University of British Columbia, Vancouver, Canada, ²Agriculture and Agri-Food Canada, Lethbridge Research Centre, Canada.

Feeding behavior has a significant impact on dairy cow productivity and health. Animals typically divide feeding time into a series of bouts or 'meals'. Any work involving feeding behavior must be based on the clear understanding of how these meals are defined. One way of doing this is to measure the interval between feeding events. Some of these intervals are very short, typical of breaks within a meal, and others are much longer, characteristic of separate meals. By plotting the frequency distribution of these intervals (typically log transformed), discontinuities in the distribution can be readily assessed and used to objectively define intervals between meals. The objective of this study was to apply this method of feeding bout analysis to lactating dairy cows housed under normal free stall conditions, with unrestricted access to the feed bunk. Twenty-two cows were monitored continuously for 10 d. Cows wore transponders that allowed us to automatically monitor bunk attendance at 6 s intervals. The intervals between records were log-transformed and the resulting frequencies of each interval length were plotted. These frequency distributions were bi-modal, with the first peak showing intervals within meals and the second showing intervals between meals. The meal interval was defined as the low point in the trough separating these distributions. Based on this definition, intervals greater than 1660 ± 373 s (mean \pm S.D.) or 27.7 ± 6.22 min away from the feed bunk were characterized as a new meal. According to this criteria, cows consumed 7.40 ± 0.94 meals per day. Objective definitions of meal durations may lead to improved consistency in the published literature, and provide more sensitive measures of responses to treatments that affect feeding behavior.

Key Words: feeding bout criterion, feeding frequency, feeding behaviour

1486 Neuroma formation following tail docking of dairy calves. C. A. Lunam¹, A. M. de Passille², and J. Rushen^{*}, ¹Flinders University, Adelaide, SA, Australia, ²Agriculture and Agri-Food Canada, Lennoxville, QC, Canada.

Tail docking is common in the dairy industry but there is concern about the effect on the welfare of the cattle. The procedure appears to cause little acute pain but less is known about chronic pain that may result. In other species, tail docking results in the formation of neuromata, which have been associated with altered sensitivity and spontaneous neural discharges resulting in chronic pain. We examined tail stumps of tail-docked calves to determine if neuromata develop after docking. At 5 months of age, we removed the tails from slaughtered male calves that had been docked at 11d of age (range 7 to 17d) either with a hot docking iron (n=5), or with a rubber ring (n=5) and the entire tails of undocked male calves (n=6). All tails were fixed in buffered formalin, and frozen sections stained by silver impregnation for histopathology. Neuromata were identified by large tangled masses of nerve fibres within the dermis. Less extensive neuromata were also observed close to the skeletal muscle bundles. Neuromata were found in the most distal 2 cm segment of all tail stumps of docked calves but neuromata were not present in the intact non-docked tails ($P < .05$). No differences were observed between the two methods of docking ($P > .10$). In contrast to the disarray of the nerves observed in the neuromata of docked tails, all peripheral nerves observed in intact tails were organized in nerve bundles surrounded by intact perineurium. Each nerve bundle consisted of several fascicles, consisting of many myelinated axons. Peripheral nerves were aligned parallel to one another throughout the length of the intact tails, suggesting that removal of the tail at any region along its length could lead to neuromata that persist for several months after docking. The presence of neuromata 5 months after docking suggests that this practice may lead to chronic pain or altered sensitivity of the nerves in the tails, raising concern about the well-being of docked cattle.

Key Words: Tail docking, Pain, Neuroma

1487 Comparison of analgesia methods for removing velvet antler in elk. N.J. Cook^{*1}, J.R. Webster², J. Church³, L.R. Matthews², T. Church⁴, and A.L. Schaefer¹, ¹Agriculture and Agri-Food Canada, Lacombe, AB, ²AgResearch, Hamilton, New Zealand, ³Agriculture Food and Rural Development, Red Deer, AB, ⁴Canadian Rocky Mountain Ranch, Calgary, AB.

The present study compared three methods of providing analgesia to elk during velvet antler removal. The animals were gathered into a conventional holding facility, restrained and had one of three analgesic treatments applied prior to antler removal. The lidocaine treatment (L, n=8) consisted of a ring block procedure using 1.25 ml of buffered, neat lidocaine per cm pedicle circumference followed by a 4 min wait pre-antler removal. The compression treatment (C, n=32) consisted of applying a latex band around the base of a pedicle at high tension followed by a 4 min wait (AgResearch devise). For animals in an electrical analgesia treatment (EA, n=10) a direct pedicle placement of a trans-cutaneous nerve stimulation (TENS) device was applied and a 9 v alternating current applied for 45 s as per standard industry practice. Analgesia efficacy was assessed by measuring behavioural responses to saw cuts to the antler after the respective times. Also, infrared temperatures of the orbital region and beta endorphin from venous samples collected prior to, during and after antler removal were measured. Behavioural responses were ranked on a scale from 0 (no response) to 4 (struggle) and scores of 2 or above indicated aversiveness. Animals in EA displayed higher scores ($P < 0.01$) than L or C. Maximum infrared temperatures recorded after antler removal were higher in EA (41.24° C) than either L (40.22°) or C (39.73°). With respect to beta endorphin, highest levels were found once again in EA (210.3 pg per mL) compared to either L (192.2) or C (196.7). Taken together, these data consistently suggest that EA, as used, was less effective at providing analgesia for velvet removal than either lidocaine or compression.

Key Words: Elk, Antler, Analgesia

1488 Influence of tail docking and tooth resection on behaviour and performance of piglets. M.C. Meunier-Salaun^{*1}, G. Bataille², Y. Rugraff², and A. Prunier¹, ¹INRA-UMRVP Saint-Gilles/ France, ²ITP Le Rheu / France.

Tail docking and tooth resection and performed in pig herds in order to reduce the consequences of biting are criticized since their efficiency is controversial and they are supposed to be painful. Two experiments were carried out on their short term consequences on behaviour and growth performance. The first one was performed on 160 piglets allotted to 5 treatments applied the day after birth: tail docking, tail docking and a cold analgesic spray, control handling, control handling and spray, no handling. Tail was docked with an iron docking (cautery). During treatment, tail docking caused more movements (legs and/or body, + 13%) and howls ($P < 0.05$). During the following 20 s, docked piglets demonstrated more tail jamming and wagging (+ 60%; $P < 0.05$). Both types of docking consequences were attenuated with the use of the cold spray. During the following 12 h, treatment had no effect on the resting time and activity at the sow udder. Growth rate during the first wk of life and the occurrence of injuries at the tail were also not affected ($P > 0.1$). The second experiment was realized on 128 piglets allotted to 4 treatments applied the day after birth: tooth resection with a grinding or with cutting pliers, simulated grinding, no handling. The percentage of piglets with leg movements was higher during grinding of teeth (94% vs 75%, $P < 0.05$). Piglets submitted to tooth resection (grinding and clipping) demonstrated more chewing behaviours over the 20-s period following treatment (65% vs 38%, $P < 0.05$). During the following 12 h, time spent by the piglets resting or being active at the sow udder was similar in the 4 groups. At 7 d of age, lip lesions were more numerous for the resected piglets (48% vs 18%, $P < 0.05$) and clipped piglets were lighter than control ones (~ 300 g, $P < 0.05$). In conclusion, tail docking and tooth resection causes probably pain of moderate amplitude in short term. However, tooth clipping with pliers had a detrimental influence on piglet skin integrity and the growth rate during the first week of life

Key Words: Piglets, Tail docking, Tooth resection

1489 Behavior of primi- and multiparous lactating dairy cattle in commingled groups. W.C. Matzke* and R.J. Grant, *University of Nebraska*.

The objective of this study was to collect baseline behavioral data on primiparous and multiparous lactating dairy cattle in commingled groups housed in a free stall facility. Cows were observed in two operations; two 24-h observations were performed on a commingled group (every 20 min). Dairy A had a 6-row free stall design (3 rows per group); Dairy B had a 4-row free stall design (2 rows per group). Dairy A, observation A1 was a 48-h behavioral observation during hot weather (45% primiparous). Observation A2 was a 48-h behavioral observation during thermoneutral weather (50% primiparous). Dairy B, observation B1 was a 72-h behavioral observation during hot weather (28% primiparous). Observation B2 was a 48-h observation during thermoneutral weather (31% primiparous). Data were recorded for 7 categories of behavior and location within the pen. Dairy A results showed that 1) more heifers than cows were standing at the manger ($P < 0.05$), 2) more heifers than cows were observed to be eating ($P < 0.05$), 3) there was no difference in numbers resting, 4) there was no difference in numbers resting and ruminating, 5) heifers spent more time in crossovers and alleys than did cows ($P < 0.10$), and 6) there was no difference in the number of heifers and cows drinking water. Cows locked in headlocks consumed feed for approximately 1 h, and during the next h, 30-40% gradually began to ruminate. Dairy B results showed that 1) more heifers than cows were standing at the manger ($P < 0.07$), 2) there was no difference in the number of heifers and cows eating, 3) cows spent more time resting in Observation B1 than did heifers ($P < 0.05$) but there was no difference in observation B2, 4) there was no difference in numbers resting and ruminating, 5) there was no difference in numbers in crossovers and alleys, and 6) there was no difference in numbers drinking water. Reducing pen size to match parlor capacity increased resting time from 36 to 49%. There are behavioral differences between cows and heifers in commingled groups, but analysis within a day will be necessary to effectively describe them.

Key Words: Dairy cattle behavior, Primiparous, Multiparous

1490 Effect of sprinkling cattle on behavior and incidence of zoonotic pathogens. J.L. Morrow¹, T. Callaway², F.M. Mitloehner³, M.L. Galyean⁴, J.W. Dailey¹, T. Edrington², R. Anderson², and D. Nisbet², ¹USDA-ARS Livestock Issues Research Unit, Lubbock TX, ²USDA-ARS Food and Feed Safety Research Unit, College Station TX, ³Dept. Animal Science, University of California, Davis CA, ⁴Dept. Animal Science, Texas Tech University, Lubbock, TX.

Eight pens of finishing cattle were used to determine whether cooling cattle with sprinklers altered their behavior or the presence of *Salmonella* and *E. coli* in their feces or on their hides. Heat stress is a common challenge for fed cattle in the Texas panhandle during summer. The study was conducted between June and September when average ambient temperatures for Lubbock, TX are between 12 and 35 C. Typical methods of cooling cattle include provision of shade and/or water. The effect of cooling cattle with water has not been studied with respect to the incidence of zoonotic pathogens. Four pens of heifers ($n = 41$) were cooled using sprinklers and four pens ($n = 43$) served as controls. Sprinkling was initiated when cattle were on full feed (July). Cattle were weighed every 56 d, and blood samples, fecal samples, and hide swipes were collected. Respiration rates were collected weekly. Cattle behavior was observed using a 10-min scan sampling technique for a 24-h period during one warm period. Behavior and production data were analyzed as a completely randomized design. Body weights and ADG did not differ between treatments ($P > 0.1$). Respiration rates tended ($P = 0.053$) to differ between treatments across the study. Several behaviors had significant time of day x treatment interactions, including drinking, lying and standing ($P < 0.05$). Chi square analysis of pathogen data (number of positive animals per treatment) did not identify differences between treatments for *Salmonella* and *E. coli* 0157:H7 in feces or on hides. The most prevalent serovars of *Salmonella* were Muenster, Kentucky and Melagridis. Sprinkling cattle to cool them during heat stress had no effect on performance measures or on presence of *Salmonella* or *E. coli* 0157: H7. Changes in behavior and respiration rates were indicative of heat stress but the level of stress experienced by these cattle was not associated with increased prevalence of zoonotic pathogens.

Key Words: cattle, stress, pathogens

1491 Evaluation of compression analgesia for velvet removal in red deer. L.R. Matthews, K.J. Bremner, A.J.T. Pearse, C.J. Morrow, and J.R. Webster*, *AgResearch, Hamilton, New Zealand*.

A series of experiments evaluated a new analgesia method for velvet removal from restrained deer, which uses compression (C) to produce a rapid nerve block. C consisted of a latex band, tightened around the pedicle to a consistent pressure, using a custom-made tool. Initially, the time for analgesia to develop after band application, was tested by measuring behavioural responses to electrical stimulation of the antler every 30s, beginning after 90s. Responses were scored on a scale from 0 (none) to 4 (struggle) and scores of 2+ grouped as aversive. The time until a score of 0 was reached was recorded for 27 stags. All were analgesic by 4 minutes, which was thereafter used as the time from application until cutting. In further experiments, C was compared to analgesia with lidocaine (L). L consisted of 2% lidocaine hydrochloride, applied at a dose of $>1\text{mL/cm}$ pedicle circumference in a ring around the pedicle, also followed by a 4 min wait until cutting. Behavioural responses to application of C (29 antlers) or L (28 antlers) did not differ ($P > 0.05$), with around 10% showing an aversive response. Analgesia was tested at cutting time from behavioural responses to light saw cuts to the base of the antler, termed a nick test, which was followed by cutting if there was no aversive response. There were no differences ($P > 0.05$) between C (67 antlers) and L (54 antlers) in responses to nick tests (no aversive responses) or cutting (1% and 2% aversive, respectively). A further experiment ($n=16$ per group) assessed stress and immune responses following velvet removal by measuring faecal glucocorticoid metabolites (FC) and haematological values (HV) from samples taken prior to and up to 7 day after cutting. Two additional treatments were included, restraint only (R) and L followed by C (LC). FC increased by around 40% following velvet removal but did not differ ($P > 0.05$) between treatments. There was no evidence of immune suppression in HV in any treatment. In summary, these experiments suggest that C can be used to successfully provide analgesia for velvet removal in red deer.

Key Words: Deer, Antler, Analgesia

1492 The effect of transport and preconditioning on radiated temperature in calves. A.L. Schaefer^{*1}, N.J. Cook¹, J.S. Church², K.S. Schwartzkopf-Genswein³, M.E. Booth⁴, G.J. Mears⁴, and T.A. McAllister, ¹Agriculture and Agri-Food Canada, Lacombe, AB, ²Agriculture Food and Rural Development, Red Deer, AB, ³Agriculture Food and Rural Development, Lethbridge, AB, ⁴Agriculture and Agri-Food Canada, Lethbridge, AB.

Transport and handling conditions to which calves are exposed during marketing are known stressors and can predispose the animals to energy loss, poor growth and disease. The purpose of the present study was to measure the impact of these conditions on thermal characteristics and to examine whether a pre-conditioning program enabled the calves to better tolerate the transport stressors. Eighty eight healthy, pasture raised Charolais and Angus steer calves, weighing between 180 and 225 kg were used in the study. All male calves had been castrated within two weeks of birth. Animals allocated to the pre-conditioning program (PC, $n=44$) were weaned 14 days pre- transport and were vaccinated and treated for parasites 30 days pre-transport. Non- preconditioned calves (NPC, $n=44$) received no treatments and were weaned the day of transport. All calves were transported on commercial carriers for 964 km (15h) followed by unloading and a 1 h rest before reassessment. Infrared thermal scans (IRT) of the orbital region were collected with an Inframetrics 740 camera pre-loading and again approximately 1 h following off loading. Orbital IRT values are measures of an animals energy sufficiency and ACTH driven events. The average pre-transport IRT orbital max value for all calves was 39.70 (1.15 SD) which dropped significantly ($P < 0.01$) to 38.75 (0.65) post transport. This reduction was apparent in both NPC calves (38.87 (0.86) pre vs 38.63 (0.66) post; $P=0.15$) and in the PC calves (40.56 (0.69) pre vs 38.88 (0.62) post; $P < 0.01$). The difference in IRT change was greatest in the PC animals seemingly due to the higher initial temperature in PC (40.56) compared to NPC calves (38.87; $P < 0.01$). The higher initial orbital max IRT measurements in the PC animals was likely due to a stress response to recapture and rehandling pre-transport.

Key Words: preconditioning, calves, infrared

1493 Sole lesions in dairy cattle. E. Bell and D. Weary*,
University of British Columbia, Vancouver, BC, Canada.

One of the principal causes of lameness in cattle is sole lesions on the hoof. Our aim was to describe the prevalence of sole lesions in dairy cattle from the Fraser Valley of British Columbia, and determine farm management and environmental factors that are most associated with sole lesions in this area. We recorded the number, severity and location of lesions in the claws of 624 Holstein cows from 20 herds during hoof trimming. Lesions were found in cows from all herds. The mean (SD) herd prevalence of cows with at least one lesion was 85.7 (13.8)%. The mean (SD) herd prevalence of cows with at least one severe lesion (severe haemorrhage or ulcer) was 34.9 (15.1)%. Within the cow, we found differences in the number of lesions observed on different claws, with the hind lateral claws containing the most lesions ($P < 0.0001$). Overall, the hind lateral claws contained 54.9% of the lesions followed by the front medial (17.7%), the hind medial (16.4%) and the front lateral (10.9%). We found a very similar pattern when considering only the most severe lesions. Focusing on the distribution of lesions within the claws, zones differed in the total number of lesions. Of the 2116 lesions observed, 47.1% were located in Zone 4, 26.8% in Zone 3, 14.2% in Zone 5, 7.9% in Zone 2, and 4.0% in Zone 1. Once again, we found a very similar pattern of results for the most severe lesions. Primiparous cows were at greater risk for sole lesions at the beginning of their lactation ($P < 0.001$) while multiparous cows were more likely to have visible lesions in mid- to late-lactation ($P < 0.01$). Overall, cows with higher body condition scores were less likely to have sole lesions than those with lower scores ($P < 0.001$). Cows were more likely to have lesions on farms with high steps ($P < 0.01$), computer grain feeders ($P < 0.01$), automatic alley scrapers ($P < 0.01$), and flooring imperfections ($P < 0.05$). In conclusion, sole lesions affect the majority of dairy cows in the Fraser Valley. The risk of lesions is related to stage of lactation, individual cow factors, and farm characteristics.

Key Words: Dairy cattle, Lesion, Lameness

1494 Preferences of pigs for floor types according to ambient temperature. E. Ducreux¹, V. Courboulay², and M.C. Meunier-Salaun^{*1}, ¹I.N.R.A. Joint Research Unit for Calf and Pig production Saint-Gilles/ France, ²I.T.P. Pig Technical Institute, Le Rheu /France.

The environmental enrichment of housing through flooring is a way to improve the well-being of pigs. The objective of the study was to determine the preference of groups of six growing pigs (70 kg) for three types of floor (Deep-Litter: L, concrete: C and slatted: S) offered as free choice within the same pen. In each flooring type the space allowance was similar (0.78 m²/pig) and a feeder was supplied. Sixteen groups were penned in two experimental rooms where the ambient temperature was at a low level (18°C, n = 8 groups) or at a high level (27°C; n = 8 groups). Each group was videotaped during a 24-h period and the behavioral activities were recorded by 10-min scan sampling. The data analysis was focused on the nature, the localisation and the context of the behavioural activities. Major activities within a 24-h period were resting (70% of total time, $P < 0.05$) and investigation (20%, $P < 0.05$) whatever the ambient temperature. The pigs preferred the litter flooring during time spent investigating ($P < 0.05$) at both temperature levels (62% of total time of investigation). Pigs exposed at 18°C spent more time lying on litter (71% of resting time vs 12% at 27°C, $P < 0.05$) whereas they lied down on concrete or slatted floor when exposed at 27°C (44% vs 15% at 18°C, $P < 0.05$). Pigs adopted, more frequently, a ventral posture and contact with congeners at low temperature level compared to pigs lying down on their sides without physical contact when exposed to warm conditions (66% of resting time vs 34% in "recumbent", $P < 0.05$; 55% vs 44% in "ventral", $P < 0.05$). Pigs used separate areas for resting and dunging activities ($P < 0.05$). These results illustrate that temperature may influence the floor preference of pigs. They point out various preference degrees related to the behavioral activity such as strong use of litter for investigation. Recommendations for housing conditions should therefore consider behavioural needs and thermal context related to season and geographic location.

Key Words: Pig, Floor type, Temperature

Animal Health Mastitis

1495 The effects of pre-milking procedures on hygienic quality of milk. R. Skrzypek* and J. Wojtowski, *Agricultural University, Poznan, Poland.*

The study was carried out over 1999-2000 in 120 dairy herds. The average number of cows in the herd was 47, and ranged from 4 to 244. In the period of observations, the following pre-milking procedures were recorded: fore-stripping (Yes, with tester vs. Yes, without tester), practicing fore-stripping as the first routine before milking (Yes vs. No), and method of udder and teat cleaning before milking (method 1 - wet paper towel with a disinfectant; method 2 - washing with water containing a disinfectant, drying with a cotton towel; method 3 - dry paper towel; method 4 - washing with clean water, drying with a cotton towel). For the statistical analysis, data on somatic cells count (SCC) and total microorganisms count (TMC) were also used. Both variables were determined in bulk tank milk fortnightly. Before calculations, the raw data on SCC and TMC were transformed with the natural logarithm. The method of fore-stripping affected the SCC only: a lower SCC was found in herds practicing fore-stripping with a tester (12.27 vs. 12.45; $P \leq 0.01$), and in herds in which fore-stripping was not the first routine before milking (12.28 vs. 12.44; $P \leq 0.01$). Out of the methods of udder and teat cleaning before milking, method 2 was most effective in decreasing the SCC (12.25 vs. 12.35-12.44 for other methods; $P \leq 0.01$), whereas method 3 was most effective in decreasing the TMC (10.93 vs. 11.27-11.34 for other methods; $P \leq 0.01$).

Key Words: Pre-milking procedures, Milk, Hygienic quality

1496 Impact of lactoferrin or lactoferricin with or without penicillin G on the morphology and ultrastructure of *Staphylococcus aureus*. M.S. Diarra^{*1}, P. Lacasse¹, G. Grondin², C. Paradis-Bleau¹, and D. Petitclerc¹, ¹AAFC-Dairy and Swine Research and Development Centre, Lennoxville, Quebec, Canada, ²Sherbrooke University, Sherbrooke, Quebec, Canada.

In a previous study, we found a synergism between lactoferrin or lactoferricin and penicillin G against *S. aureus* (Diarra et al., J. Dairy Sci., in press). To investigate the mechanism of action of lactoferrin or lactoferricin with or without penicillin G, transmission electron microscopy was performed on thin sections of two penicillin-resistant *S. aureus* strains: a clinical bovine mastitis *S. aureus* strain SHY97-4320 and a reference strain PC-1. Lactoferrin affected the ultrastructure of both *S. aureus* strains and groups of multiple cells were observed after lactoferrin treatment with or without penicillin G. These results suggest that lactoferrin can affect staphylococcal cell separation. After treatment with lactoferrin, cells from *S. aureus* SHY97-4320 were less covered ($P < 0.05$) with WGA-gold thus suggesting that lactoferrin affected binding to N-acetyl- β -D-glucosamine and/or the synthesis of peptidoglycan. Lactoferricin with or without penicillin G induced the lysis of many bacteria. Lactoferricin also induced formation of merosomal structures. Our data indicate that lactoferrin can affect *S. aureus* cell separation thus preventing dissemination of daughter cells from spreading infection and increasing susceptibility to phagocytes. Furthermore, lactoferrin can induce a weakening of the cell wall that could enhance *S. aureus* killing by penicillin G.

Key Words: lactoferrin, *Staphylococcus aureus*, morphology

1497 Synergetic effect of neomycin and cefazolin with bovine lactoferrin and lactoferricin against *Escherichia coli* and *Klebsiella pneumoniae*. M. S. Diarra*, D. Petitclerc, and P. Lacasse, *Dairy and Swine Research and Development Centre, Lennoxville, QC, Canada.*

The objective of the present study was to evaluate therapeutic potential of bovine lactoferrin (Lf) or lactoferricin (Lfcin) in combination with cefazolin and neomycin against *Escherichia coli* SHY97-3923-1 and *Klebsiella pneumoniae* SHY99-723-1 strains isolated from clinical bovine mastitis cases. Minimal inhibitory concentrations (MICs) of Lf, Lfcin, and tested antibiotics, were determined by macrodilution broth technique. Lf demonstrated a weak inhibitory activity against these strains with MICs >25 mg/ml. The MICs of Lfcin, cefazolin and neomycin were 256, 1 and 0.5 mg/ml in *E. coli* and >256, 2 and 1 mg/ml in *K. pneumoniae*, respectively. The effect of Lf (0 to 4 mg/ml) and Lfcin (0 to 64 mg/ml) alone and their combination with neomycin (0 to 1 mg/ml) and cefazolin (0 to 2 mg/ml) were evaluated on growth rate in both strains. Alone, Lf did not affect the growth of *E. coli* but, at concentration ≥ 0.5 mg/ml it partially inhibited ($P < 0.01$) the growth of *K. pneumoniae*. In *E. coli*, no synergetic effect was observed between cefazolin and Lf but, completed growth inhibition was obtained when 0.5 mg/ml or more of LF was combined to 1/2 MIC of neomycin. In *K. pneumoniae*, effects of Lf and cefazolin were additive while a strong synergism ($P < 0.001$) occurs with neomycin. At concentration sub-MICs, Lfcin alone, strongly inhibit the growth of *E. coli* ($P < 0.01$) but marginally decreased growth of *K. pneumoniae* ($P < 0.05$). Lfcin acted synergistically ($P < 0.1$) with sub-MIC of cefazolin and neomycin to reduce the growth of *E. coli* and with cefazolin in *K. pneumoniae*. Post-antibiotic effect (PAE) was studied by exposure of *E. coli* to 2 X MIC of neomycin, 1/8 MIC of Lfcin alone or in combination. After a 2 h incubation, cells were washed and incubated and the regrowth was monitored by standard count of cfu/ml and by determination of the culture turbidity. A negative PAE was induced by Lfcin alone but its combination to neomycin increased the PAE of this antibiotic. PAEs averaged - 53.33 3.84, 55.67 3.76 and 109.62 22 for Lfcin, neomycin and neomycin + Lfcin, respectively. These data suggest a potentiation effect of Lf and Lfcin with neomycin and cefazolin against environmental Gram negative bacteria pathogens isolated from bovine mastitis.

Key Words: Mastitis

1498 Bulk tank milk analysis inference program. B. M. Jayarao*¹ and T. Kim², ¹*The Pennsylvania State University, PA, USA*, ²*Kyungsu University, Pusan, South Korea.*

Data mining is the process of discovering interesting knowledge from the original raw data scattered as a natural state. The ability to make meaningful generalizations from a few scattered facts or to discover patterns in chaotic collections of observations is now of growing importance for the development of knowledge-intensive decision support systems. When milk produced on a farm is examined for bacteriological milk quality and mastitis causing bacteria it can disclose descriptive information about the general udder health status of the herd, milk hygiene, and milking practices on the farm. Many dairy producers periodically receive information about their bulk tank milk with reference to somatic cell counts, standard plate counts, and preliminary incubation counts. This information, when collected over a period of time, in combination with bulk tank mastitis culture reports can become a significant knowledge base. In this study, inference rules were established to evaluate the milking practices and milk quality based on bulk tank milk microbiology test results. Inductive decision trees were generated based on attribute selection measure, following which bulk tank milk quality was classified as good, cleaning problem, mastitis problem, or mixed with mastitis and cleaning problem. The results from induction rules were compared with those from K-means clustering algorithms. The findings of the study resulted in development of an induction-based data mining software for classifying bulk tank milk quality. It is anticipated that the software would be of great help to dairy farmers, extension specialists, dairy health consultants, and veterinary health professionals in the decision making process on issues related to milk quality and mastitis.

Key Words: milk quality, mastitis, decision trees

1499 Farm management practices that influence the number and type of Streptococci and Streptococci-like organisms in dairy herds. D. R. Wolfgang, B. M. Jayarao*, A. A. Sawant, S. R. Pillai, C. M. Burns, and L. J. Hutchinson, *The Pennsylvania State University, University Park, PA, USA.*

Streptococci and streptococci-like organisms (SSLO) consist of a large heterogeneous group of organisms. Organisms belonging to the genera streptococci, enterococci, lactococci and aerococci have been isolated from bulk tank milk (BTM). In this study, four BTM samples were collected at interval of 15 days from each of the 126 dairy herds that participated in the study. The BTM samples were examined for; 1) Somatic cells (BTSCC), 2) Standard plate count (SPC), 3) Preliminary incubation count (PIC), 4) Laboratory pasteurization count (LPC), 5) *Staphylococcus aureus* (SA) count, 6) Coagulase negative staphylococcal (CNS) count, 7) Streptococci and streptococci-like organisms (SSLO) count, 8) Coliform count (CC), and 9) Gram-negative non-coliform (NC) bacteria. It was observed that an increase in the number of SSLO in BTM was associated with an increase in BTSCC, SPC, PIC, LPC, SA, and CNS. This observation clearly suggests when mean SSLO count (4 BTM samples) exceeds 1000 cfu/ml; it likely that milk quality is affected, and might indicate that cows with contagious and environmental mastitis exist in the herd. Mastitis pathogens including *S. uberis*, *S. agalactiae*, and *S. dysgalactiae* were isolated from BTM with elevated BTSCC (mean BTSCC 441667 cells/ml). The SPC of milk samples collected from 24 farms was influenced by the SSLO count. The predominant SSLO organisms observed in BTM were *A. viridans*, *S. uberis*, *S. dysgalactiae*, *S. equinus* and enterococcal spp. It was observed that the LPC (n=3) was also influenced by the SSLO count, the predominant organisms found in the laboratory pasteurized milk samples were enterococcal spp. The PIC (n=5) was influenced by the SSLO count. Enterococcal spp. were isolated from milk samples that were subjected to PIC assay. A critical review of farm management practices using a self-administered questionnaire followed by consultations with dairy producers strongly indicated that; 1) Having more than 40% of the cows that are in 4+ lactation in the herd (farm DHIA record analysis), 2) Expanding the herd with newly purchased lactating cows, 3) Use bedding materials other than sand, 4) Pre-dipping or post-dipping only, and 5) Failure to pre-rinse the milking system before milking, can in varying degrees contribute to high SSLO counts in BTM.

Key Words: streptococci, bulk tank milk, management practices

1500 Antimicrobial susceptibility patterns of streptococci isolated from quarter milk and bulk tank milk. A. A. Sawant*, B. C. Love, and B. M. Jayarao, *The Pennsylvania State University, University Park, PA, USA.*

Isolates of *S. agalactiae* (n= 37), *S. dysgalactiae* (n = 131), and *S. uberis* (n=165) from quarter milk (n=207) and bulk tank milk (n=126) were examined for their susceptibility to antimicrobial agents. Susceptibility to ampicillin, ceftiofur, cephalothin, erythromycin, oxacillin, penicillin, penicillin-novobiocin, pirlimycin, sulfadimethoxine, and tetracycline was determined. The findings of the study are presented in Table 1. The findings of the study suggest that selection of an antibiotic for treating mastitis should be based on antimicrobial susceptibility of isolates from quarter milk rather than isolates from bulk tank samples. All isolates of *S. agalactiae* isolated from quarter milk were susceptible to ceftiofur, cephalothin, and oxacillin. While most of the isolates of *S. uberis* from quarter milk samples were susceptible to penicillin-novobiocin (95%), ceftiofur (92%), and cephalothin (91%). *Streptococcus dysgalactiae* was observed to be susceptible to ampicillin (97%), ceftiofur (97%), penicillin-novobiocin (97%), cephalothin (96%), oxacillin (95%), and pirlimycin (91%).

	Quarter milk	Quarter milk	Quarter milk	Bulk tank	Bulk tank	Bulk tank
	<i>S.</i> <i>uberis</i>	<i>S. dys-</i> <i>galactiae</i>	<i>S.</i> <i>agalac-</i> <i>tiae</i>	<i>S.</i> <i>uberis</i>	<i>S. dys-</i> <i>galactiae</i>	<i>S.</i> <i>agalac-</i> <i>tiae</i>
Suscepti- bility						
Ampicillin	77%	97%	94%	100%	100%	100%
Ceftiofur	92%	97%	100%	100%	100%	95.2%
Cephalothin	91%	96%	100%	100%	100%	100%
Erythromycin	60%	88%	75%	82.7%	92.4%	90.5%
Oxacillin	85%	95%	100%	98%	100%	100%
Penicillin	52%	83%	81%	84.6%	98%	100%
Penicillin/ Novbiocin	95%	97%	94%	100%	100%	100%
Pirlimycin	55%	91%	75%	69.2%	84.9%	95.2%
Sulphadi- methoxine	0.8%	12%	12%	1.9%	11.3%	19%
Tetracycline	49%	32%	63%	61.5%	41.5%	76.2%

Key Words: antimicrobial susceptibility, mastitis, streptococci

1501 Thermographic measurement of udder temperature: Predictability and potential of an early warning system for mastitis. R. J. Berry¹, A. D. Kennedy^{*1}, S. L. Scott², B. Kyle¹, and A. L. Schaefer³, ¹University of Manitoba, Winnipeg, Manitoba Canada, ²Agriculture and Agri-Food Canada, Brandon, Manitoba Canada, ³Agriculture and Agri-food Canada, Lacombe, Alberta, Canada.

An increase in udder temperature is an important indicator of mastitis onset in dairy cows. The ability to detect the early onset of mastitis will ameliorate the potential damage of a case by ensuring prompt treatment, hence reducing economic losses (drug costs, decreased yield and milk quality). Previous work by Scott (*et al*) showed that endotoxin infusion into the udder caused an increase in udder temperature by 2.3 C from the pre-infusion baseline, as measured by infrared thermography (IRT). Implementation of an IRT mastitis detection system requires reference data on the daily variation and predictability of udder temperature of non-mastitic animals. The udder temperatures of 10 multiparous Holstein cows (mean parity 2.5, DIM 104) were measured over a 51-day period between May and July 2000 using IRT. Cows were housed in tie stalls, milked twice daily and allowed a 2 h outdoor exercise period between 9-11 am. Measurements were taken 30 min prior to the exercise period (following milking) and immediately after the exercise period. Care was taken to ensure udders were clean and dry before IRT measurement. Rectal temperatures were recorded at each sampling and ambient barn temperature was automatically recorded every 20 min. Udder temperature increased significantly after exercise. Udder temperatures post exercise were less variable (mean udder temperature pre exercise=33.44 C SEM 0.35, post exercise=34.61 C SEM 0.22, P<0.001). Autoregression modeling showed that animal factors (rectal temperature, udder area) rather than environmental factors (ambient temperature at sampling, mean ambient temperature over the previous 2h, 12 h and 10 d) were good determinants of udder temperature both before and after exercise (R² 0.57, p<0.001). Udder temperature on the previous day was not a reliable determinant of current udder temperature (P>0.05). This preliminary study confirms that daily variation in udder temperature is smaller than the rise resulting from an induced mastitis response. Current research investigating seasonal and farm differences will determine if IRT technology has future application for early mastitis detection.

Key Words: Dairy Cattle, Mastitis, Infrared Thermography

1502 Effect of copper source on resistance to coliform mastitis. R. W. Scaletti^{*}, C. H. Hamilton, and R. J. Harmon, University of Kentucky, Lexington, KY.

The objective was to determine the effect of copper (Cu) source on response to intramammary challenge with *Escherichia coli*. Twenty primigravid Holstein heifers were maintained on a basal diet (6.5 ppm Cu; CON) or diets supplemented (10 ppm) with copper sulfate (CUS) or Cu proteinate (Bioplex; Alltech, Inc.; CUP) beginning 60 d prepartum through 49 d of lactation. Liver biopsies were taken to determine liver Cu concentration. Milk samples were taken weekly postpartum for bacteriology and somatic cell count (SCC) determination. The overall

mean liver Cu concentration was about threefold higher (P = 0.003) for CUS and CUP groups (171 and 147 µg/g DM) compared to CON cows (62 µg/g DM). At d 32 of lactation, one pathogen-free quarter per animal was infused with 27 colony-forming units (cfu) of *E. coli* strain 727. Quarter foremilk samples were aseptically collected for bacterial enumeration and SCC determination. Whole blood was collected for determination of packed cell volume and white blood cell enumeration. Udders were given a clinical score and rectal temperatures were determined. Measurements were taken 24 h preinfusion, 0 h, and 6, 12, 18, 24, 36, 48, 72, 96, 144, 192, and 240 h postchallenge. Milk production (MP) and DMI were measured daily following challenge. Milk bacteria count (log₁₀ cfu/ml) was lower (P < 0.08) for the CUP group at 24 h compared to CON and CUS groups (1.90 vs 3.19 and 3.12). Clinical score was lower at 144 h (P < 0.1) in CUP cows compared to CON cows (1.38 vs 2.43). Rectal temperature was lower at 24 h (P < 0.04) and 144 h (P < 0.1) in the CON and CUS groups compared to CUP cows. Overall white blood cell count was greater for CUP cows than CON (P < 0.06) and CUS (P < 0.1) cows. Dry matter intake following challenge was greater (P < 0.03) on d 4 postchallenge for CUP and CON groups compared to CUS cows. Overall MP was greater for CUP cows compared to CON (P < 0.12) and CUS (P < 0.05) cows. Packed cell volume and SCC did not differ among groups following challenge. No differences in peak responses were noted among treatments, but moderate improvements in some clinical parameters were observed with CUP supplementation.

Key Words: Mastitis, Copper, *Escherichia coli*

1503 Effect of prepartum milking of primigravid cows on mammary gland health and lactation performance. J.E.P. Santos^{*1}, R.L.A. Cerri¹, J.H. Kirk¹, S.O. Juchem¹, M. Villasenor¹, and M.A. Ballou¹, ¹University of California Davis.

Objectives were to determine the effects of prepartum milking of primigravid cows on udder health, lactation, and metabolic parameters during late gestation and early lactation. Primigravid Holstein cows, 267, were blocked according to age and day of expected calving and randomly assigned to one of the two treatments at 15 d prepartum. Treatments consisted of either no milking or milking 3 x daily prepartum. The study finished at 135 days in milk (DIM). Cows in both treatments were housed together during the pre- and postpartum periods and fed the same ration. Milk samples were collected for microbiological culture at d -15 prepartum (milking group) and at 3 and 29 DIM (all cows). The degree of udder edema was determined in each cow once at 3 DIM by measuring the udder floor areas before and after milking. The greater reduction in size upon removal of milk from the mammary gland indicated less edema. Blood was collected from 40 cows/treatment at d -11 and -4 relative to calving, and at 4 and 17 DIM for the analyses of plasma glucose, b-OH-butyrate, and nonesterified fatty acids. Continuous data were analyzed using the PROC MIXED procedure of SAS. The Kaplan-Meier model, for the survival analysis procedure of Minitab, was used to assess the effect of treatment on DIM when a cow left the study (cullled or dead). Incidence of health disorders was analyzed by Chi-square. Prepartum milking of primigravid cows increased the reduction of udder floor area (23.9 vs 16.9%; P < 0.001), decreased SCC score (2.39 vs 3.23; P < 0.0001) and incidence of mastitis (6.1% vs 14.1%; P < 0.04) during the first 135 DIM. Prepartum milking increased yields of milk (36.6 vs 34.9 kg/d; P < 0.001), 3.5% FCM (37.0 vs 35.9; P < 0.004), and milk true protein (1,041 vs 994 g/d; P < 0.001), and tended to increase yields of milk fat (1,308 vs 1,282 g/d; P < 0.12). Plasma glucose decreased in the milking group just prior to calving (66.5 vs 72.6 mg/dl; P < 0.0008). Incidence of diseases and culling did not differ between the two groups. Prepartum milking of primigravid cows reduced udder edema, improved udder health and lactation performance with minor effects on metabolic parameters.

Key Words: Prepartum cows, Milking, Mastitis

1504 Effect of clinical mastitis incidence on lactational and reproductive performance of Holstein dairy cows. J.E.P. Santos^{*1}, R.L.A. Cerri¹, M.A. Ballou¹, G. Higginbotham¹, J.H. Kirk¹, and S.O. Juchem¹, ¹University of California Davis.

One thousand Holstein cows from 3 commercial dairy farms were divided into 4 groups: control (G1), first clinical mastitis prior to first postpartum AI (G2), first clinical mastitis between first postpartum AI

and pregnancy diagnosis (G3), and first clinical mastitis after diagnosed pregnant (G4). Within each dairy, every cow in the mastitis groups was matched with a control cow that was in the same lactation, calved in the same month and had a similar 305-d milk yield in the previous lactation. Data were collected for the first 320 days in milk (DIM). Mastitis diagnosis was performed at every milking by the herd personnel. A fore sample of milk was collected from every clinical case for microbiological culture. Reproductive management consisted of estrus synchronization with PGF2a prior to 70 DIM and timed AI afterwards for the first postpartum AI. Cows diagnosed as open at rectal palpation were re-inseminated following a timed AI protocol. Pregnancy was diagnosed 35 d after AI and reconfirmed either at 160 d pregnant or at 300 DIM. Continuous and binomially distributed data were analyzed by the GLM and the LOGISTIC procedures of SAS, respectively. The Kaplan-Meier survival analysis procedure was used to assess the effect of treatment on days open. Results are presented according to the following sequence: G1, G2, and G3. Conception rate at first postpartum AI was decreased by mastitis (28.7 vs 22.1 vs 10.2%, $P < 0.001$). Pregnancy rate at 320 DIM also decreased for cows with mastitis (85.4 vs 72.3 vs 58.5%; $P < 0.001$). Days open were extended for cows with mastitis ($P < 0.001$). Incidence of abortions was 5.8, 11.8, 11.6, and 9.7% for G1, G2, G3, and G4, respectively ($P < 0.04$). Mastitis prior to first AI decreased yields of milk (35.9 vs 34.4 vs 35.3 kg/d; $P < 0.001$) and 3.5% fat-corrected milk (36.5 vs 35.1 vs 36.0 kg/d; $P < 0.01$). Mastitis also increased linear SCC score (1.78 vs 2.75 vs 2.80; $P < 0.001$). Mastitis either prior to or after first postpartum AI decreases conception, increases incidence of abortions and decreases milk production in lactating dairy cows.

Key Words: Mastitis, Reproduction, Milk production

1505 Bacterial counts in bedding and on teat ends of cows housed on sand and sawdust. M. Zdanowicz*, J. A. Shelford, C. B. Tucker, and D. M. Weary, *University of British Columbia, Vancouver, Canada.*

The objectives of the study were to compare bacteria counts of mastitis causing organisms in sand and sawdust bedding, and determine the relationship between bacteria counts in bedding with those on the cows' teats. Sixteen cows were housed on either sand or sawdust bedded free-stalls using a cross over design with 3 weeks per bedding type. Fresh bedding was added every 7 days. Visible fecal matter was removed daily as needed to keep stalls clean and dry. Bedding samples were collected on day 0 (prior to cows lying on the bedding), day 1, 2 and 6. Teat ends were sampled prior to the morning milking on day 1, 2 and 6. All samples were analyzed for the growth of coliforms, *Streptococcus* spp., and *Klebsiella* spp.. Bacteria counts in bedding and on the teat ends were analysed using analysis of variance. Treatment differences on each day were tested by Bonferroni multiple comparison test. Correlations among bacterial counts in bedding and on teat ends were determined by Pearson's correlation coefficients. For both bedding and teat end samples, there were significantly more coliform and *Klebsiella* bacteria

associated with sawdust than with sand ($P < 0.01$) but there were more *Streptococcus* associated with sand than with sawdust ($P < 0.01$). In both sawdust and sand bedding, coliform and *Klebsiella* and *Streptococcus* counts increased over the week, although patterns varied with the bedding and the bacteria type. Bacteria counts in bedding were highly correlated to bacteria counts on teat ends. In conclusion, coliform and *Klebsiella* bacteria are more numerous when using sawdust bedding, but *Streptococcus* bacteria are more numerous in sand.

Key Words: Environmental bacteria, Stall management, Udder cleanliness

1506 Sensitivity and specificity of MAS-D-TEC to detect subclinical mastitis in dairy cattle. H. Ghasemzadeh-Nava*, M. R. Hosseini², and F. Gharagozloo¹, ¹Dept. of Large Animal Clinical Sciences, Faculty of Vet. Med; University of Tehran, ²Private Practitioner, Garmsar, Iran.

Early diagnosis of subclinical mastitis in dairy cows may be important in reducing production losses and enhancing prospects of recovery. In recent years, most effort has gone into the system that uses changes in the electrical conductivity of milk. The purpose of this study was to evaluate the Sensitivity (Se) and Specificity (Sp) of MAS-D-TEC (a manually cow-side detector of mastitis test) for detection of subclinical mastitis by changes in electrical conductivity of foremilk. Fore milk samples of each cow ($n=236$ quarters) were first examined by MAS-D-TEC device (Westcor Inc; Logan, USA). MAS-D-TEC graded from 0 to 9. On the basis of the factory recommendation, sample grades ≥ 5 are highly indicative of presence of infection. Quarter milk samples were then collected aseptically and sent to the diagnostic lab for bacteriological cultures on blood agar and MacConkey agar media. The results of this study revealed that Se of MAS-D-TEC for detection of subclinical mastitis was 100% (137/137, that means all of 137 specimens with ≥ 5 grades in MAS-D-TEC procedure were positive in bacteriological cultures), but the Sp of this device was 43.3% (26/60, that means only 26 out of total 60 negative culture specimens in MAS-D-TEC procedure had ≤ 4 grades, so 34 of negative culture specimens had ≥ 5 grades in MAS-D-TEC procedure). The false positive results of this device to detect subclinical mastitis may be attributed to the stage of lactation, parity, presence of the bacteria in the milk cells (more commonly about the presence of *Staphylococcus aureus* in the macrophage cells), presence of other microorganisms other than bacteria in the milk samples and so on. In conclusion, the present study revealed that milk specimens with degrees ≤ 4 in MAS-D-TEC procedure are highly indicative of absence of pathogens in the udder, so it is not necessary to take samples from them for bacteriological cultures, but specimens with degrees ≥ 5 may be indicative of subclinical mastitis which bacteriological cultures must be done to ascertain the presence of bacteria and kind of the pathogens involved, necessary for control and preventive mastitis programs in dairy herds.

Key Words: Mastitis, Electrical Conductivity, Cattle

Animal Breeding and Genetics Molecular Genetics

1507 The bovine gastrointestinal tract: A gene expression profile. C. Hansen¹, A. Fu¹, Y. Meng¹, C. Li¹, E. Okine¹, C. W. Sensen², P. Gordon², and S. S. Moore*, ¹Dept. of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, Canada, ²Dept. of Biochemistry and Molecular Biology, University of Calgary, Calgary, AB, Canada.

The bovine gastrointestinal (GI) tract is a complex system of chambers that function to break down and absorb what is often low quality feed. Although genes expressed along the GI tract have been intensely studied, for the most part experiments have only reported on one or a few genes at a time. We have used gene expression profiling to catalogue the genes and their level of expression in various tissues of the bovine GI tract and thus gain insight into the functionality of these tissues. Directionally cloned cDNA libraries of each of the segments of the tract were constructed using the Stratagene ZAP cDNA synthesis kit and approximately 2000 expressed sequence tags (ESTs) were generated for each region. Sequences were submitted to the MAGPIE program, a system for the automated analysis of biological sequences, and functional assignments were made for the various ESTs. Gene ontology assign-

ments were made using the GO classification system. Gene expression differences were analyzed statistically using the chi-square test. Tissue specific transcripts were found highly expressed in some regions. For example, the lysozymes were very abundant in the abomasum, but they are virtually absent from other regions. Ribosomal proteins too showed differences in level of expression between regions, indicating differences in the level of protein synthesis. Interestingly enough, a number of the GI regions did not appear to express a particular type of sequence preferentially. Rather, there was a steady, low level of expression of all genes observed. A comprehensive overview of the differences found will be presented.

Key Words: Gene Expression, Gastrointestinal Tract, Bovine

1508 Construction and characterization of ORESTES cDNA libraries generated from bovine mammary gland tissues. A. F. da Mota^{*1}, T. S. Sonstegard¹, C. P. Van Tassell¹, E. E. Connor¹, A. V. Capuco¹, M. A. P. Brito², M. A. Machado², M. L. Martinez², and L. L. Coutinho³, ¹*Gene Evaluation & Mapping Laboratory*, ²*EMBRAPA, Gado de Leite*, ³*University of Sao Paulo-ESALQ*.

Currently, there are approximately 200,000 bovine expressed sequence tags (EST) available in public databases. This is ten-fold less sequence information than that available for human and mouse. As such, additional bovine EST need to be generated to more thoroughly identify, annotate and classify expressed genes. This information will be essential to the interpretation of results generated from functional genomic studies. The objective of the present study was to generate 5,000 EST from the mammary gland, while maintaining a maximum discovery rate of novel EST. Based on this criteria, we chose to construct cDNA libraries using the open reading frame EST (ORESTES) method. This method uses arbitrarily primed cDNA synthesis to generate a partial profile of gene expression that can be PCR amplified, cloned, and arrayed into mini-libraries. The clones are usually sequences representing the central portion of expressed genes. In a preliminary study, primers that amplify estrogen receptor gene family members and mRNA from a pre-pubertal Holstein heifer were used to create six mini-libraries. Clones from three of these libraries were processed for sequence analysis. After processing to assign quality score and trim vector sequence, 455 sequences met minimum GenBank submission criteria. These sequences were assembled using GAP4 (Staden-Package) to assess rate of clonal redundancy and to provide consensus sequences for BLAST analysis. A total of 64 tentative consensus (TC) sequences were assembled leaving 178 singletons (ST) to generate a rate of redundancy of 47%. However, BLAST analysis of the 242 unique sequence elements (TC and ST sequence) against GenBank nt and the Bos taurus Gene Index (BtGI) databases revealed that most of these sequences were new relative to other cattle EST. Eighty-one sequences (17%) had no match to the nt database, and 147 (32%) did not match BtGI. Because ORESTES produced a high rate of novel cattle sequences, this method will be exploited to generate EST from mammary gland mRNA isolated from Brazilian dairy cattle (Gir). The presence of novel sequences within these libraries will be a valuable resource for studying gene expression differences in the mammary gland of Holstein and Gir cattle.

Key Words: Expressed sequence tags, Functional genomics, Mammary gland

1509 Influence of a differential allelic expression of bovine kappa-casein gene on micelle properties and renneting parameters. G. Lapointe^{*3}, G. Robitaille¹, M. Britten³, J. Morisset¹, Y. Pouliot³, and D. Petitclerc², ¹*Sherbrooke University*, ²*DSRDC, Agriculture & Agri-Food Canada (AAC), Lennoxville (Qc), Canada*, ³*FRDC, AAC, St-Hyacinthe (Qc), Canada*.

A differential allelic expression of the κ -casein (κ -CN) gene has been recently reported in Holstein cows. Two groups were distinguished within a population of κ -CN AB cows: group HH showed similar amounts of alleles A- and B-specific κ -CN mRNA within mammaryocytes, whereas the allele B-specific gene of group HL was transcribed into mRNA more efficiently than the allele A-specific one. The objectives of the study were to evaluate the impact of differential expression combined with heat treatment on milk rennetability, micelle size, and hydration. At each test-day, milk samples from individual cows (HH n=5, HL n=6) were collected, skimmed, and analysed for protein composition. They were dialyzed overnight at 4°C against bulk milk and standardized for protein content. Micelle size and hydration were determined on non-treated and heated milk (75°C, 64 min). Kinetics of curd formation were monitored using a microplate reader (650 nm) after addition of rennet to intact or heated milk (75°C for 2 to 64 min); coagulation parameters were obtained by fitting optical density data to an appropriate mathematical model. Solubility of whey proteins and micelle hydration decreased significantly with heat treatment ($P < 0.05$), while micelle size tended to increase when heated. Group had no effect ($P > 0.1$) on these parameters. Heat treatment and the group of cows significantly affected ($P < 0.05$) the kinetic of coagulation of milk, but there was no interaction between them. Gel formation rate decreased and clotting time (CT) increased as the heat treatment duration increased, and group HL had a faster gel formation rate and a shorter CT than group

HH. These results suggested that milk from cows of group HL has a better rennetability than milk from cows HH. However, statistical analysis revealed that impact of differential allelic-specific expression of κ -CN on the rennetability of heated milk stayed low compared to other genetic effects. Funded by FCAR-NOVALAIT-MAPAQ.

1510 A differential allelic expression of bovine-kappa casein gene is maintained throughout lactation. D. Vachon^{*1}, G. Robitaille¹, M. Britten³, J. Morisset¹, and D. Petitclerc², ¹*University of Sherbrooke, Sherbrooke, (Qc) Canada*, ²*DSRDC, Agriculture & Agri-Food Canada, Lennoxville (Qc) Canada*, ³*FRDC, Agriculture & Agri-Food Canada, St-Hyacinthe (Qc) Canada*.

A differential allele-specific expression of kappa -casein (k-CN) gene has been found in Holstein cows (Robitaille & Petitclerc, J. Dairy Sci. 81; 377). Indeed, we identified cows for which allele B-specific gene was transcribed into mRNA with greater efficiency than allele-A specific gene within a population of cows k-CN AB. The objective of this study was to test the effect of stage of lactation on this expression polymorphism. Holstein cows k-CN AB (n=16) were analyzed for the relative proportion of k-CN A and B-specific transcripts in mammaryocytes throughout lactation. Milk samples were collected from individual cows at different stages of lactation (4 to 7 test days/cow) and somatic cells were harvested by centrifugation at 2,500 RPM for 5 min. Cells were lysed with Trizol[®] reagent and total RNA was prepared following standard procedures. The relative proportion of each allele specific mRNA was determined by densitometry following a combination of reverse transcription polymerase chain reaction and single-strand conformation polymorphism. Change in the relative proportion of allele-B specific mRNA according to stage of lactation was analyzed for significance using SAS procedures. A differential allele-specific expression of k-CN gene was observed and mean values for the relative proportion of allele-B specific mRNA during lactation was $53.8 \pm 0.2\%$. The relative proportion of allele-B specific mRNA was not significantly affected ($P > 0.25$) by stage of lactation; LSMeans values averaged 53.7%, 54.1%, 53.9% and 53.7% for < 90, 91-180, 181-270 and > 271 days in milk, respectively. In conclusion, the allele-specific k-CN gene expression within mammaryocytes is not affected by stage of lactation. A better understanding of the mechanism involved in the differential allelic expression of k-CN would support the use of k-CN expression polymorphism as a genetic selection marker. Funded by FCAR-NOVALAIT-MAPAC.

Key Words: Kappa-casein, Expression polymorphism

1511 Polymorphism within the bovine kappa-casein gene. G. Robitaille^{*1}, M. Britten³, J. Morisset¹, and D. Petitclerc², ¹*Sherbrooke University*, ²*DSRDC, Agriculture & AgriFood Canada*, ³*FRDC, Agriculture & AgriFood Canada*.

Kappa-casein (κ -CN) A and B are the two main genetic variants in Holstein cows. We described a differential allele-specific expression of κ -CN gene that could account, at least in part, for the established association between κ -CN allele B and high κ -CN content in milk (Robitaille et al, 2000, JDR 67:107). Indeed, within cows genotyped AB, we observed a group of cows (HH) with similar level of expression of each allele and another group of cows (HL) over-expressing the allele B-specific κ -CN gene compared to allele A. In this study, we compared DNA sequences of allele A and B gene variants to evaluate single nucleotide polymorphisms (SNPs) associated with A and B genetic variants and with the differential expression of κ -CN gene. Genomic DNA was sequenced from 3 cows HL, 3 cows HH and from homozygous AA and BB cows for κ -CN genetic variants. The κ -CN gene (12 995 base pairs (bp)) contains five exons (64, 61, 207, 612 and 118 bp) and four introns (2426, 5915, 1837 and 1755 bp). We first determined the unpublished sequence of the 2402 bp region within intron II. Then, we compared the gene sequence of genetic and expression variants of κ -CN gene. Exons I, II and III are well conserved and we did not detect any polymorphism within these exons. A total of 35 SNPs were found within exons IV and V and within introns I to IV after comparison between allele-A and allele-B specific genes. SNPs located within the κ -CN gene coming from HL cows were identical to those of HH cows; these SNPs were strictly related to allele A and B-specific sequences. This observation was confirmed using DNA sequence of κ -CN gene from AA and BB cows. In conclusion, the differential allele A and allele B-specific expression pattern cannot be related to specific mutations within the κ -CN gene. Further extensive analysis of the 5' upstream region κ -CN gene is being carried out to find

additional SNPs potentially related to the differential allelic expression of κ -CN gene. Funded by FCAR-NOVALAIT-MAPAC

Key Words: κ -casein, Gene expression, DNA sequence

1512 SNP discovery in candidate genes for a bovine ovulation rate QTL. K.J. Tessanne^{*1}, K.E. Gregory², and B.W. Kirkpatrick¹, ¹University of Wisconsin-Madison, ²USDA Meat Animal Research Center.

The primary aim of this study was to identify candidate gene polymorphisms for an ovulation rate QTL on bovine chromosome 19 (BTA19). This QTL was identified in an elite sire using a three-generation family within the USDA Meat Animal Research Center (MARC) twinning herd, and it was this sire that was screened for polymorphisms. Growth hormone (GH), insulin-like growth factor binding protein-4 (IGFBP-4), and 17 β -estradiol dehydrogenase type 1 (17 β -HSD) were selected as potential candidate genes and searched for single nucleotide polymorphisms (SNPs) using PCR amplification and DNA sequencing. Two SNPs were found in 5695 bp of sequence, and both were located in GH at positions 253 (C253T) and 1692 (C1692T) of the published bovine sequence. To determine association of these SNPs with ovulation rate, a one-way ANOVA was implemented using deviation from midparent estimated breeding value for ovulation rate as the phenotype of interest. This was calculated for a sample of 177 individuals from the MARC twinning herd born in 1992. No significant association with ovulation rate was detected. In the course of this study four SNP genotyping methodologies were evaluated for accuracy, these being allele-specific PCR, primer extension, forced restriction fragment length polymorphism (RFLP) analysis, and the invader technology. Of these, both the allele-specific PCR and primer extension gave inaccurate genotyping results when compared to the RFLP assay. Primer extension gave an error rate of 41% (n = 41) and allele-specific PCR gave error rates of 74% (n = 23) and 18% (n = 17) for two different primer sets when compared with the forced RFLP results. No errors were observed with the invader technology when compared with forced RFLP results. Efforts to identify polymorphisms in linkage disequilibrium with the QTL were hampered in this case by the broad confidence interval for QTL location. The QTL needs to be refined further before a candidate gene search is performed.

Key Words: Genetic marker, Polymorphism, Cattle

1513 Genetic diversity among the Angus, the American Brahman, the Senepol, and the Romosinuano cattle breeds. R. A. Brennen¹, C. C. Chase, Jr.^{*1}, D. G. Riley¹, T. A. Olson², and S. W. Coleman¹, ¹USDA, ARS, SubTropical Agricultural Research Station, Brooksville, FL, ²University of Florida, Gainesville, FL.

The objective of this study was to quantify the genetic diversity among the breeds under evaluation at the USDA, ARS, SubTropical Agricultural Research Station (STARS). Twenty-six microsatellite loci were used to estimate parameters of genetic diversity among a *Bos indicus* breed, Brahman (B), and three *Bos taurus* breeds, Angus (A), Senepol (S), and Romosinuano (comprised of two distinct bloodlines, R₁ from Colombia and R₂ from Costa Rica). Forty-seven animals from each of the respective STARS herds were selected by pedigree and sampled as breed or bloodline representatives. Analysis was performed using GENEPOP v3.2a. The genetic differentiation detected between the populations was highly significant (P < 0.001). Pairwise measures related to genetic differentiation are shown in Table 1. The R₁ and R₂ populations were most similar, having the smallest genetic distance (D_S), population subdivision (F_{ST}), and proportion of private alleles (Pvt alleles), and the largest gene flow (N_M). The A and R₁ populations appeared to be most diverse, having the largest F_{ST} and proportion of Pvt alleles, and the smallest N_M. Results indicate that the use of molecular genetics techniques combined with population genetics analyses may be useful to substantiate historical development of these breeds. In conclusion, inferences based on genetic distance were shown to be useful in purebred studies, and may be used to determine relationships between breed diversity and observed heterosis in future crossbreeding studies.

Pairs of breeds	D _s	F _{ST}	Pvt alleles	N _M
R2, S	1.106	0.240	0.137	0.299
A, B	1.104	0.204	0.114	0.406
B, R1	0.932	0.262	0.140	0.314
B, R2	0.910	0.240	0.131	0.333
A, R1	0.870	0.287	0.177	0.194
B, S	0.759	0.216	0.122	0.368
R1, S	0.729	0.216	0.137	0.313
A, R1	0.679	0.309	0.184	0.190
A, S	0.615	0.234	0.135	0.296
R1, R2	0.349	0.143	0.106	0.485

Key Words: Beef breeds, Genetic distance, Genetic markers

1514 Identical by descent haplotype sharing analysis: application in fine mapping of QTLs for birth weight in commercial lines of *Bos taurus*. C. Li¹, J. Basarab², W. M. Snelling³, B. Benkel⁴, B. Murdoch¹, J. Kneeland¹, C. Hansen¹, and S. S. Moore^{*1}, ¹Department of AFNS, University of Alberta, Edmonton, AB, Canada, ²Lacombe Research Centre, AAFRD, 6000 C&E Trail, Lacombe, AB, Canada, ³USDA, ARS, US MARC, Clay Center, Nebraska, USA, ⁴AAFC, Lethbridge Research Center, AB, Canada.

Fine mapping QTLs will greatly facilitate the identification and cloning of the causative genes. To this end we have utilized historical recombinations in commercial beef cattle lines to better define QTL regions. It is expected that individuals within a semi-closed population, such as a commercial line of cattle, may be derived from one or a limited number of founders. Some common haplotypes originating from the common ancestors should carry on and segregate among the individuals of the breeding line, particularly when selection is applied. These common haplotypes may harbor QTLs of interest and make it possible to locate QTLs segregating in the line. We demonstrated an application of an identical by descent haplotype (IBD) sharing analysis in fine mapping QTLs for birth weight EBV (estimated breeding values) on bovine chromosome 5 in two commercial lines of *Bos taurus* from Beefbooster Inc. Canada. The M1 line was developed from an Angus base and the M3 line from small cows of various breeds. Both lines have been selected for maternal traits for over 30 years. Common haplotypes within each commercial line were identified along BTA5 using 16 microsatellite markers and the association between a common haplotype and the birth weight EBV was tested by regression analysis. Two chromosomal regions at 10 cM to 20 cM and 65 cM to 78 cM were identified having significant associations with the birth weight EBV in both commercial lines. The two chromosomal regions were also confirmed by interval mapping. The QTLs identified using the IBD haplotype sharing analysis were better defined, indicating the effectiveness and accuracy of the IBD haplotype sharing analysis in fine mapping of QTLs in commercial lines of *Bos taurus*.

Key Words: QTL, IBD haplotype sharing analysis, Bovine

1515 Investigation of the association between the estrogen receptor beta gene and reproductive components in swine. B.J. Isler^{*}, K.M. Irvin, S.M. Neal, and S.J. Moeller, *The Ohio State University, Columbus, OH.*

The association between a polymorphism in the estrogen receptor beta (ER β) gene and reproductive tract components in swine has been evaluated. The ER β genotype of 75 Yorkshire (Y \times Y), 80 Large White (LW \times LW), and 99 crossbred (33 LW \times Y, 66 Y \times LW) females was determined to be AA, AB, or BB using a PCR-RFLP procedure. All animals were mated to Hampshire or Duroc boars and slaughtered at approximately 75 days of gestation. Data collected from gravid uterine tracts included ovulation rate, uterine weight, uterine horn length, number of fetuses, total fetal weight, average fetal weight, number of mummies, fetal space, and fetal survival. Data were analyzed using a model that included the effects of ER β genotype, breed, parity, and significant two-way interactions. Uterine horn was also included in some analyses to determine the presence of between horn effects. ER β genotype was found to be associated (P < 0.1) with fetal weight per uterus, average fetal weight per uterus, number of fetuses per horn, fetal weight per horn, and average fetal weight per horn. Animals with the BB genotype had a significantly (P = 0.003) greater number of fetuses per horn

(5.63 ± 0.51) than animals with the AA genotype (4.83 ± 0.15). BB animals also had a significantly ($P < 0.05$) smaller total (1687 ± 75 g) and average (335.4 ± 14.2 g) fetal weight per horn than AA animals (1821 ± 29 g, 368.7 ± 5.7 g). The ER β gene appears to act in a dominant manner, with the B allele being dominant over the A allele. Animals with the dominant phenotype gestate larger, lighter litters of piglets than animals with the recessive phenotype. Other traits displayed statistically non-significant trends with respect to the BB genotype: increased fetal survival and total number of fetuses per uterus and decreased uterine weight and fetal space per horn. The ER β gene is positively associated with several reproductive tract traits.

Key Words: Swine, Genetic Marker, Reproductive Traits

1516 Polymorphisms at the mink prolactin locus. T.L. Vardy and A. Farid, *Nova Scotia Agricultural College*.

The objective of this study was to find polymorphisms at the mink prolactin (PRL) locus. This gene plays important roles in mammary gland development, initiation and subsequent maintenance of lactation, termination of embryonic diapause as well as fur growth and coat molt

cycles. Sequence of the cat PRL gene was used to design primers for the amplification of the mink PRL exon 1 and part of exon 2, which were not previously known, by the polymerase chain reaction (PCR). The entire exons 2, 3, 4 and 5 and the intervening introns were also PCR amplified using overlapping primers. PCR products were bidirectionally sequenced in four to seven mink of different colour types (black, pastel, brown, wild). Four nucleotide substitutions were detected in introns, which were in linkage disequilibrium. Genotypes of 86 mink (25 black, 20 pastel, 20 brown, 21 wild) were determined at a NlaIV site (C to G substitution) in intron 3. One allele which was not detected in black mink, had low frequencies in brown (0.05) and pastel (0.025), while it had a moderate frequency (0.20) in wild mink. The result may suggest that the region of DNA containing the PRL locus has been under selection pressure in ranch mink. Three polymorphic tandem repeats; a (GT)₁₅ and a (TTC)₅(T)₄₇ in intron 2, and a (CA)₇(GA)₁₄ in intron 4, were also detected. These microsatellites facilitate genetic screening of mink at the PRL locus.

Key Words: Mink, Prolactin, Polymorphism

Dairy Foods Processing

1517 Implementation of HACCP system to large scale processing line of plain set yogurt. A. Rabi¹, R.R. Shaker², A. Banat¹, and S.A. Ibrahim^{*3}, ¹*Jordan University of Science and Technology*, ²*Washington State University, Pullman, WA*, ³*North Carolina Agriculture and Technical State University, Greensboro, NC*.

Limited data on the microbiological quality of traditional dairy products in Jordan are available. Recent studies have shown that yeast is the major contaminant in many of these products. The problem of such contamination could be attributed to many factors. Therefore, it is important to develop a hazard analysis and critical control points (HACCP) system for traditional products. The implementation of such system to yogurt is of great importance in order to produce microbiologically safe dairy product. The system was implemented for yogurt processing line as produced by large dairy company in Jordan. Six critical control points were identified in the flow chart of yogurt production; corrective actions and effective preventive measure were suggested. The microbial results have demonstrated how the hazards at the four critical control points of the process are easily and effectively controlled through implementation of the HACCP system. The microbial results demonstrate how the hazards at the critical control points (CCPs) of the process are easily and effectively controlled through the implementation of the HACCP system to popular dairy products

Key Words: yogurt, HACCP, safety

1518 Influence of lactic cultures, added linoleic acid, and fructo-oligosaccharides on conjugated linoleic acid concentration in nonfat set yogurt. Tung Lin*, *Chinese Culture University, Taipei, Taiwan*.

Skim milk mixed with 5% fructo-oligosaccharides and/or 0.1% linoleic acid (LA) was fermented with one of three lactic cultures: *Lactobacillus acidophilus* (CCRC14079), yogurt bacteria (*L. delbrueckii*ssp. *bulgaricus* and *Streptococcus salivarius* ssp. *thermophilus*), and mixed cultures of *L. acidophilus* (CCRC14079), and yogurt bacteria at 37°C for 8-24 h to reach a 0.9% acidity, and the levels of c9,t11-conjugated linoleic acid (c9,t11-CLA) were determined by HPLC. Sensory attributes and Hunter L, a, b values of the products were also evaluated. A significant increase in c9,t11-CLA level was observed in the LA added yogurt inoculated with mixed cultures, and the CLA content was 2.95 μ g/g yogurt. The total acceptability ratings ranged from 6.0 to 6.7 were not significant difference among 8 yogurt treatments. Hunter L, a, and b

values showed only slight differences among those yogurts too. Inoculations of mixed cultures with LA addition, therefore, are suggested for CLA-rich nonfat set yogurt production.

Key Words: Lactic culture, Conjugated linoleic acid, Fructo-oligosaccharides

1519 Viability of bifidobacteria in yogurt products found in North Carolina. J.P. Carr*, S.A. Ibrahim, G. Shahbazi, M. Worku, and C.W. Seo, *North Carolina Agricultural and Technical State University, Greensboro, NC*.

The use of bifidobacteria as dietary adjuncts is a subject of intense and growing interest. Several probiotic benefits such as improvement of gastrointestinal motility, lactose intolerance systems, and anticholesterol effects have been associated with bifidobacteria. Because of these benefits, there has been an increasing interest in incorporating viable cells of this microbial group into dairy products. However, during processing and storage, the number of viable cells tends to decline. There are few scientific studies reporting the viability of bifidobacteria in commercial yogurt products in the U. S. Therefore, the purpose of this work was to screen the yogurt products for viable yogurt cultures specifically bifidobacteria, and to test these isolates for probiotic properties. Fifty-eight commercial yogurt products (containing bifidobacteria in addition to the traditional yogurt culture) were obtained from local stores. Experiments were performed within 24h of purchase. MRS and G-M17 were used for the enumeration of *Lactobacillus burglarious* and *Streptococcus thermophilus*, respectively. Modified BIM-25 was used for the enumeration of bifidobacteria. All plates were incubated for 72h at 37C. Isolates of bifidobacteria were examined for the phenotypic and genotypic characteristics. Our results showed that the bacterial counts ranged from 6.00 to 9.89 Log₁₀CFU/ml, 6.60 to 9.48 Log₁₀ CFU/ml, for *Streptococcus*, and *Lactobacillus*, respectively. The counts for bifidobacteria among the tested samples ranged from 0.00 to 5.00 Log₁₀CFU/ml. Of the 58 products claiming the inclusion of Bifidobacteria in their products, only 44 (75.9 %) contained viable cultures. The β -galactosidase activity for bifidobacteria isolates ranged between 200 and 500 Miller units. One strain showed antimicrobial activity against *E. coli* 0157:H7. The PCR fingerprinting procedure indicated that bifidobacteria isolates were closely related. Regulation on viable probiotic bacterial counts should be more restricted to ensure that products deliver sufficient amount of viable bifidobacteria.

Key Words: Bifidobacteria, Yogurt, Viability

1520 Effect of high pressure CO₂ on *Pseudomonas fluorescens* in saline and milk. M. Rajagopal* and J. Hotchkiss, *Northeast Dairy Foods Research Center, Ithaca, NY/USA.*

Alternatives or adjuncts to conventional pasteurization may find use in milk processing. Our objective was to study the inactivation of common milk spoilage organisms by high-pressure carbon dioxide. *Pseudomonas fluorescens* was treated in saline and milk with carbon dioxide at pressures up to 153 atm and temperatures up to 45°C for 0 to 60 min. Survivors were enumerated by standard methods. Inactivation curves were expressed as log (survivors) vs time and linear and non-linear models fit to the data. The combination of CO₂ pressure, temperature, and time reduced the counts from approximately 10⁸ cfu/ml to 10⁵ cfu/ml after 15 minutes and 2.8*10⁴ cfu/ml after 45 min. and <10¹ cfu/ml after 60 min. D-values ranged from 7.7 min to 16 min in a time, pressure, temperature-dependent manner. These data suggest that pressurized CO₂ might be useful for inactivating microorganisms in milk.

Key Words: Shelf life, Carbon dioxide, Milk

1521 Develop an environmentally safe wood finish product using whey protein as a co-binding material. Jiancai Li* and Mingruo Guo, *University of Vermont, Burlington VT 04505.*

Whey is a byproduct from cheese making. Expanding the use of whey is a high priority for the dairy industry. Whey proteins have been shown to be a good film-forming agent. The objective of this study was to develop an environmentally friendly wood finish coating formulation system by using whey protein isolate (WPI) and an environmentally safe acrylic resin as the binding materials. Thermally denatured (90C, 30min) whey protein isolate solution was incorporated into an acrylic-based environmentally safe wood finish coating mix at ratios of whey protein to total solids ranged from 0 (control), 10, 15, and 25% (w/w). The physiochemical properties (pH, density, viscosity, drying time, hardness, color, and etc.) of coating mix and/or the films were examined in comparison with selected commercial wood finish products. Incorporation of WPI significantly increased the pH (from 6.3 to 6.6), density (from 1.00 to 1.02 g/cm³), and viscosity (from 17.76 to 437mPa.s)(p<0.05) of the WPI-acrylic resin coating formulations, which release a much smaller amount (< 80g/l) of volatile organic compounds than the commercial wood finish products (250-450g/l). The WPI-acrylic coatings displayed shorter drying-through time and higher gouge and scratch hardness compared to those of commercial products. Improved clarity and color attributes of the coatings by the addition of WPI were observed. Puncture strength (PS) and water vapor permeability (WVP) of the WPI-acrylic composite films ranged 46-64N/mm and 0.16-1.32 g.mm/m².h.kPa depending on the ratios of the protein to total solids in the formulations. Both of PS and WVP of the films were comparable to the commercial counterparts. The results show that the environmentally friendly wood finish coating prototype product may be a good alternative for coating furniture, toys, and other high-end wooden products.

Key Words: Whey protein, environmentally safe, wood finish

1522 Combined effects of casein concentration and stabilizers on textural properties of stirred yoghurt. Caroline Lapointe*¹, Daniel St-Gelais¹, and Mario Proulx², ¹*Food Research and Development Centre, Agriculture and Agri-Food Canada, St-Hyacinthe, Quebec,* ²*Ultima Foods Inc., Granby, Quebec, Canada.*

In this study, stirred yoghurts were produced from milk standardized to 4% total proteins with sodium caseinate and whey protein concentrate (WPC 35), 1% fat and 0.125% of calcium. However, the contribution of casein to total protein was 66, 73, 78 or 83%. Three stabilizers, a starch derived from waxy maize (S1), a starch used to prepare gelatin-free yogurt (S2), and a combination of starch S1 with an agar agar (S1A) were added to milk base to produce three types of stirred yoghurt (YS1, YS2 and YS1A, respectively). The manufacture of all stirred yoghurts was similar. The effects of casein concentrations and stabilizers on textural properties were investigated. A dynamic stress rheometer was used to determine apparent viscosity (AV). A TA-XT2 Texture Analyser was used to determine the gel strength (GS). The susceptibility of syneresis was tested by a centrifugal method and the microstructure was determined by transmission electron microscopy. The experiment was replicated five times. A factorial design was used to compare treatments. The AV and the GS were lower, whereas the syneresis was higher for yoghurts YS1 than for yoghurts YS2. In addition, for yoghurts YS2, the

GS and the AV decreased, whereas the syneresis increased with casein concentration. The apparent viscosity and the gel strength for yoghurts YS1 were not affected by casein content but the syneresis increased with casein concentration. However, with addition of agar to yoghurt YS1, the AV and the GS increased, whereas the syneresis decreased with casein concentration. Stabilizers and casein concentration affected the microstructure of yoghurt. The addition of agar and casein resulted in the formation of larger cluster of casein micelles. The results confirm that casein content has a real impact on textural properties of yoghurt but the effects of casein depend on the stabilizer used.

Key Words: yoghurt, casein concentration, stabilizer

1523 Effect of ultrasound treatment on total bacteria and *Listeria monocytogenes* levels in milk. M. Guo*, T. M. Silk, and J. Wu, *University of Vermont, Burlington VT 05045.*

Heat treatment is widely used to pasteurize milk and other fluid food products. Although heating can kill pathogens, it can cause undesirable side effects such as loss of nutrients, and unacceptable changes in color and flavor. Heating can also induce interactions between components (protein-protein, protein-carbohydrate, and protein-lipid interactions) in food systems. The objective of this study is to use ultrasound as an alternative means to treat milk and other liquid food products. Milk samples were treated using a digital Sonifier (Model 450W, Branson Ultrasonics Co.) at a constant frequency (20kHz) and 110 W ultrasonic output power that was measured calorimetrically with a thermocouple. Raw milk, from the University farm, was portioned into 20 ml samples at the time of treatment. Milk samples were placed in steril aluminum tubes (23 X 80 mm). During treatment, the tubes were kept on ice minimizing temperature increases of the milk samples resulting from ultrasound treatment. Samples were individually treated with ultrasound for one or three minutes. Treated milk was then appropriately diluted in Butterfield's phosphate buffer and plated on Petrifilm APC plates. Plates were incubated at 35°C for 48 hours. In addition, UHT milk was inoculated with *Listeria monocytogenes* strain F5069(ATCC 51414) serotype 4b and treated with ultrasound. Ultrasound treatment of raw milk resulted in an overall reduction of microorganisms. Aerobic bacterial levels in raw milk decreased from 7.04+/-0.20 log CFU/ml to 5.62+/-0.25 log CFU/ml with one minute of treatment. Microbial levels decreased to 3.33+/- 0.11 log CFU/ml with three minutes of treatment. Levels of *Listeria monocytogenes*, inoculated milk decreased from 7.53 log CFU/ml to 7.07 log CFU/ml with one minute of treatment. Three minutes of ultrasound treatment decreased *Listeria monocytogenes* levels to 6.04 log CFU/ml. The results show that ultrasonic treatment might be a promising alternative method for milk treatment.

Key Words: Ultrasound treatment, milk, microbial reduction

1524 Coagulation properties of skim milk fortified with various dried milk proteins. B. S. Oommen*¹ and D. J. McMahon¹, ¹*Utah State University.*

Coagulation properties such as rennet coagulation time (RCT) and curd firmness of skim milk (2.91% protein) fortified with non-fat dried milk (NFDM), calcium caseinate, and sodium caseinate to a protein concentration of 2.99%, 3.17% and 3.35% were measured using a Formagraph. The dried protein powders were hydrated in water as a 12% protein solution by high shear mixing for 5min and subsequent stabilization for 8h before supplementation with skim milk. At higher levels of added calcium caseinate and sodium caseinate, the milk exhibited undesirable coagulation properties such as longer RCT. Therefore, potassium-dihydrogen-phosphate and calcium chloride were added to milks supplemented with calcium caseinate and sodium caseinate respectively, prior to rennet addition in the Formagraph. Coagulation time of milk fortified with NFDM decreased with higher amounts of fortification while that of milks supplemented with calcium caseinate increased with higher rates of supplementation. These differences diminished with phosphate addition and the RCT was comparable to that of milk between 9 and 18 mM of phosphate addition. A similar trend of increased RCT with increased fortification and diminishing RCT with calcium addition was seen in sodium caseinate supplemented milks. With 0.6 to 1.2 mM of added calcium, the RCT was comparable to that of control milk. Curd firmness increased with higher fortification with NFDM. Curd firmness for calcium caseinate supplemented milks decreased when compared to the control milk while it increased with addition of phosphate. Similarly, with milk supplemented with sodium caseinate there was a reduction in

curd firmness and addition of Ca increased the firmness to that of the control skim milk. The microstructure of the curds made from skim milk supplemented with proteins did not show any apparent difference. Even though milk supplementation with various milk proteins can destabilize the coagulation properties, these can be brought back to that of original milk by addition of various salts such as calcium hydroxide and potassium phosphate without affecting the microstructure.

Key Words: protein supplementation, microstructure, Formagraph

1525 Effect of temperature on strain ratio during continuous production of lactic starters containing probiotics with immobilized cell technology. Y Doleyres, I Fliss, and C Lacroix, *Dairy Research Centre STELA, Université Laval, Québec, PQ, Canada.*

Fermented dairy products are the main carriers for probiotic cultures. However, these cultures are fastidious to grow and usually not propagated in mixed cultures. In this study, cell immobilization (separate entrapment) in polysaccharide gel beads (2.75 % κ -carrageenan and 0.25 % locust bean gum) was studied for the continuous production of a mixed culture composed of an acidifying strain, *Lactococcus lactis* ssp. *lactis* biovar. *diacetylactis* MD, and a probiotic culture, *Bifidobacterium longum* ATCC 15707. A two-stage fermentation system was used, with a first reactor (R1, 120 ml) containing immobilized cells (separate entrapment) and a second reactor (R2, 600 ml) in series operated with free cells released from beads in R1. The system was fed with MRS-cystein medium (240 ml/h) and different temperatures in the range from 32 to 37°C were tested with pH controlled at 6.0 in both reactors. Cell concentrations in gel beads and medium for both strains were strongly temperature-dependent, and at 35°C a balanced culture of the two strains was produced in the fermented medium from R2, with $3.40.7 \times 10^8$ CFU/ml *B. longum* and $7.80.2 \times 10^9$ CFU/ml *L. diacetylactis*. *B. longum* did not grow in the second reactor, which served as a conditioning step to increase stress resistance of the culture, whereas *L. diacetylactis* concentrations were up to five times higher in R2 than in R1. A surface cross-contamination from the other strain of the mixed culture was observed in gel beads entrapping a pure culture using an immunofluorescent method involving double color labelling and confocal microscopy. After 17 days, all beads had the same composition, with $3.70.7 \times 10^{10}$ and $8.31.7 \times 10^9$ CFU/g for *L. diacetylactis* and *B. longum*, respectively. Our study showed that cell immobilization permits a stable continuous production of mixed cultures with a probiotic strain, and that temperature can be used to control the strain ratio in the mixed cultures.

1526 Development of vanilla-flavored ice cream using sucralose as sweetener. K. Adhikari*, R.D. Linhardt, A.T. Woods, K.A. Hein, and H. Heymann, ¹University of Missouri.

Alternative sweeteners have replaced sucrose as the sweetening agents in many food products that boast fewer calories and more choice to diabetic consumers. Sucralose is one such sweetener whose chemical composition is very similar to sucrose, although it is about 600 times sweeter than sucrose and the human body cannot metabolize sucralose. The primary objective of this study was to develop vanilla flavored ice cream using sucralose as the sweetener, and compare their sensory characteristics to ice creams containing sucrose. Regular- (10%) and reduced-fat (7.5%) fat ice creams with 0%, 25%, 50%, 75% and 100% sucrose replacement with sucralose (equivalent amounts in sweetness) were manufactured. Physical measurements included viscosity of ice cream mixes and hardness of ice creams. Descriptive sensory analysis was performed out on the ice creams by a panel of 10 judges. Canonical variate analysis (CVA) was done to find differences among the ice creams, and partial least square (PLS2) regression was done to correlate the sensory data to the physical data. Multivariate analysis of variance showed that #ice cream effect# was highly significant, indicating notable differences among the various ice creams. The CVA biplot showed that ice creams with up to 50% sucrose replacement were comparable to the control ice creams. The ice creams with higher replacement of sucrose were perceived to be porous, dry, bitter and chewy due to the presence higher concentrations of maltodextrin, which was used as a bulking agent. PLSR2 indicated that viscosity of the mixes and hardness of the ice creams were able to predict the creaminess, fluffiness, chewiness, crumbliness and meltdown (sensory texture attributes) with correlation coefficients (r) more than 0.77. The PLSR2 biplot also indicated that the ice creams mixes and

ice creams containing higher concentrations of sucralose were more viscous and harder (physical attributes), respectively, which correlated well with sensory texture attributes such as fluffiness, chewiness and crumbliness. In conclusion, further work is necessary to optimize the type and amount of bulking agent used to replace the solids lost due to the use of high intensity sweeteners.

Key Words: sucralose, ice cream, descriptive analysis

1527 Large-scale production of water-soluble whey protein-based microcapsules for stabilization and controlled release of food ingredients. A. Picot¹ and C. Lacroix*¹, ¹Dairy Research Centre STELA.

An original technology based on spray-drying was developed to produce water-insoluble food-grade microcapsules with diameter lower than 100 μ m suitable for stabilization and/or controlled release of food ingredients. A suspension of polymerized whey proteins (10% w/w heat-denatured WPI solution) was used as coating (method A) or immobilizing (method B) agent to prepare microparticles designed to protect hydrophobic or hydrophilic compounds (e.g. active molecules, lipids, vitamins and minerals) and sensitive probiotic lactic cultures, respectively. Method A consisted in dispersing an hydrophobic phase, which contained the hydrophobic or hydrophilic material to be protected, in soluble WPI polymers and spray-drying the resulting o/w emulsion. The hydrophilic material is incorporated in the form of fine dried particles by suspending a micronized powder in the hydrophobic phase before emulsification. The process is operated continuously by using a dynamic loop mixer connected to a spray-dryer. Anhydrous milk fat and skim milk powder (SMP) were used as model core materials during the development of the technique and optimization of the operating conditions. Best results in terms of encapsulation efficiencies were obtained with a 95/5 (w/w) hydrophilic/hydrophobic phase ratio, 5% (w/w) SMP in the hydrophobic phase, and SMP particle size with a $D(v, 0.9) < 25 \mu$ m. Using method B, powder particles containing up to 2×10^9 cfu/g of *Bifidobacterium* ssp. were prepared by dispersing fresh cultures in soluble WPI polymers and spray-drying the resulting cell suspension. Immobilization of probiotic bacteria in whey protein-based microcapsules increased significantly their survival during refrigerated storage in yoghurt and when subjected to conditions similar to those encountered in the human gastrointestinal tract. The simple whey protein-based microencapsulation technology developed in this study, with low cost and large-scale capacity, could be used in foods or supplements to deliver efficiently bioactive ingredients to the consumers.

Key Words: Microencapsulation, Whey proteins, Spray-drying

1528 Evaluation of sodium caseinate isolate and whey protein concentrate in liquid coffee creamers. A. E. Golde and K. A. Schmidt*, ¹Kansas State University, ASI Dept.

The majority of U.S. consumers adds a sweetener or creaming agent to their brewed coffee to soften the acidic taste. When placed in coffee, an ideal coffee creamer should have a cream-like flavor, remain stable (not feather), dissolve readily and provide good whitening ability. The objectives of this study were to: develop a visual feathering guide for creamer evaluation and to evaluate sodium caseinate (SCI), whey protein concentrate (WPC) and their combination as coffee creamers. Coffee creamers (11% fat, 5.5% sweetener, 3% protein, 2.4% emulsifiers and 0.45% stabilizer and buffer) were made. A visual feathering guide was developed for evaluation of coffees in 4, 6 and 8% brewed coffee solutions, by utilizing different acid concentrations to induce feathering. Laminated, color photo guides were made. Creamer samples were evaluated for density, pH, and color (L^* , a^* , b^*) as individual liquids. Coffee creamers were placed in brewed coffee (4, 6 and 8% (w/v) concentration) and evaluated for feathering tendency and whitening ability. Statistical analyses indicated that as coffee creamers, the SCI samples were lower in b^* , density, hue angle, pH and saturation index and higher in a^* than the WPC and SCI/WPC samples. However, all coffee creamers were stable in the hot coffee solutions and did not exhibit any tendency to feather. Also, when coffee creamers were added to hot, brewed coffee, similar whitening properties were observed. These results indicate that WPC may be used as a partial replacement for sodium caseinate in liquid coffee creamers.

Key Words: Sodium caseinate, Whey protein concentrate, Coffee creamer

1529 The effect of antioxidants on solubility of trace minerals in infant formula. C. R. Smith*, M. R. Guo, and R. S. Tyzbit, *University of Vermont, Burlington VT 05405.*

In infant formula, the solubility and availability of essential trace elements, especially iron (Fe) and zinc (Zn), may be affected by the forms of added mineral salts as well as the oxidation state of the mineral. Solubility and bioavailability of Fe may also be related to the oxidation state, being more soluble in a reduced state. To maintain a reduced environment in formula, we used high levels (200-300% RDA) of the naturally occurring antioxidant nutrients ascorbic acid (vitamin C) and vitamin E, both of which can be used at up to 10,000% of the RDA with little or no side effects. Ten 2.0 kg paired batches of milk-based, whey-protein dominated liquid infant formula (40:60 casein to whey protein ratio) were processed in our university laboratory, with either organic salts, i.e., gluconate, (OF) or inorganic salts, i.e., sulfate, (IF) of Fe and Zn; and 100% (control), 200%, or 300% the RDA of vitamin C or vitamin E. Mineral distribution was determined by measuring contents of the minerals in the fat, serum, and pellet fractions obtained on centrifuging the formula at 45,000 X g for 2 hours at 4°C. Mineral levels were evaluated by inductively coupled plasma atomic emission spectroscopy. There were no significant improvements on the solubility of iron and zinc in OF and IF by either ascorbic acid or vitamin E at all levels (200 & 300%). According to these results, the antioxidants used may have no effect on the solubility of trace minerals in infant formula. Further research is needed to elucidate and verify methods to increase trace mineral solubility and availability in infant formula.

Key Words: Infant formula, mineral solubility, antioxidant

1530 Carbonation of frozen soft-serve confections. L.V. Ogden*, L.K. Jefferies, and A. Ellsworth, ¹*Brigham Young University, Provo UT.*

A Taylor model 8756 soft-serve freezer was modified to pump carbon dioxide, instead of overrun air into the pressurized freezing chamber as the mix was freezing. Non-fat Yogurt soft-serve mix containing 12% MSNF was frozen while injecting carbon dioxide. The amount of carbon dioxide injected was adjusted the maximum that could be uniformly incorporated in the product. Soft frozen product at -7 °C had an overrun of 60 % and contained 1.3 volumes of dissolved carbon dioxide. The product had a distinct and pleasant carbonation flavor. Hard freezing the product resulted large carbon dioxide containing voids as gas was excluded from the freezing matrix.

Key Words: Frozen, Confection, Carbonation

1531 Effect of homogenization pressure on rheological properties and microstructures of heat-set whey protein emulsion gels. R. Suhareli*, G. Perez-Hernandez, and R. Richter, *Texas A&M University, College Station, TX.*

The objective of this experiment was to determine the effect of homogenization pressure on heat-set, whey protein emulsion gels. Whey protein

concentrates from acid and sweet whey were used. Gels contained 10 % protein and 20 % milkfat. Samples were heated to 65 C for homogenization at 20 and 90 MPa. The Dvs and viscosity of the emulsions were analyzed before the emulsions were heated at 90 C for 30 minutes. Stress-relaxation parameters were determined for the gels. Gels microstructure was observed by using ESEM.

The particle size distribution was affected by protein source and homogenization pressure. The Dvs of emulsions prepared with acid whey increased when the homogenization pressure was increased from 20 to 90 MPa. However, the Dvs of emulsions prepared with sweet whey decreased as the homogenization pressure was increased from 20 to 90 MPa. The consistency coefficient of the emulsion increased when the homogenization pressure was increased for emulsions from both sweet and acid whey. Emulsions prepared with acid whey had a higher consistency value compare to gels made with sweet whey.

The emulsions prepared with acid whey exhibited shear-thinning ($n < 1$). Emulsions prepared with sweet whey had Newtonian behavior after homogenization at 20 MPa but were susceptible to shear-thinning when the emulsions were homogenized at 90 MPa. Gels prepared from acid whey were stiffer after homogenization of the emulsions at 90 MPa than gels made from emulsions homogenized at 20 MPa. The micrographs showed that acid gels had a textured surface compare to sweet whey that had smoother surfaces.

Key Words: Homogenization, Whey Protein, Emulsion Gels

1532 Folic acid fortified fat free sugar free plain set yogurt. Kayanush Aryana*, *Louisiana State University.*

Folic acid is used in preventing birth defects of the spine and brain, hardening of arteries and colon cancer. Yogurt is not a good source of folic acid. Fortifying yogurt with folic acid may or may not alter its characteristics. Objective was to elucidate the effect of folic acid on the texture of yogurt. Texture was studied using a Brookfield DV II + viscometer fitted with a T-C spindle which operated at 30 rpm. Folic acid was added at either of the two stages, during mix preparation or after culture addition. Folic acid was also added at either of the two levels, a quarter or half the recommended daily allowance of 300 micrograms. Means were separated using the least significant difference test and the differences were determined at 5 percent level of significance. Addition of folic acid prior to heat treatment increased the viscosity significantly from 130.56 dyn.s/cm² in control to 140.73 dyn.s/cm². Doubling the concentration of folic acid significantly decreased the viscosity of yogurt from 128.39 dyn.s/cm² to 106.02 dyn.s/cm². Folic acid impacted the texture of yogurt.

Key Words: supplement, health

Forages and Pastures Silages, Small Grains, and Fertilization

1533 Effects of molasses-based preservative on fermentation and nutritive value of Albizia lebbeck silage. T. Clavero* and R. Razz, *La Universidad del Zulia.*

A trial was carried out in Venezuela in order to evaluate fermentation characteristics and silage quality of Albizia lebbeck with different levels of molasses. Chopped fresh plant materials of about 1 cm length were ensiled into a laboratory silo and stored at 25°C. Treatments were applied according to a 3x3 factorial arrangements in a completely randomized design. Factors studied were three rates of legumes: molasses, 1:2, 1:4, 1:8 (w/v) and three storage times (1, 2 and 3 months). After opening the silos, pH, total nitrogen content (TN), rumen soluble nitrogen (SN), NFAD, nitrogen fixed to the cell wall of the total nitrogen (NFND/NT) and in vitro DM digestibility (IVDMD) were determined. Addition of molasses significantly ($P < 0.01$) decreased pH values but increased NT. The lowest pH values (5.1) and the highest TN values (2.44) were obtained with the relation 1:8. No significant differences ($P > 0.05$) in SN, NFAD, NFND/NT and IVDMD were found between levels of

molasses. The time of storage significantly affected ($P < 0.01$) the loss of TN, SN, NFAD and NFND/NT. IVDMD was reduced significantly by the ensiling process, from 71.76% after 1 month to 70.1 after 3 months of ensiling. This study concluded that Albizia lebbeck fodder can be preserved successfully by ensiling with the addition of molasses.

Key Words: Albizia lebbeck, Silage quality, Molasses

1534 Effects of molasses-formic acid silage preservatives on fermentation of Leucaena leucocephala silage. M. Betancourt*¹, T. Clavero², R. Razz², S. Pietrosemoli², and O. Araujo², ¹INIA, ²La Universidad del Zulia.

A trial conducted at tropical very dry forest located in the western part of Venezuela in order to evaluate the effect of molasses, formic acid and fermentation time on the pH and temperature of microsilos of Leucaena leucocephala. A factorial arrangement (3x3x8) with two replications was used, three levels molasses (0, 2.5 and 5%, three levels of formic acid (0,

0.25 and 0.5%) and eight fermentation time (10, 21, 27, 34, 41, 48, 55 and 62 days). There were significant differences ($P < 0.05$) for the interaction molasses x fermentation time, acid x fermentation time and acid x molasses on pH and temperature. The lowest values of pH (4.3, 4.4 and 4.36) were observed with 5% of molasses and 27 days; 0.5% formic acid x 27 days and 2.5% molasses x 0.25% formic acid, respectively. The lowest values of temperature (26.27, 26.22 and 28C) were obtained with 0% molasses x 21 days; 0.5% acid x 21 days and 2.5% molasses x 0.5% formic acid. Addition of molasses and formic acid were positive in all treatments. The temperature values showed in the microsilos were in an optimum range (20-30C). In all the treatments, pH values were consistent between 27 and 41 days. According to the results, it is concluded that *L. leucocephala* could be used in silage procedures with the use of conservants.

Key Words: *Leucaena leucocephala*, Silage

1535 The effects of height of cutting, hybrid, and stage of maturity at harvest on the nutritive value of corn silage for lactating dairy cows. J. M. Neylon^{*1}, T. L. Ebling¹, C. C. Taylor¹, M. P. Lynch¹, M. A. Reddish¹, M. I. Endres², and L. Kung, Jr.¹, ¹*University of Delaware, Newark, Delaware*, ²*Mycogen Seeds, Egan, MN*.

We studied the effect of increasing the cutting height of whole-plant corn at the time of harvest from 12.7 (NC) to 45.7 (HC) cm on yield and nutritive value of silage for dairy cows. Three leafy corn silage hybrids (TMF 100, 108, and 2404, Mycogen Seeds) were harvested at NC and HC at 1/2 millkline (E) and black layer (L) and ensiled in laboratory silos. Increasing the height of cutting lowered yields of harvested DM/ha by approximately 10%. The concentration of DM was higher (38.6 vs. 36.6%) and starch (34.4 vs. 32.4%) were higher ($P < 0.05$) but the concentrations of CP (8.29 vs. 8.43%), and ADF (23.4 vs. 25.3%) were lower ($P < 0.05$) in HC than in NC. The concentrations of NDF and lactic acid tended to be lower ($P < 0.10$) in the HC (41.3 and 4.23%) than the NC (42.9 and 4.41%), respectively. The concentration of acid detergent lignin was also lower ($P < 0.05$) in HC (2.42 vs. 3.27%), but only in corn harvested at E. In vitro digestion (30 h) of NDF was greater ($P < 0.05$) in HC (50.7%) than NC (48.3%). Calculated yield of milk per tonne of forage DM was greater for HC than for NC at E but not at L. Increasing the height of cutting of another leafy corn silage hybrid, TMF 29400, in general also resulted in similar changes in nutrient composition as just described. When fed to lactating dairy cows, HC corn silage resulted in tendencies ($P < 0.12$) for greater NDF digestion in the total tract (34.3 vs. 31.8%), higher milk production (+1.5 kg/d) and improved feed efficiency. Results from this study suggest that increasing the cutting height of whole plant corn at harvest can improve nutritive value of corn silage for lactating dairy cows.

Key Words: Cut Height, Corn Silage

1536 Comparison of physical and chemical characteristics of mechanically processed brown midrib, unprocessed brown midrib, or processed normal corn silage. T. L. Ebling^{*}, J. M. Neylon, D. H. Kleinschmit, J. M. Ladd, C. C. Taylor, and L. Kung, Jr., *University of Delaware, Newark, DE*.

We compared the physical and chemical compositions of processed brown midrib (PBMR), unprocessed brown midrib (UBMR) (Cargill 867, 118 d), and processed normal (P7511) (Cargill 7511FQ, 115 d) corn silage. All forages had a theoretical length cut of 19 mm and processed forage went through rollers with a clearance of 3 mm. Fresh forage was harvested at 1/2 millkline and ensiled in bag silos for 7 mo. Silage composites were collected three times per wk during a 5-wk period in a lactation trial (companion abstract). During the collection period, P7511 silage had a lower concentration of CP (6.19 vs. 8.21, 8.37%) compared to PBMR and UBMR. The concentration of NDF (41.5%) and ADF (24.2%) were similar for all silages. However, lignin was higher for P7511 (2.24 vs. 1.03, 0.87%) than PBMR and UBMR. Thirty hour in vitro NDF digestion was higher for the UBMR and PBMR than P7511 silage (54.0, 51.0 vs. 39.9%). The UBMR had more particles >1.91 cm than PBMR and P7511 (13.7 vs. 8.1, 3.28%) and more whole kernels (39.4 vs. 6.8, 8.6). Dry matter disappearance after 3 h of a macro in situ incubation was greater for the PBMR and P7511 silage than the UBMR (45.6, 46.0 vs. 40.8%). After 12 h, PBMR and P7511 had a greater DM disappearance than UBMR (52.8, 52.7 vs. 47.5%). By 30 h, DM disappearance was similar for all silages (65.2%). These data

showed that mechanical processing decreased particle size and whole kernels and increased DM digestion in normal and brown midrib corn silages.

Key Words: Processed, Brown midrib, Silage

1537 Effect of feeding mechanically processed brown midrib (PBMR), unprocessed brown midrib (UBMR), or processed normal corn silage (P7511) in diets for dairy cows on DM intake, milk production and digestion. T. L. Ebling^{*}, J. M. Neylon, D. H. Kleinschmit, J. M. Ladd, C. C. Taylor, and L. Kung, Jr., *University of Delaware, Newark, DE*.

Thirty Holstein cows producing 46 kg of milk/d (143 ± 32 DIM) were blocked and assigned randomly to one of three treatments to investigate the effects of feeding PBMR, UBMR, or P7511 corn silage on DM intake, milk production, and digestion. All forage had a theoretical length cut of 19 mm and processed forage passed through a roller width of 3 mm. Fresh forage was harvested at 1/2 millkline and ensiled in bag silos for 7 mo. Diets were fed as TMR and consisted of 42% PBMR, UBMR, or P7511 corn silage, 10% alfalfa silage, 8% chopped alfalfa hay, and 40% (DMB) concentrate. The first wk of the 6-wk study was a preliminary period where cows were offered a combination of the corn silages. Data collected during this period were used as covariate in statistical analysis of production data collected during wk 2 to 6. Cows fed a TMR with P7511 produced more ($P < 0.05$) milk protein content (%) than cows fed PBMR and UBMR. However, cows fed PBMR had a higher ($P < 0.05$) milk fat yield (1.48 vs. 1.31, 1.25 kg/d) and produced more 3.5 % fat corrected milk (43.3 vs. 40.3, 39.3 kg/d) than P7511 and UBMR. Dry matter intake (24.0 kg/d) and milk yield (44.2 kg/d) were similar among treatments. Cows fed the processed corn silages had greater ($P < 0.05$) total tract digestibility of OM (65.1 vs. 56.5%), CP (65.0 vs. 58.2%), and starch (98.9 vs. 88.5%) compared to UBMR. Total tract digestibility of ADF and NDF was greater ($P < 0.05$) for PBMR (39.6%, 42.1%) than P7511 and UBMR (32.8, 32.1%; 34.1, 30.0%). Cows fed the TMR containing unprocessed corn silages had more particles >1.91 cm remaining in the bunk after a 24-h period than cows fed processed corn silage. These data show that processing results in corn silage with fewer large particles and whole kernels, improves total tract digestibility, and reduces sorting when fed to dairy cows. Mechanical processing can improve the nutritive composition of brown midrib corn silage.

Key Words: Processed, Brown midrib, Silage

1538 The effect of adding *Lactobacillus buchneri* 40788 (LB), enzymes (ENZ), or ENZ and LB on the fermentation and aerobic stability of high moisture corn in lab silos. T. L. Ebling^{*}, J. M. Neylon, C. C. Taylor, M. A. Reddish, M. P. Lynch, and L. Kung, Jr., *University of Delaware, Newark, DE*.

We investigated the effects of adding a heterofermentative lactobacilli, *L. buchneri* 40788, alone or in combination with enzymes on the fermentation and aerobic stability of high moisture corn (HMC). High moisture corn (29% moisture) was ensiled in laboratory silos (27 x 36 cm) at a wet packing density of approximately 806 kg/m³. Treatments were applied by liquid application. Treatments were: 1) no additive (C), 2) ENZ (β -glucanase [5250 IU/g], α -amylase [2625 IU/g], xylanase [2850 IU/g], galactomannase [480 IU/g]), 3) LB to achieve 1×10^6 cfu/g, and 4) LB + ENZ (Biotol, Inc., Eden Prairie, MN). After 90 d of ensiling, HMC treated with LB (treatments 3 and 4) had the greatest ($P < 0.05$) concentrations of acetic acid (0.70 vs. 0.28%, DM basis), but highest ($P < 0.05$) pH (4.24 vs. 4.02) when compared to other treatments. The concentration of lactic acid was also numerically lowest in HMC treated with LB (0.56 vs. 0.77%, DM basis). Aerobic stability (number of h prior to a 2°C rise in temperature after exposure to air) was markedly ($P < 0.05$) improved with the addition of LB (> 210 h) in comparison to other treatments (< 50 h). Treatment with LB alone or in combination with ENZ had no effects on the concentrations of ADF, NDF, or CP. Addition of ENZ alone had no effect on the fermentation or aerobic stability of HMC. *Lactobacillus buchneri* 40788 is an effective biological control agent that anaerobically converts lactic acid to acetic acid and improves the aerobic stability of HMC, but combining it with enzymes did not enhance its effectiveness.

Key Words: *Lactobacillus buchneri*, Aerobic stability, High moisture corn

1539 Effect of fresh and ensiled alfalfa and red clover on the microbial protein synthesis in the rumen of sheep. J.M.J. Gosselink* and C. Poncet, *Institut National de la Recherche Agronomique, Theix, France.*

Six wethers of approximately 55 kg BW were fitted with ruminal and duodenal cannulas to study the effect of alfalfa and red clover (fresh vs ensiled) on the microbial protein (MP) synthesis in the rumen. In four periods the animals received in sequence fresh alfalfa (AF), alfalfa silage (AS), fresh red clover (RCF) or red clover silage (RCS) at sub ad libitum level. The forages were cut at the button stage and either fed directly or ensiled with formic acid (80 %). Three markers, Cr-EDTA (Cr), Ru-phenanthroline (Ru) and ¹⁵N, were continuously infused intraruminally to measure the digesta flow (Cr and Ru) and MP (¹⁵N) in the duodenum. After the infusing was stopped the passage rates (Kp) of Cr and Ru in the rumen were measured. OM apparently digested in the rumen (OMADR) differed between the forage species and between fresh and ensiled. The efficiency of MP synthesis (MP/OMADR) was the highest for AF. However the yield of MP per kg of DMI was similar between AF and RCF and was similar between AS and RCS. Kp of Cr and Ru were higher when feeding AF and lower when feeding RCS compared with other forages. The results imply that in comparison with RCF and RCS, the MP synthesis in the rumen with AF and AS was more affected by their passage rates and less affected by their ruminal OM digestion.

	AF	AS	RCF	RCS
NDF, % of DM	49.8	43.8	41.2	51.0
CP, % of DM	19.8	16.6	16.8	16.6
OMADR, % of OM intake	32.9 ^a	41.0 ^b	51.8 ^c	45.8 ^d
MP, g/kg of OMA	432 ^a	265 ^b	266 ^b	228 ^b
MP, g/kg of DMI	124 ^a	98 ^b	123 ^a	94 ^b
Kp of Ru, %/h	8.6 ^a	6.8 ^b	6.3 ^b	4.6 ^c
Kp of Cr, %/h	12.0 ^a	9.6 ^b	8.8 ^b	7.2 ^c

^{a,b,c,d} Means with different superscripts within the same row are significantly different (*P* < 0.05).

Key Words: Microbial Protein, Alfalfa, Red Clover

1540 Influence of glyphosate tolerant (trait NK603) corn silage and grain on feed consumption and milk production in Holstein dairy cattle. R.J. Grant¹, D. Kleinschmit¹, A.L. Sparks^{*1}, E.P. Stanisiewski², and G.F. Hartnell², ¹University of Nebraska, Lincoln, ²Monsanto Company, St. Louis, MO.

The objective of this experiment was to evaluate the effect of a glyphosate tolerant (trait NK603) corn hybrid on feed intake and milk production of dairy cows compared with the non-transgenic hybrid and two reference hybrids. Sixteen multiparous Holstein dairy cows (95 DIM) were assigned to one of four treatments in a replicated 4 x 4 Latin square with 28-d periods (14 d adaptation and 14 d collection). The diets contained 40% (DM basis) of either glyphosate tolerant corn silage (Roundup Ready[®]; RR), control corn silage (CON), or two non-transgenic reference hybrids which are commercially available (REF1 and REF2). Each diet also contained 23% corn grain (DM basis) from the same hybrid that supplied the silage. Hybrids were harvested for silage at the same physiological maturity, and chemical composition was similar among the four hybrids, except for DM. The RR silage was harvested last, and rapid drying conditions resulted in the RR silage being drier (average 42.5% DM) and undergoing a less extensive fermentation than the CON, REF1, and REF2 silages (average 35.5% DM). Consequently, DMI and milk production were reduced (*P* < 0.05) by 14 and 12%, respectively, for cows fed the RR diet compared with the other diets. However, there was no effect of the RR diet on efficiency of 4% FCM production (FCM/DMI) which averaged 1.43 kg/kg for all diets. The content of fat (3.91%), true protein (3.07%), lactose (4.66%), SNF (8.61%), SCC (114.8/ml), and milk urea nitrogen (20.8 mg/dl) was not influenced by diet. Under the conditions of this experiment, the RR diet resulted in similar milk composition and efficiency of FCM production compared with the non-transgenic control and two commercial corn hybrids.

Key Words: Glyphosate tolerant, Corn silage, Dairy cows

1541 Effect of feeding brown midrib-3 corn silage or conventional corn silage cut at either 23 or 71 cm on milk yield and milk composition. D.D. Dominguez^{*2}, V.R. Moreira², and L.D. Satter^{1,2}, ¹U.S. Dairy Forage Research Center, USDA-ARS,, ²Dairy Science Department, University of Wisconsin, Madison.

The objective was to measure milk yield when brown midrib-3 corn silage (bm3) cut at 23 cm or conventional corn silage cut at either 23 or 71 cm was fed to lactating dairy cows. Thirty lactating Holstein cows averaging 113 DIM (±27) and 37.3 kg milk daily (±4.7) were randomly assigned to one of six trts in a 6x6 Latin Square design. Trts were two levels of dietary NDF (low-27.6 to 29.2% and high-32 to 33.5%), and three corn silage sources: bm3 (bag silo), normal cut (23 cm, NC) and high cut (71 cm, HC), both ensiled in tower silos. The bm3 corn silage was Cargill 657, and NC and HC were Dekalb 520 RR. The corn silage sources were chopped at 0.95 cm theoretical length of cut. Diets with low NDF had 60.5, 63.5 and 62% of forage for NC, HC and bm3 and diets with high NDF had 77, 80.5 and 75.5%. Corn silage supplied 67% of forage DM. The length of each of four experimental periods was three wk. Statistical analysis was done as an unbalanced and incomplete 6x4 Latin square in SAS. HC corn silage had higher DM content than NC corn silage (40.9 vs 38.4%), while NDF content was decreased (33.9 and 38.6%). DMI was increased for bm3 trts (2.9 kg/d). Milk yield tended to be higher for bm3 (1.1 kg/d) and was higher for the low NDF trts. HC and NC trts supported the same milk yield. Fat percentage was decreased by low NDF trts. Feed efficiency was higher for the low NDF trts, and was reduced with the bm3 trts.

	Low NDF%			High NDF%			<i>P</i> value		
	28.8 NC	27.6 HC	29.2 Bm3	33.5 NC	32.0 HC	33.0 Bm3	Bm3 vs NC	Bm3 vs HC	HC vs NC
DMI (kg/d)	19.8 ^a	20.3 ^a	22.6 ^b	19.7 ^a	20.2 ^a	23.2 ^b	.64	≤.001	≤.001
Milk Yield (kg/d)	34.1 ^a	34.4 ^a	35.0 ^a	30.9 ^b	31.5 ^b	32.6 ^b	≤.001	.26	.09
3.5% FMC	34.6 ^a	34.8 ^a	35.3 ^a	32.4 ^b	32.5 ^b	33.7 ^a	.003	.32	.22
Fat (%)	3.61 ^a	3.60 ^a	3.57 ^a	3.81 ^b	3.69 ^b	3.73 ^b	.04	.96	.55
Fat (kg)	1.22 ^a	1.23 ^a	1.24 ^a	1.17 ^a	1.15 ^b	1.21 ^a	.07	.36	.41
Protein (%)	3.05 ^a	3.07 ^a	3.06 ^a	3.01 ^a	3.00 ^a	3.00 ^a	.04	.79	.97
Protein (kg)	1.02 ^a	1.06 ^a	1.07 ^a	0.93 ^b	0.94 ^b	0.97 ^b	≤.001	.46	.06
SNF (%)	8.67 ^a	8.83 ^a	8.79 ^a	8.73 ^a	8.77 ^a	8.70 ^a	.56	.53	.71
SNF (kg)	2.93 ^a	2.96 ^a	3.10 ^a	2.65 ^b	2.63 ^b	2.86 ^c	≤.001	.04	.03

Means in rows with different superscripts are different (*P* ≤ .05)

Key Words: Corn silage, Brown midrib-3, Milk production

1542 Characteristics of silage prepared from alfalfa, sainfoin, and alfalfa:sainfoin mixtures. Y. Wang*, L.R. Barbieri, and T.A. McAllister, *Agriculture and Agri-Food Canada, Lethbridge, AB.*

To investigate the effects of including a forage containing condensed tannins on ensiling characteristics of alfalfa, whole first cut alfalfa (A) and sainfoin (S) were ensiled in ratios (% fresh weight) of 100:0, 75:25, 50:50, 25:75 and 0:100. The forages were swathed in mid-bloom, wilted for 2-4 h, chopped to a theoretical length of 1.0 cm, mixed manually (blends denoted A, A75, A50, A25 and S) and packed into 3-L laboratory-scale silos. Silage pH and concentrations of reducing sugars (RS), ammonia, soluble N, NPN and VFA, and microbial enumerations (d 20 only) were determined in triplicate silos opened after 1, 7, 20 and 72 d of storage at 22°C. The pH of all ensiled forages decreased rapidly in the first 7 d; all were below 4.5 at d 72. Over the 72 d, pH was consistently higher (*P* < 0.001) in A than in S, and the mixed silage pH values were intermediate to A and S, in the order A75 > A50 > A25. Concentrations of acetic acid and total VFA were consistently higher (*P* < 0.05) in A than in S, and a quadratic effect (*P* < 0.05) of sainfoin in the mixture was observed at d 72. At d 20, populations of lactobacilli were lower (*P* < 0.05) in silage S than in A or the blends, but there was no difference (*P* > 0.05) among A-S mixed silages. Total bacterial populations decreased linearly (*P* < 0.05) as the proportion of sainfoin increased; the differences attained significance with sainfoin at 75% (*P* < 0.05) and 100% (*P* < 0.01). Soluble N, NPN and ammonia N (as % of total N) also decreased

linearly ($P < 0.01$) as sainfoin increased, but the proportion of insoluble digestible N increased ($P < 0.01$) with sainfoin content during 72 d of ensiling. In all silages, N transformations occurred primarily during the first 7 d of ensiling. Over the first 20 d, rates of N transformation were lower ($P < 0.05$) in A25, A50, A75 and S than in A. Including sainfoin with alfalfa increased forage fermentability and reduced proteolysis during ensiling, and may be a practical means to preserve alfalfa protein during ensiling.

Key Words: Sainfoin, Alfalfa, N Transformation

1543 The effect of Tween 80 on kinetics of *in vitro* ruminal fermentation of silages. J. Baah^{*1}, J.A. Shelford², Y. Wang¹, T.A. McAllister¹, and K.-J. Cheng³, ¹*Agriculture and Agri-Food Canada, Lethbridge, AB*, ²*University of British Columbia, Vancouver*, ³*Academia Sinica, Taipei, Taiwan*.

Tween 80 (T80) has been shown to improve enzyme production and digestion of pure cellulose by mixed ruminal bacteria. This study was undertaken to examine the effects of T80 on *in vitro* fermentation of three cellulosic substrates: silages prepared from alfalfa (AS), corn (CS) and orchardgrass (OS). Each substrate (150 mg) was incubated for 24 h at 39°C with 15 mL of buffered ruminal fluid and 0 or 0.2% (w/w) T80. Three incubations, each in triplicate, were conducted. Gas production (GP) was measured at 10-min intervals via pressure transducers implanted in the flasks, and VFA profiles at 24 h were determined by gas chromatography. Effects of T80 on *in vitro* fermentations were substrate specific. With AS, T80 decreased ($P < 0.05$) the lag in GP (from 0.48 to 0.16 h) and specific rate of GP (to 0.058/h from 0.067/h), and increased ($P < 0.05$) the extent of GP (19.5 vs 18.1 mL/100 mg DM). With CS, T80 increased ($P < 0.05$) the lag and the specific rate of GP (from 0.77 h and 0.046/h to 0.88 h and 0.049/h, respectively), and decreased ($P < 0.05$) the extent of GP (25.9 vs 26.6 mL/100 mg). With OS, lag in GP was decreased by T80 (0.41 h vs 0.65 h; $P < 0.05$), specific rate of GP was increased (0.073 vs 0.070/h; $P < 0.05$), and extent of GP was decreased (13.8 vs 14.6 mL/100 mg; $P < 0.05$). Concentrations of total VFA at 24 h were increased ($P < 0.05$) by T80 in incubations of CS (by 17%) and OS (by 22%), but were reduced in AS incubations (by 10%, $P < 0.05$). Tween 80 reduced ($P < 0.05$) molar proportions of acetate and increased (by 150%; $P < 0.05$) isobutyrate and isovalerate in AS incubations; with OS, accumulation of these branched-chain FA was decreased ($P < 0.05$). These data suggest that T80 may be exerting its effects on specific microbial populations or enzymes; the overall substrate-specific effects on *in vitro* fermentation kinetics and products may be reflecting diet-specific rumen microbial species profiles.

Key Words: Tween 80, Silage, Ruminal Fermentation

1544 Performance of dairy cattle fed high moisture shelled corn inoculated with *Lactobacillus buchneri*. C. Kendall, D. K. Combs^{*}, and P. C. Hoffman, *University of Wisconsin, Madison*.

The objective of this study was to determine if intake and milk production of dairy cows is affected by inoculation of high moisture shelled corn (HMSC) with *Lactobacillus Buchneri* (LB). Twenty lactating cows were fed total mixed rations (TMR) containing one of four sources of HMSC : 1) untreated HMSC removed from a silo immediately before feeding, (FC); 2) LB inoculated HMSC (5×10^5 CFU/g fresh corn) removed from a silo immediately before feeding, (FLBC); 3) untreated HMSC that was stored in a feed cart at ambient temperature for 48 h before feeding (TC); 4) LB inoculated HMSC that was stored in a feed cart at ambient temperature for 48 h before feeding (TLBC). Cows were randomly assigned to one of five 4 x 4 Latin squares. All cows were fed diets that contained 29% of DM as HMSC from one of the four treatments. Lactate levels in FC, FLBC were similar. Lactate levels of untreated HMSC declined when exposed to air but did not change in LB-inoculated HMSC. Acetate concentrations in FC and TC were lower than in FLBC and TLBC. Intake of TMR DM was not affected by either LB or exposure to air. Milk yield did not differ due to LB inoculation but was depressed when either corn was removed from the silo and stored for 48h. Although inoculation of HMSC with LB improved its aerobic stability, milk production was depressed when cows were fed TMR's containing either source of HMSC that had been exposed to air for 48h prior to feeding.

	FC	FLBC	TC	TLBC	SE	C vs LB ^a	F vs T ^b
Composition of HMSC							
pH	4.8	4.6	6.4	4.7	0.2	NS	P<0.01
Lactate, % DM	0.46	0.37	0.14	0.34	0.08	NS	P<0.05
Acetate, % DM	0.05	0.42	<0.01	0.11	0.06	P<0.01	P<0.05
Animal performance							
DMI, kg/d	19.6	19.8	19.3	19.7	0.31	NS	NS
Milk yield, kg/d	31.7	32.2	30.9	30.8	0.9	NS	P<0.05

^a Untreated corn vs LB-inoculated corn. ^b Corn as it was removed from the silo vs corn that was fed 48 h after it was removed from the silo.

Key Words: High moisture corn, *Lactobacillus buchneri*, Dairy

1545 Evaluation of small grain cultivars for forage in north Alabama. M. Lema^{*}, E. Cebert, and V. Sapra, *Alabama A & M University*.

Small grains can play an important role as emergency feed source for livestock in the fall and winter in North Alabama. Data regarding the comparative forage yield and quality of triticale (*X Triticosecale Wittmack*), wheat (*Triticum aestivum* L.) and rye (*Secale cereale* L.) cultivars for forage in North Alabama is scarce. Six triticale cultivars (TCL-105, TCL-111, TX-98D955, TX-96VT5019, Tritical 498 and Tritical 2700), two cultivars of each of wheat (Madison and Roberts) and rye (Maton and Oklon) were planted in four replicated 6-row plots 6.1 m long with rows 1.22 m apart in a randomized complete block design. Forage was harvested and dry matter (DM), crude protein (CP), extract (EE), gross energy (GE), acid-detergent fiber (ADF), neutral-detergent fiber (NDF), in-vitro dry matter digestibility (IVDMD), P, K, Ca, Mg, S, Na, Fe, Mn, Zn and Cu were determined. Dry matter and digestible DM (DDM) production of the rye cultivars Maton (4,112.2 and 3,915.74) and Oklon (3,321.22 and 3,134.56 kg/ha, respectively) were higher ($P < 0.05$) than that of the other wheat and triticale cultivars. TCL105 and TCL111 produced the lowest ($P < 0.05$) DM (1,541.61 and 1,526.57) and DDM (1,261.01 and 1,205.17 kg/ha, respectively). TCL105 had the lowest ($P < 0.05$) CP (17.45 %) and TCL111 the highest ($P < 0.05$) ADF (39.16 %) content than the other small grain cultivars. Maton (81.1 %), Oklon (80.0%), TCL2700 (80.39 %), TCL498 (79.01 %), TX96VT5019 (81.07 %) and TX98D955 (81.24 %) had similar but higher ($P < 0.05$) IVDMD than TCL105 (76.19 %), TCL111 (76.52 %), Jackson (78.45 %) and Roberts (78.67 %). Similarly, significant differences were observed in P, Ca, Mg, K, S, Zn, Cu, and Fe contents among cultivars. Among small grain species, rye was higher ($P < 0.05$) in DM (4,007.84 kg/ha) and DDM (3,222.19 kg/ha) than triticale (2,268.99 and 1,846.69) and wheat (2,174.76 and 1,703.14 kg/ha, respectively). Significant differences ($P < 0.05$) were also observed among rye, triticale and wheat in P, Mg, K, S, Fe, and Cu contents.

Key words: Small grain forage, forage quality.

Key Words: Small grain forage, Forage yield, Forage quality

1546 Assessment of ruminal N disappearance kinetics for wheat forage as affected by harvest technique and sampling date. W. K. Coblenz^{*}, K. P. Coffey, J. E. Turner, D. A. Scarbrough, J. B. Humphry, J. V. Skinner, and D. W. Kellogg, *University of Arkansas*.

A trial was initiated in September of 1999 to assess the effects of harvest techniques and sampling dates on ruminal N disappearance kinetics and forage quality of wheat forage. #Delta King 9027' soft-red winter wheat was established at the Forage Research Area in Fayetteville. Wheat forage was grazed lightly throughout the fall to control growth. Forages were harvested on three dates in the spring, which corresponded to vegetative, mid-elongation, and boot stages of growth (6 March, 27 March, and 11 April, respectively). Sampling techniques evaluated on each date included three clipping techniques (whole plant, random pluck, and top half) and two evaluations of masticates (oven or freeze dried). Concentrations of total N, neutral detergent insoluble N (NDIN), and acid detergent insoluble N (ADIN) were affected by sampling technique, harvest date, and the associated interaction of these main effects ($P < 0.017$). Oven-dried masticate had greater ($P < 0.05$) concentrations of NDIN

than did freeze-dried masticate on all harvest dates. For ADIN, a similar relationship ($P < 0.05$) was observed for the 27 March and 11 April harvest dates, but not for 6 March ($P > 0.05$). When these wheat forages were evaluated by the situ technique in five confined steers (393 ± 54 kg), sampling technique, harvest date, and their associated interaction all affected ($P < 0.001$) disappearance rate, potential extent, and effective ruminal degradability of N. For each harvest date, disappearance rate was greater (by 56 to 104%; $P < 0.05$) for freeze-dried masticate than for oven-dried masticate. Similar ($P > 0.05$) estimates of disappearance rate and effective degradability were observed for freeze-dried masticate and the top-half clipping treatment on the first two harvest dates, but not ($P < 0.05$) on the final harvest date. The other clipping treatments were not effective in mimicking the diet selected by steers. Oven-drying masticate samples greatly affected characteristics of ruminal N disappearance relative to those that were freeze dried.

Key Words: wheat forage, N disappearance kinetics, forage quality

1547 Effects of sampling date and nitrogen fertilization on forage yield, quality and tetany hazard of soft red winter wheat. C. R. Bailey*, W. K. Coblenz, L. B. Daniels, E. B. Kegley, T. J. Wistuba, and L. J. McBeth, *Department of Animal Science, University of Arkansas, Fayetteville.*

A study was conducted from December 1999 through March 2000 using a completely randomized design to evaluate forage yield, quality, and tetany hazard in soft red winter wheat (*Triticum aestivum* L.) forage as influenced by nitrogen (N) fertilization rate and sampling date. Paddocks were randomly assigned to a control (0 kg N ha^{-1}), or one of two rates of ammonium nitrate fertilization ($34\text{-}0\text{-}0$) to supply 38 kg N ha^{-1} (Low), or 76 kg N ha^{-1} (High). Forage yield and IVOMD as well as DM, OM, ADF, NDF, CP, Mg, K, and Ca concentrations were evaluated. Forage yield was determined by clipping three 0.25-m^2 quadrats per $30.5 \times 3.1\text{-m}$ paddock. Nitrogen fertilization had no effect on forage yield, OM, ADF, NDF, IVOMD, Ca, or Mg. Forage dry matter ($P < 0.01$) concentrations decreased while CP ($P < 0.01$) and K ($P < 0.01$) increased linearly with increasing levels of N fertilization. Organic matter increased ($P < 0.05$) linearly with sampling date. Dry matter yield, NDF, and ADF increased ($P < 0.01$), while CP decreased ($P < 0.01$) quadratically with sampling date. Magnesium ($P < 0.05$), K ($P < 0.01$), Ca ($P < 0.01$), and IVOMD ($P < 0.01$) decreased in a cubic manner in respect to sampling date. Dry matter concentration reacted quadratically ($P < 0.01$) to sampling date peaking in February and declining through the end of March. Results indicate caution should be taken when grazing lactating cows on soft red winter wheat forage in the early spring as Mg and Ca concentrations fall below required levels and DM decreases. Nitrogen fertilization of soft red winter wheat increases tetany hazard as it increases CP and K and causes a decrease in DM concentrations. Although forage quality decreased in respect to calendar date, nutritive value of soft red winter wheat forage remains acceptable through the end of March if supplementary minerals are provided.

Key Words: Forage Quality, Nitrogen Fertilization, Sampling Date

1548 Effect of soil type and fertilization level on mineral concentration of pasture: relationship to ruminant performance and health. K.J. Soder*, W.L. Stout, W.J. Gburek, and G.J. Folmar, *USDA-ARS, Pasture Systems and Watershed Management Research Unit, University Park, PA.*

A study was conducted to measure the effects of varying levels of dairy slurry application on mineral content of forages from three soils types. Slurry was applied to orchardgrass (*<i>Dactylis glomerata </i>* L., cv. Pennlate) using 60 cm diameter drainage lysimeters to measure the direct impact of four levels of slurry (urine and feces) N application (0 , 168 , 336 , 672 kg N/ha/yr) on mineral content of the forage on three soil types (Hagerstown, Hartleton, and Rayne soil types). The results were then related to potential impacts on performance and health of grazing dairy cows. Forage P was not affected by slurry application (mean = 0.46% DM). Forage grown on the Hartleton soil had the highest P content (0.6% DM). Forage K increased with increased slurry (2.50 , 2.85 , 3.22 , and 3.45% DM, respectively), and was lowest for forage grown on the Rayne soil (2.69% DM). Forage Ca decreased with increased slurry (0.59 , 0.56 , 0.50 , and 0.49% DM, respectively) and was not affected by soil type. Forage Mg also decreased with increased slurry (0.25 , 0.24 , 0.24 , and 0.23% DM, respectively), and was highest for the Hartleton soil (0.27% DM). The variable results in mineral content associated with

soil type may have, in part, been due to prior soil fertility. The P and Mg levels in all treatments were generally adequate for grazing dairy cows. The K levels were high in relation to NRC recommendations for prepartum dairy cows, which may predispose them to milk fever. The Ca levels were inadequate for lactating dairy cows. Comprehensive forage testing and ration balancing based on individual farm situations is the best strategy to ensure proper mineral nutrition of grazing animals.

Key Words: animal health, pasture, slurry fertilization

1549 Forage macro- and trace mineral concentrations from pastures fertilized with broiler litter. K. P. Coffey*, J. B. Humphry¹, T. J. Sauer², H. L. Goodwin¹, P. A. Moore, Jr.³, Z. B. Johnson¹, E. B. Kegley¹, L. J. McBeth¹, B. C. McGinley¹, and W. K. Coblenz¹, ¹University of Arkansas, Fayetteville, AR, ²USDA National Soil Tilth Lab, Ames, IA, ³USDA-ARS, Fayetteville, AR.

Repetitive application of broiler litter to pastures leads to accumulation of various nutrients in the soil that can be potentially taken up by forages. Four farms in NW Arkansas and NE Oklahoma that routinely applied broiler litter were monitored for nutrient cycling from April 2000 to February 2001 under a project supported by USDA/NRICGP Agricultural Systems Program grant number 99-35314-8655. The four farms had a forage base of bermudagrass and cool-season perennials or annuals, and initial soil test P (STP; Mehlich 3 extract) levels of 230, 282, 526, or 636 kg/ha . Random forage samples were gathered monthly during normal grazing periods and analyzed for macro- and trace elements, but were not gathered when pastures were being stockpiled for hay. Mineral concentrations within farm were averaged across sampling dates and compared with requirements for gestating and early lactating beef cattle using a t-test. The equivalent ratio of K to Ca plus Mg was calculated to indicate the potential for grass tetany. Mean forage Ca, P, S, Co, and Fe from each farm exceeded ($P < 0.05$) lactating cow requirements. Forage Mg from the farm with the highest STP exceeded ($P < 0.05$) Mg requirements for lactating cows, but the other three farms exceeded ($P < 0.05$) only Mg requirements for gestating cows. Only the two farms with the lowest STP levels had average grass tetany ratios below ($P < 0.05$) 2.2, but every farm had grass tetany ratios above 2.2 when sampled in the spring. The farm with the lowest STP had inadequate ($P < 0.05$) forage Cu, but forage Se and Zn did not differ ($P < 0.05$) from NRC requirements. The farms with the two highest STP levels exceeded ($P < 0.05$) Se requirements and farms with the three highest STP levels exceeded Zn requirements. Therefore, producers grazing broiler litter amended sites should be able to reduce Ca and P supplementation, but should provide adequate supplemental Mg in the spring.

Key Words: Manure Management, Phosphorus, Forage

1550 Chemical characterization and ruminal nutrient degradabilities of spineless cacti. A. Batista¹, A. Mustafa², and I. Adeleye*, ¹Bolsista da coordenacao de Aperfeicoamento de Pessoal de Nivel Superior, Brasilia, DF-Brazil, ²McGill University.

This study determined the chemical composition and in situ ruminal nutrient degradabilities of three cactus varieties grown in northeastern Brazil. These were Gigante, IPA-20 and Mida. Results of the chemical analysis showed no significant differences in ash (average 16.8%), ether extract (average 2.0%), CP (average 6.3%) and NDF (average 27.8%) between the three cactus varieties. However, ADF was highest for IPA-20 (19.4%), intermediate for Gigante, (17.6%) and lowest for Mida (16.5%). Fractionation of carbohydrate and true protein based on rates of ruminal degradation indicated that the main carbohydrate component was the rapidly degradable fraction while the main true protein component was the intermediately degradable fraction. No differences in these carbohydrate or protein fractions were observed between the cactus varieties. Results of the in situ experiment showed small differences in ruminal nutrient kinetic parameters between the three cactus varieties. The average effective ruminal degradability of DM, CP and NDF was 59.2, 59.9, and 39.5%, respectively. Our data indicate little or no differences in chemical composition or ruminal nutrient degradabilities between the three cactus varieties used in this study.

Key Words: Spineless cacti, Chemical characterization, Ruminal degradability

1551 Predicting the production of milk from forage on Quebec dairy farms using their ration characteristics. N. St-Pierre^{*1}, G. Allard¹, D. Lefebvre², A. Bregard¹, and D. Pellerin¹, ¹Université Laval, QC, Canada, ²PATLQ inc, Montréal, QC, Canada.

Chemical and physical characteristics of dairy cow rations affect their production of milk from forage (MF). Our objective was to determine which chemical and physical characteristics could be used to predict MF on farms. Across Quebec, Canada, 90 farms were studied: 22 used corn silage and 68 did not. Forage and concentrate contents in CP, ADF, NDF, NEL and RDP were determined. Grain and silages were also screened to determine their particle size. Cows from all farms were pooled in groups of early (DIM < 90 d), mid (DIM from 90 to 200 d) and late (DIM > 200 d) lactation. In order to select the best characteristics for predicting MF, we used the SAS procedure PROC REG with a stepwise approach and a linear model, a significant entrance threshold of 0.25 and a significant stay threshold of 0.10. In the farm group not using corn silage, regression equations predicted 39, 38 and 32 % of the variation in MF between cows for early (EL), mid (ML) and late (LL) lactation cows, respectively. For EL and ML cows, MF was improved by a higher RDP content in concentrates and finer grain milling. A shorter particle size for silage decreased MF for EL cows, but increased it with LL cows. Forages with better quality as determined by CP and ADF contents increased MF production for all cows. In the farm group using corn silage, regression equations predicted 43, 52 and 51 % of the variation in MF between cows for EL, ML and LL cows, respectively. As without corn silage, all cows produced more MF with increasing RDP in concentrates. However neither grain milling nor forage particle size or forage quality affected MF. Our results suggest that MF can be predicted based on some specific characteristics of cow rations as long as the DIM for each cow and the availability of corn silage are known. For almost all cows, an increase in RDP content in the concentrates is associated with higher MF. This suggests that an appropriate choice of concentrate adapted to the forage served lead to higher MF.

Key Words: Milk From Forage, Forage Particle Size, Grain Milling

1552 Effects of Tasco (a kelp extract) and heat stress on metabolism of wether lambs. J. H. Fike^{*1}, K. E. Saker², N. G. Marriott³, S. F. O'Keefe³, D. L. Ward², J. P. Fontenot⁴, and H. P. Veit², ¹Crop and Soil Environmental Sciences, ²VA-MD Regional College of Veterinary Medicine, ³Food Science and Technology, ⁴Animal and Poultry Sciences, Virginia Tech.

Wether lambs (n = 27, average BW = 40 kg) were used to test response to forage treated with Tasco-Forage (an extract of the brown kelp *Ascophyllum nodosum*) prior to conserving, or to direct feeding of Tasco-EX. Hays made from endophyte-infested tall fescue-based pasture received 0 or 3 kg of Tasco/ha prior to harvest. Lambs, blocked by weight, were randomly allotted to one of three diets: 1) control hay, 2) treated hay, and 3) #1 + Tasco-EX fed at 1% of the diet. Hays were low in CP (< 7%) so all lambs were fed soybean meal (12% of the diet) and trace mineralized salt. Diets were fed at 1.5% BW to prevent refusals. Total collections (7 d) were made during periods without or with applied heat stress. After each period, rumen contents were obtained to determine pH, NH₃ and VFA. Lambs were sacrificed post-trial. A subset was used to evaluate sensory traits and muscle fatty acids. Lambs were in negative N balance during the study and Tasco treatments did not affect N metabolism. Fecal N tended (P < 0.10) to increase with short duration heat stress causing a concomitant decrease (P < 0.05) in apparent N digestibility (58.6 vs. 56.1%; SE = 0.7). Urinary N loss decreased (P < 0.0001) with heat stress (8.0 vs. 5.9 g/d; SE = 0.2), resulting in increased (P < 0.0001) N retention (21.8 vs. 4.5%; SE = 2.8). Apparent OM digestibility was not affected by heat stress but increased (P < 0.05) with Tasco-EX treatment. Tasco diets decreased (P < 0.05) ruminal butyrate. Heat stress increased (P < 0.05) acetate and total VFA and decreased (P < 0.01) ruminal pH. A tendency (P < 0.11) of increased 14:1ω5 and decreased (P < 0.05) 18:0 fatty acids in muscle were observed with Tasco diets. Muscle color and flavor was unaffected by any Tasco treatment. The data suggest Tasco may alter rumen function but has no effect on N metabolism or meat quality of sheep fed restricted, low-quality diets.

Key Words: Tasco, Heat stress, Fescue

1553 Validation of the GrassGro decision support tool: steer methane emissions and intakes. R.D.H. Cohen^{*1}, J.P. Stevens¹, A.D. Moore², M. Freer², and J.R. Donnelly², ¹Department of Animal Science, University of Saskatchewan, Canada, ²CSIRO Division of Plant Industry, Canberra, Australia.

Predicted methane emissions and dry matter intakes (DMI) of steers using the GrassGro decision support tool were compared with field data from an experiment at Brandon, Manitoba in which steers grazed alfalfa/grass pastures at 1.1 or 2.2 steers/ha in continuous and rotation systems 1992-1994. Observed methane in 1994 (271.4±43.1) did not differ from predicted data (276.8±11.4). Observed (13.8±0.8) and predicted (11.6±0.6) DMI differed (P=0.02), perhaps due to incomplete recovery of fecal marker. Experimental steers required 33 d in a feedlot to reach Canada grade A at 620 kg. GrassGro predicted that supplementing barley at pasture would increase (P=0.000) final liveweight from 504±39 to 615±11 kg and body condition score (BCS) from 3.2±0.3 to 4.6±0.1 (scale 1-5). Neither trait differed between years, stocking rate or grazing systems but barley intake differed (P=0.002) between years (5.27, 2.25, 4.10 kg/d). GrassGro indicated lower (P=0.02) methane emissions for steers at 2.2/ha (275.8±11.8 g/d) compared with 1.1/ha (286.1±7.3 g/d) but no difference between rotation (282.5±10.8 g/d) and continuous (279.5±11.2 g/d) grazing. Methane emissions per unit liveweight gain (LWG) did not differ between stocking rates or grazing systems but were reduced (P=0.000) for supplemented steers (287.8±6.5 vs 274.1±10.1 g/kg LWG). Total methane emissions were reduced (P=0.0001) for steers finished at pasture (38.7±7.3 vs 54.4±4.0 kg). Neither stocking rate nor grazing system affected total metabolizable energy intake (MEI) or MEI/kg LWG. However, mean MEI/kg LWG of steers finished at pasture (68.28±6.73 MJ) was less (P=0.000) than feedlot finished steers (169.58±8.84 MJ). Similarly, methane emissions/kg LWG were reduced for pasture finished steers (133±22 vs 199±20 g/kg LWG; P=0.000). Finishing at pasture is energetically efficient and environmentally friendly.

Key Words: Methane, Intake, Steers

1554 Influence of nitrogen fertilization rate on content and in situ solubility of selected macrominerals from common bermudagrass harvested on two dates. N. W. Galdamez^{*1}, K. P. Coffey¹, W. K. Coblenz¹, J. L. Gunsaulis², D. A. Scarbrough¹, J. E. Turner¹, E. B. Kegley¹, K. A. Teague², and M. B. Daniels³, ¹University of Arkansas, Fayetteville, AR, ²Cooperative Extension Service, Fayetteville, AR, ³Cooperative Extension Service, Little Rock, AR.

Forage mineral concentrations may vary across the growing season due to several factors such as forage species and fertilization levels. Common bermudagrass [*Cynodon dactylon* (L)] growing on a layer manure-amended site was fertilized with ammonium nitrate at four rates (0, 56, 112, and 168 kg N/ha) at approximately one month before a first and third harvest on May 30 and August 18, 2000 to evaluate forage concentration and ruminal release of Ca, P, Mg, and K. Ruminally cannulated crossbred steers (n=5; 421.5 kg BW) were used to evaluate these forages in situ in a randomized complete block design with a 2 x 4 (harvest x N fertilization rate) factorial arrangement. Forage P content decreased (P<0.01) with increasing N fertilization on August 18, while forage Mg increased (P<0.01) and forage Ca content tended (P=0.08) to increase with increasing N fertilization on both harvest dates. Approximately 99% of plant K was immediately soluble compared with approximately 82%, 72%, and 48% of Mg, P, and Ca, respectively. The potentially degradable fraction and effective degradability for Ca, P, Mg, and Ca were affected by the linear or quadratic interactions between N fertilization and harvest date. Effective P degradation on August 18 decreased quadratically (P<0.01) and effective Mg degradation increased linearly (P<0.01) on both dates with N fertilization rate. The potential extent of P, Mg, and K degradation was greater (P<0.05) on May 30 than August 18, but the mean values for each date were > 86%. Rate of Mg disappearance responded quadratically (P<0.01) to N fertilization rate and was greater (P < 0.05) on August 18 compared with May 30. Therefore, N fertilization rates affected the concentration and ruminal solubility of macrominerals from bermudagrass, and the potential extent of mineral degradation was greater than 83% in all instances.

Key Words: *Cynodon dactylon*, Minerals, In Situ Degradation

1555 Effect of poultry litter applied as fertilizer on forage mineral concentrations. E. B. Rayburn, W. L. Shockey*, D. A. Seymour, B. D. Smith, T. J. Basden, and J. D. Lozier, *West Virginia University, Morgantown, WV.*

Mineral supplementation of grazing livestock is not precise because most pastures are not tested for mineral content, livestock are not fed individually, pasture fertilizer application varies, and pasture forage species are not constant. To improve the mineral supplementation for grazing livestock, an experiment was conducted at 4 locations to determine the effects of fertilizer treatment on pasture mineral content. Pastures received no fertilizer, commercial fertilizer applied at WV Soil Testing Laboratory recommendations, 4,480 kg poultry litter/ha, or 8,960 kg poultry litter/ha. Poultry litter increased ($P<.05$) P and K in grasses, legumes and broadleaf weeds; Ca and S in legumes; and Mo in grasses and legumes. Results suggest that phosphorus supplementation of cattle consuming forages fertilized with poultry litter could be reduced, but not eliminated. Copper concentration of forages fertilized with poultry litter did not increase ($P>.05$), even though poultry litter contained higher levels of Cu than standard commercial fertilizer. Increased concentrations of S and Mo indicate that Cu supplementation may be important for cattle that consume forage fertilized with poultry litter. Results show that poultry litter did not adversely affect forage mineral concentrations for grazing livestock and that mineral supplementation is a vital component of a pasture-based livestock production system.

Key Words: Pasture, Minerals, Livestock

1556 Forage pasture species selection and nitrogen fertilization rates. G. Cuomo, D.G. Johnson*, A. Singh, and M. Rudstrom, *University of Minnesota, Morris, MN.*

The objective was to identify forage species and dry urea nitrogen fertilization combinations for pastures to feed grazing dairy cows in the

Midwest. Five species-fertilizer combinations were studied in a randomized complete block experiment with three replicates over three years. Combinations were Bromegrass with no N (B0N), Bromegrass with 56 kg/ha early N + 56 kg/ha late N (B56-56N), Bromegrass with 112 kg/ha early N (B112-0N), Bromegrass with 112 kg/ha late N (B0-112N), and Bromegrass with Legume and no nitrogen fertilization (BL). Early fertilization was before the first grazing of the year and late fertilization was after the second grazing. The pasture was organized in species strips 21m by 164 m with fertilization plots 21m by 14 m. Pastures were initially prepared by a glyphosate spray for weed control, fall moldboard plowing, spring disking and planting into a prepared seedbed. Bromegrass (Bounty) seeding rate was 667 seeds/m². Bromegrass-legume seeding rate (seeds/m²) was Bromegrass (Bounty), 398; Alfalfa (Amerigraze421), 108; Birdsfoot trefoil (Noreen), 215; and Kura Clover (Endura), 215. Pastures were grazed by lactating dairy cows 4-5 times per year for a 24 hr grazing period at a density of approximately 67 Mg/ha. Utilization of BL was approximately 50%, whereas utilization of B ranged from 29-35%. Intake was determined by difference of quantity of forage by clipping before and after grazing. Annual total intake varied by year ($P=.02$), and forage-fertilizer combination ($P=.0001$). Grazing pressure was restricted the first year to increase the probability of maintaining stand. Annual intakes (Mg/ha) were B0N, 1.62; B56-56N, 2.02; B112-0N, 2.41; B0-112N, 2.29; and BL, 6.26. These results indicate that diverse mixes of legumes and bromegrass are more productive than bromegrass monoculture with or without supplemental nitrogen fertilization

Key Words: Pasture systems, Grass vs. legume pasture

International Animal Agriculture

1557 Transport of preimplantation embryos in the genitalia of buffalo heifers superovulated with pFSH and variable doses of LH. A.M. Osman* and S.H. Shehata, ¹Dept. Theriogenology, Fac. Vet. Medicine, Assiut Univ. Assiut, Egypt.

Twelve buffalo heifers of similar age (21-25 month) and body weight (325-385 kg) were superovulated during mid luteal phase using pFSH (total 65 NIH unit Super-Ov divided into 6 equal dose, 1.4 ml each, for 3 consecutive days) and lutalyse (25mg injected with the 5th injection). To improve ovarian response variable doses of LH (0, 2, 4, 5, 7 and 10 thousands USP unit, Steris, Lab. Inc Phoenix, Arizona) were injected at the morning of the 4th day of the treatment in 6 trials ($n=2$). Fertile bulls were allowed to mount heifers frequently after 24hour (h) from onset of estrus. Heifers were classified into 3 equal groups (2 trials/each) which slaughtered at various time intervals from the onset of estrus: 72-89, 100-106 and 118-120 (h). After slaughter, the intact genitalia were dissected free and transported to the lab in a thermos container at 4C. The number of newly formed corpora lutea (CL) and unovulated, >1cm, follicles (UF) in both ovaries were done. Flushings of the oviduct and uterine horn were performed separately using phosphate buffer saline to identify the numbers and locations of embryos. The duration of estrus(h), numbers of CL and UF were 41.5 11.2, 3.11.3 and 1.10.76 respectively. The overall ovulation and embryo recovery rates were 72.5 and 54% respectively. Group without LH gave low response (50 and 0% respectively). The higher ovulation rate (66-100%) were recorded for heifers supplemented with 4000 and more unit LH while the higher embryo recovery rates (50-100%) were associated with the doses of 4000-7000 unit LH. At 72-89h postoestrus (48-65h postinsemination) 6 embryos were collected from the oviducts and one embryo from the uterus. Some non-motile spermatozoa were observed in the oviduct. At 100-106 and 118-120 h postoestrus (76-82 and 94-96 h postinsemination) 7 and 6 embryos were recovered respectively from the uterus. The rate of embryo transport in the oviduct of superovulated buffalo heifers appeared to be 30 h and more faster than in buffalo or bovine cows.

Key Words: buffalo heifer, superovulation, embryo

1558 Factors affecting the reproductive performance of Bali cattle in Manokwari, Papua, Indonesia. O.R. Faidban¹, J.B. Gaughan^{*2}, and R.S. Copland², ¹The Papua State University, Manokwari, Papua Province, Indonesia, ²The University of Queensland, Gatton, Australia.

Poor reproductive performance of cattle is a problem in many developing countries. The major objective of this study was to characterize the reproductive performance of Bali cows ($n=336$) based upon nutritional management practices where the cattle were (i) grazing (G), (ii) were tethered in paddock during day, tethered at the farmers house at night with grass cut and carried at night (PZ), and (iii) had zero grazing, with all feed supplied to tethered animals via cut and carry (Z). A second objective was to determine the major factors which influence the reproductive performance of these animals. Cattle were identified using ear tags or neck collars (prior to the study most animals had no identification), aged (using their teeth) into groups (1.5 # 3 years of age; 3.5 # 5; 5.5 # 7; > 7 years of age), body condition scored (BCS; 1 # 5; 1 # emancipated, 2 # lean, 3 # medium, 4 # fat, 5 # very fat), and reproductive status assessed (lactating, pregnant or not pregnant, ovarian activity or no activity). The data were collected three times (March, July and October) over a 9-mo period. Data were analyzed using SAS. Over the period the mean pregnancy rate across all treatments was 57%. There were no measured seasonal effects on pregnancy rate. Cows that were over 7 years of age ($n=25$) had a higher ($P<.01$) pregnancy rate (74%) compared to those aged 1.5 # 3 years of age (37%) ($n=25$). The majority of cows had a BCS of either 2 ($n=162$) or 3 ($n=128$). Five cows had a BCS of 5 (very fat) and 10 cows had a BCS of 1 (emancipated). Pregnancy rates increased ($P<.05$) as BCS increased (37%, 50%, 64%, 73%, 63% respectively for BCS 1 # 5). Over the 9-mo period, 84% of the P cows, 92% of the PZ cows and 78% of the Z cows were either pregnant, lactating or cycling at one of the three data collections. However, the feeding system had a significant ($P<.05$) effect on pregnancy rate, with the Z cows averaging 30% pregnancy over the 9-mo period compared to 58% for the G group and 57% for the PZ cows.

Key Words: Beef cattle, Reproduction

1559 Survey of milking characteristics and milk quality of Brazilian dairy cows. D. A. Costa* and D.J. Reinemann, *University of Wisconsin, Madison, Wisconsin, USA.*

Brazil has the second largest dairy herd in the world and most Brazilian dairy herds are made up of crossbred cows (mainly Holstein crossed with Indian breeds such as Zebu and Gir). A survey tool was developed to gather information on current milking, breeding and general management practices and the decision-making framework used by Brazilian dairy farmers. This opinion survey was administered to 135 dairy producers at a major agricultural exposition in April 2001. Of the 52% of producers who wanted to increase the percentage of Holstein genetics of their herd the main reason given was to obtain higher production. For the producers who did not wish to increase their herd Holstein percentage the main reason was that crossbred cows were thought to be more resistant to diseases and more adapted to hot climate and pasture as principal source of food. About 2/3 of producers reported using calves for pre-milking stimulation. A field survey was carried out on 5 farms in Brazil between May and June of 2001 to study the milking characteristics of different crossbred cows (1/2, 3/4 and 7/8 Holsteins) and the effect of using calves for pre-milking stimulation of crossbred cows. During one morning milking, the milk yield of individual cows was recorded in one-minute intervals using milk meters. Total yield, average flow rate, peak flow rate, milking time and occurrence of overmilking were recorded. Other characteristics were also observed such as milking practices, cleanliness of the teats and teat score of some cows. Milk samples were collected and Somatic Cell Count (SCC) measured. Our results suggest that the influence of calf suckling on milking performance is minimal. The peak milk flow rate of typical crossbred Brazilian cows is substantially lower than for purebred Holstein cows in the USA and Europe. Increasing Holstein genetics from 1/2 to 3/4 showed a moderate increase in milk production and increase in SCC. The differences in milk production and SCC between 3/4 and 7/8 Holstein were not significant. The farmers' perception that crossbred cows have lower production and more resistance to mastitis appears justified.

Key Words: Brazilian dairy cows, milking characteristics, crossbred cows

1560 Ectoparasite control in lactating cows using aqueous extracts of Neem (*Azadirachta indica* A. Juss) leaves. S. Pietrosemoli*, R. Olave, and K. Noriega, *Facultad de Agronomía. La Universidad del Zulia. Maracaibo/Venezuela.*

Twenty-four crossbred Brahman, Brown Swiss and Holstein cows (avg BW: 475 ± 75 kg) from a commercial production unit located in the tropical dry forest of the state Zulia, Venezuela were used to determine the potential of aqueous extracts of neem (*Azadirachta indica* A. Juss) leaves to control ectoparasites. Four treatments were evaluated (T0) Control, (T1) 150 g of leaves of Neem/L water, (T2) 300 g of leaves of Neem/L water; (T3) 25 g of Deltamethrin. Aqueous extracts were prepared with freshlyground leaves and soaked in water for 12 h before being filtered. The experimental design was a split plot, with treatments as main plots, and day of parasite counts as split plots. Treatments were applied topically in a single application. The number of ticks (*Boophilus microplus*) was determined using a 10 x 7 cm plastic pattern placed in the perineal area of the animal. A videocamera was used to calculate fly (*Hamaetobia irritans*) counts in a defined rectangle located on the right side of the animal. Ticks and fly counts were determined before, and 7, 14, 21 and 28 d after the application of the treatments. Data were Log transformed as Log (n+1) and initial infestation (20.8 ticks/cow and 17.2 flies/cow) was used as a covariable. Differences were observed for ticks among treatments (P < .001) and days (P < .001). Treatment T2 (300 g/L), differed from others treatments (P < .001, P < .001 and P < .001), for T0, T1 and T3 respectively; and caused a 64.8% reduction of the number of ticks compared to T0. Fly counts did not differ among treatments. Nevertheless, T2 had a tendency to reduce fly infestation. The use of 300 g/L aqueous extracts of Neem leaves reduced tick infestation in grazing cows.

Percentage reduction of number of ticks, compared to control in lactating cows treated with aqueous extract of neem,

<i>Azadirachta indica</i> A. Juss, Leaves.		
Treatment	g/L water	% Reduction
T1	150	- 6.6
T2	300	64.8
T3	25	-22.6

Key Words: *Azadirachta indica*, Ectoparasites, Bovine

1561 Coccidiosis (*Eimeria* sp) control in calves using aqueous extract of neem (*Azadirachta indica* A. Juss) Seeds. S. Pietrosemoli*¹, R. Olave¹, C. Plaza¹, and Z. Valera², ¹Facultad de Agronomía., ²Facultad de Ciencias Veterinarias. La Universidad del Zulia. Maracaibo/Venezuela.

Sixteen crossbred Brahman, Brown Swiss and Holstein calves (22 ± 9 d old, avg BW of 38 ± 8 kg) from a commercial production unit located in the tropical dry forest of the state Zulia, Venezuela, were used. The objective was to evaluate the effect of different doses of an aqueous extract of Neem (*Azadirachta indica* A. Juss) seeds, (AENS), on the number of oocyst per gram of faeces (OPG) in grazing calves. Calves were fed 2 L of milk and 2 kg of a commercial concentrate (16 % CP) daily. The AENS was prepared with 60 g of ground dry neem seed/L of water soaked for 12 h before being filtered. Four doses of the aqueous extract were tested: 0 (T0), 10 (T1), 20 (T2) and 30 (T3) cc/kg calf BW. The treatments were drenched orally in a single application. No adverse reaction was observed. The OPG was determined using a modified McMaster procedure. Coccidia counts were made before drenching the calves with AENS and 7, 14, 21 and 28 d thereafter. The experimental design was a split plot, with treatments as main plots and days of parasite counts as split plot. Data were Log transformed as Log (n+1). Initial infestation was used as covariable. Differences were observed between T0 and T1 (P < .01), and T0 and T2 (P < .002). Differences between T2 and T3 (P < .0353) were also observed. The greatest reduction in OPG values were observed with T2. Treating calves with 20 cc/kg BW of AENS decreased coccidia infestation.

Percentage reduction of number of oocyst g⁻¹ of faeces, compared to control in calves treated with aqueous extract of neem, *Azadirachta indica*, seeds.

Treatment	cc AENS/kg BW	% Reduction
T1	10	36.6
T2	20	97.3
T3	30	48.8

Key Words: *Azadirachta indica*, Coccidiosis, Calves

1562 Coccidiosis (*Eimeria* sp) control in grazing calves using aqueous extract of neem (*Azadirachta indica* A. Juss) leaves. S. Pietrosemoli*¹, R. Olave¹, C. Plaza¹, and Z. Valera², ¹Facultad de Agronomía., ²Facultad de Ciencias Veterinarias. La Universidad del Zulia. Maracaibo/Venezuela.

Sixteen crossbred Brahman, Brown Swiss and Holstein calves (43 ± 8 d old, avg BW of 47 ± 6 kg) from a commercial production unit located in the tropical dry forest of the state Zulia, Venezuela, were used. The objective was to evaluate the effect of different doses of an aqueous extract of neem (*Azadirachta indica* A. Juss) leaves (AENL), on the number of oocyst per gram of faeces (OPG), in calves grazing *Brachiaria humidicola*. Animals were fed 2 L of milk and 1 kg of a commercial concentrate (16 %CP) daily. The AENL was prepared with 150 g of freshly ground leaves of neem/L of water soaked for 12 h before being filtered. Four doses of the aqueous extract were tested: 0 (T0), 10 (T1), 20 (T2) and 30 (T3) cc/kg calf BW. The treatments were drenched orally in a single application. No adverse reaction was observed. The OPG was determined using a modified McMaster procedure. Coccidia counts were made before drenching the calves with AENL and 7, 14, 21 and 28 d thereafter. The experimental design was a split plot, with treatments as main plots and days of parasite counts as split plot. Data were Log transformed as Log (n+1). Initial infestation, 5462 oocyst g⁻¹, was used as covariable. Differences among treatments (P < .014) and days (P < .031) were observed; T0 control, differed from other treatments (P < .092; P < .002 and P < .031) for T1, T2 and T3 respectively. T2 and T3 presented differences (P < .035). The greatest reduction in OPG values were found with T2. Treating calves with 20 cc/kg BW of AENL decreased coccidia infestation.

Percentage reduction of number of oocyst g⁻¹ of faeces, compared to control in calves treated with Aqueous Extract of Neem, *Azadirachta indica*, Leaves.

Treatment	cc/kg BW	% Reduction
T1	10	64.2
T2	20	83.7
T3	30	57.2

Key Words: *Azadirachta indica*, Coccidiosis, Calves

1563 Use of Prickly Pear forage in sheep diets. I. Mejia-Haro*¹, I.B. Camarillo-Solis¹, J. Mejia-Haro², and J.T. Frias-Hernandez², ¹CIGA ITA de Aguascalientes, Mexico, ²Universidad de Guanajuato, Mexico.

In Mexico, the use of grains in sheep diets is expensive, an alternative is the use of native forages in combination with grain byproducts. Prickly pear forage used in sheep diets may be useful. Prickly pear forage is found in native and cultivated arid and semiarid regions of Mexico. Although the protein and phosphorus content of this forage is low, the energy value is acceptable (2.6 Mcal/ kg of DE) and the calcium content and DMD are high. The objective of this study was to evaluate the inclusion of prickly pear forage in sheep diets. This study was carried out in the CIGA-ITA of Aguascalientes, Mexico in 2001. Twenty-four male sheep (BW 29.9 kg) of mixed crossed breed (Dorset, Suffolk and Rambouillet) were completely randomized and assigned to one of four treatments (inclusion of dehydrated Prickly pear in diet) ; T0, inclusion of 0% ; T20, 20%; T30, 30% and T40, 40%. The diets were formulated with 14 % of CP. Sheep were adapted to diets for 14 d, fed ad libitum during an experimental period of 62 d and weighed twice. Feed intake, feed efficiency and ADG were recorded. Feed samples were processed for DM, CP, NDF, ADF, and in situ DMD. Data were analyzed by ANOVA and Tukey tests by using the GLM procedure of SAS (1996). No significant differences ($P > .05$) were observed among treatments in ADG, the values were: T0 (222g), T20 (236 g), T30 (213 g), and T40 (253 g). Also no differences were found in values of DMD among treatments (T0,86%; T20,86%; T30,85%; T40,85%). The values of feed efficiency were: 4.6, 4.7, 5.7 and 4.6 for T0, T20, T30, and T40, respectively. In this study it was demonstrated that using 20, 30 and 40% of prickly pear in sheep diets the ADG obtained is similar to those using grains. It is important to consider the nutrient requirements of sheep for weight gain when prickly pear diets are fed although this forage most of the times is used for maintenance. Using diets with 20, 30 and 40% of prickly pear in sheep the average daily gains are like to those using grains.

Key Words: Forage, Diets, Sheep

1564 Effects of fibrolytic enzymes on degradation of Prickly pear forage (*Opuntia ficus-indica* L.(Mill)). M. A. Medina-Romo¹, C. R. Cruz-Vazquez¹, I. Mejia-Haro¹, G. Tirado-Estrada*¹, and G. D. Mendoza-Martinez², ¹CIGA ITA de Aguascalientes, Mexico, ²Colegio de Posgraduados, Texcoco, Mexico.

The objective of this study was to evaluate the effects of Prickly pear forage (PPF) treatment with exogenous fibrolytic enzymes (fibrozyme) on processes *in vitro* and *in situ* digestion and ruminal fermentation. Three experimental phases were conducted: Phase I. Previous digestion (pre-digestion; 24 h) and *in vitro* digestibility (48 h). Phase II. *In situ* digestibility (24 h). Phase III. Ruminal fermentation patterns. In phase I the effects of the level of the enzyme (E) were evaluated: 0 (control), 1.5 and 3 g /kg DM, with three application methods of the enzyme: 1) dry (DE); 2) dry + 250 ml of water (DE+W); 3) in a solution of 500 ml of water (SE). In Phase II, four E levels were used: 0, 1, 2 and 3 g /kg of DM, two treatment times of the PPF (0 h = T0 h and 24 h = T24 h), and two forage:concentrate ratios, one with 82:18 (DI), and the other with 73:27 (DII) (4x2x2). In Phase III, the effects of the four enzyme levels on digestibility were evaluated on six sampling times 0, 3, 6, 9, 12 and 24 h (4x6) after the application of the enzyme. During the pre-digestion phase the treatments affected neither the NDF nor the ADF disappearance. Treatments did not affect *in vitro* digestibility of DM (IVDMD). No effects were observed ($P > .05$) on the E levels on *in situ* DM digestibility and NDF, but DI surpassed to DII and T0 h surpassed to the T24 h in both variables ($P < .05$). The greatest concentrations of total VFA, acetate, propionate, and butyrate were obtained with 1 and 3 g of E at 3 and 9 h of sampling ($P < 0.05$). The highest concentrations of N-NH₄ were reached with 1 and 2 g of E at 3 h ($P < 0.05$). Results indicate that exogenous fibrolytic enzymes promote intra-ruminal changes in the fermentation process of PPF, but a more complete study is required.

Key Words: Fibrolytic enzymes, Forage, Prickly pear

Nonruminant Nutrition Antimicrobial Agents, Additives, and Fermentation Modulators

1565 Zinc oxide and avilamycin enhance pig performance. L. J. Broom¹, H. M. Miller*¹, K. G. Kerr¹, and P. Toplis², ¹University of Leeds, Leeds, UK, ²Primary Diets Ltd, Melmerby, UK.

Concern regarding antibiotic resistance and environmental pollution is likely to result in the elimination of antibiotic growth promoters (AGPs) and zinc oxide from EU pig diets. This experiment aimed to investigate what effect removing both avilamycin (AGP) and zinc oxide from the post-weaning diet would have on weaned piglet growth performance. Fifty two piglets (62.5% Large White, 25% Landrace, 12.5% Duroc) were weaned, at 21.2 ± 0.30 days of age (SEM) and 6.9 ± 0.16 kg BW, into commercial flatdeck accommodation. Six or 7 piglets were allocated to each pen (1.99 m²) on the basis of weight, litter and sex. Four pens were randomly allocated to one of 2 treatments. Treatments were: 1) Control - no supplementation, and 2) ZnO+ - supplemented with 0.31% ZnO and .004% avilamycin. Diets were formulated to contain 4,167 kcal DE/kg, 1.75% total lysine in Wk1, and 3,810 kcal DE/kg, 1.6% total lysine in Wk2 and 3. Thereafter, pigs received the same diets. Feed and water were provided *ad libitum*. From d20 pigs were housed in conventional grower-finisher accommodation. Piglets were weighed on d0, 20 and 118 post-weaning. Daily FI per pen was recorded from d0 to 20. Faecal samples were taken on d0 and 19 to determine total bacterial count. Data were analysed using the GLM procedure of Minitab 12.2. From d1-20, ZnO+ piglets ate more ($P < 0.01$), grew faster ($P < 0.001$) and had better FCR ($P < 0.05$) than Control piglets. ZnO+ piglets were heavier than Control pigs by d20 post-weaning (13.0 vs 11.7 kg, $P < 0.001$) and numerically heavier at slaughter (82.4 vs 79.3 kg). ZnO+ pigs had a lower total faecal bacterial count than the Control pigs on d19 (4.43×10^7 vs 1.69×10^8 colony forming units/g, $P < 0.05$). Omission of ZnO and avilamycin from the post-weaning diet reduced pig performance and increased days to slaughter at a specific weight.

Key Words: Zinc oxide, Avilamycin, Piglet growth

1566 Effect of dietary supplementation of probiotics (CalsporinTM) on sow and litter performance. Q. Yang*¹, S.K. Baidoo¹, R.D. Walker¹, T. Marubashi², and T. Imabayashi², ¹Southern Research and Outreach Center, University of Minnesota, MN 56093, ²Calpis USA Inc., Torrance, CA 90503.

The study was designed to determine the effects of dietary supplementation of CalsporinTM (probiotic) on sow, litter performance and microflora changes in the feces of sows. Fifty-two cross-bred sows were divided into 2 groups that were fed either a corn-soybean meal based diet or the basal diet supplemented with 0.1% Calsporin from d 80 of gestation until farrowing. After farrowing the concentration of Calsporin was reduced to 0.01% in lactation diets. The sows were on the same dietary treatments in lactation as in gestation. The sows were restricted fed (1%BW+500gms) and ad lib fed during lactation of a corn-soybean meal based diet. The results indicated that Calsporin had no effect ($P > 0.05$) on sow body weight changes and backfat thickness during gestation, litter size, average feed intake, and body weight changes during lactation. The total number of pigs born and weaned was not influenced by dietary treatment. The average daily gain (ADG) of piglets from sows fed Calsporin diet during gestation and lactation was 214.0g, which was significantly greater ($P < 0.05$) than 200.4g of the piglets from sows fed control diet. The number of Clostridium perfringens in the feces of Calsporin fed sows was less ($P < 0.05$) than in the feces of the control fed sows (6.13 log vs 7.13 log, CFU/g feces). The number of Bifidobacterium in the feces of Calsporin fed sows was higher ($P < 0.05$) than that of control the group fed sows (8.56 log vs 7.27 log, CFU/g feces). The number of total anaerobic bacteria in the feces of piglets from the sows fed Calsporin diet was less ($P < 0.058$) than in the feces of piglets from the sows fed control diet (9.54 log vs 10.22 log, CFU/g feces). In summary, Calsporin could improve body weight gain of the suckling piglets and increase the number of Bifidobacterium in sows during gestation and lactation.

Key Words: Sow and pigs, Probiotic, Performance and microflora

1567 Evaluation of CalsporinTM (Bacillus subtilis C-3102) on growth performance of nursery pigs. S.K. Baidoo¹, Q. Yang^{*1}, R.D. Walker¹, T. Marubashi², and T. Imabayashi², ¹*Southern Research and Outreach Center, University of Minnesota, MN 56093*, ²*Calpis USA Inc., Torrance, CA 90503*.

The objective of this study was to evaluate the use of CalsporinTM as an feed additive in the diets of nursery pigs. All diets for sows and piglets were not supplemented with antibiotic. Fifty-two cross-bred sows were allotted to two dietary treatments (1) basal corn-SBM diet; (2) diet 1 + 0.1% Calsporin based on body weight and parity from d 80 of gestation until farrowing. At farrowing, the dietary supplementation of Calsporin was reduced to 0.01%. A total of 144 pigs (BW of 5.5 kg and 21 d of age) were used in a 28-d growth assay. At weaning, treatments were arranged as a 2x2 factorial design with main effects of sows and nursery dietary supplementation. (1) basal-basal; (2) basal-Calsporin; (3) Calsporin-basal; (4) Calsporin-Calsporin with first treatments for sows and second treatment for piglets. For d 0 to 14, pigs in treatment 2 had increased (P<0.05) ADG than pigs in treatment 3 (Table 1). In conclusion, dietary supplementation of Calsporin to sow diets did not influence nursery pig performance, however, adding Calsporin to nursery diets at 100 mg/kg diet improved ADG of pigs.

Table 1. The effect of Calsporin on the Performance of weaned piglets

Sow		Sows fed control diet		Sows fed Calsporin diet	
Treatments					
Pig		Control		Calsporin	
Treatments		Control	Calsporin	Control	Calsporin
ADG					P.
(g, d 0-14)	127.2 ^{ab}	140.2 ^a	103.7 ^b	117.8 ^{ab}	<0.05
Feed/Gain	1.61	1.58	1.69	1.72	NS
ADG					
(g, d 14-28)	387.8 ^b	435.9 ^a	377.8 ^b	428.6 ^a	<0.05
Feed/Gain	1.56 ^a	1.48 ^b	1.59 ^a	1.50 ^{ab}	=0.05
ADG					
(g, d 0-28)	257.4 ^b	288.1 ^a	240.7 ^b	273.2 ^a	<0.05
Feed/Gain	1.58	1.53	1.63	1.60	NS

Note: Means with different superscript in each row are significant (P<0.05).

Key Words: Piglets, Probiotics, Performance

1568 Evaluation of germanium biotite as a substitute for antibiotics in growing pig diets. O. S. Kwon^{*1}, I. H. Kim¹, J. W. Hong¹, S. H. Lee¹, and Y. K. Jung², ¹*Department of Animal Resource & Science, Dankook University,*, ²*Seobong Biobestech. Co., Ltd, Korea*.

This study was conducted to evaluate the effect of germanium biotite as a substitute for antibiotics in growing pigs. A total of 54 crossbred pigs(Landrace×Duroc×Yorkshire) initially 32.47±0.9kg BW were used in this experiment. Pigs were allocated into three treaments. Each treatment had three replicates with six pigs per replicate. This study was carried out for 35 days. The three treaments were negative control(NC: basal diet without antibiotic), positive control(PC: NC diet + 200ppm chlortetracycline) and GB0.3(NC diet + germanium biotite 0.3%). ADG and ADFI for pigs fed PC and GB0.3 were higher(P<0.05) than for pigs fed NC. Pigs fed GB0.3 improved(P<0.05) gain/feed compared to NC treatment. DM and N digestibility were significantly different in PC and GB3.0 compared to NC(P<0.05). In conclusion, supplementation of germanium biotite 0.3% in diet has possibility as alternative substances of antibiotics in the diet of growing pigs.

Key Words: Pigs, Biotite, Antibiotics

1569 Effects of an in-feed antibiotic on the morphology of the porcine small intestine. V. Rayadurg^{*}, D.H. Zeman, M.B. Hildreth, and H.H. Stein, *South Dakota State University, Brookings, SD*.

The objective of the current experiment was to assess the effect of the antibiotic (carbadox) on the intestinal morphology. A total of 25 weanling piglets (DH x LYD) were used in the experiment. Pigs were weaned at 21 d and allotted to one of two treatment groups. A phase 1 diet was fed to appetite to the pigs during the entire experimental period. Pigs on treatment group 1 received this diet without any in-feed antibiotic.

Pigs on treatment group 2 received the diet with an antibiotic growth promoter (carbadox) included at 50 ppm. Small intestinal morphology and enterocyte mitotic index was assessed on the d of weaning (d 0), and on d 5 and d 10 of the experiment. Samples taken from the pigs included intestinal tissue obtained from 33%, 66%, and 100% of the length of the small intestine measured from the pyloric sphincter. Computerized morphometry and enterocyte mitotic index was performed on the intestinal sections. Results were analyzed using a three-way factorial analysis. For d 0, the mean villus height (VH) values were higher (P < 0.05) than for d 5 or d 10 regardless of the diet being fed post-weaning. Regardless of the site of sampling there was no effect of diet on VH. Within each diet, there was no difference (P > 0.05) between mean VH at site 33% and 66%. However, for both diets, VH at both these sites were higher (P < 0.05) than at site 100%. On d 0, site 100% had greater crypt depths (CD) than sites 33% and 66% (P < 0.05). For diet 1, the CD for site 66% at d 5 were greater than for the other two sites (P < 0.05). However, on d 10 site 100% had greater CD than site 66% (P < 0.05). For diet 2, CD were greater on d 10 regardless of sampling site. On d 5, pigs fed diet 1 had greater (P < 0.05) mean CD values at site 66% than pigs fed diet 2 (P < 0.05), but on d 10, pigs fed diet 2 had greater (P < 0.05) CD values than pigs fed diet 1. No effects of time, diet, or site were found for the mitotic index. Overall, the results of this experiment demonstrated that VH decreases after weaning while CD increases. An in-feed antibiotic such as carbadox can contribute to an amelioration of the increase in CD.

Key Words: Villus height, Crypt depth, Mitotic index

1570 Utilization of spray-dried egg protein containing specific egg yolk antibodies for weaned pigs. J. W. Hong^{*1}, I. H. Kim¹, O. S. Kwon¹, J. H. Kim², S. H. Lee¹, and J. M. Lee¹, ¹*Department of Animal Resource & Science, Dankook University,* ²*Agribands Purina Korea, Inc., Seoul, Koera*.

For the Exp. 1, thirty six Duroc×Yorkshire×Landrace pigs (6.55±0.10kg average initial BW and 21 d average age) were used in a 14-d growth assay to determine the effects of replacing spray-dried plasma protein (SDPP) with spray-dried egg protein containing specific egg yolk antibody (SDEP) on growth performance and nutrient digestibility in weaned pigs. Dietary treatments were 0, 3 or 6% SDEP contained 6, 3 or 0% SDPP, respectively. Through entire experimental period, ADG, ADFI and gain/feed tended to decrease as the concentration of SDEP in the diets was increased. However, there were not significant differences among the treatments. As the addition of SDEP in the diets was increased, apparent digestibilities of DM and N were decreased without significant differences. For the Exp. 2, thirty six Duroc×Yorkshire×Landrace pigs (2.63±0.04kg average initial BW and 10 d average age) were used in a 14-d growth assay to determine the effects of antibiotic replacement with SDEP on growth performance and digestibility in segregated early-weaned pigs. Dietary treatments included 1) CON (corn-dried whey-SBM based diet+0.08% antibiotic), 2) SDEP 0.5 (corn-dried whey-SBM based diet+0.5% SDEP), 3) SDEP 1.0 (corn-dried whey-SBM based diet+1.0% SDEP). ADG and gain/feed of pigs fed SDEP1.0 diet were higher than pigs fed CON diet without significant difference. Pigs fed the diet with SDEP 1.0 tended to have increased apparent digestibilities of DM and N on compared to pigs fed the CON diet without significant differences. In conclusion, the SDEP supplementation seemed to be partial replacing the SDPP portion of high nutrient dense diet and to be approximately 1.0% or more when the pigs fed the antibiotic-free diet for early-weaned pigs.

Key Words: Animal protein, Egg yolk antibody, Pigs

1571 Dietary effect of egg immunoglobulins containing anti-pathogenic antibodies to pre- and postweaning pigs on growth performance till market weight. C. Y. Liu^{*1}, B. J. Chang¹, G. Y. Lee¹, and Y. Kodama², ¹*Animal Technology Institute Taiwan, ROC,* ²*Immunology Research Institute, Japan*.

Two experiments were conducted to evaluate the effect of feeding egg immunoglobulins (Ig) containing anti-pathogenic antibodies to pre- and postweaning pigs on growth and subsequent performance till market weight. In Exp. I, 20 littles of 14-day old piglets (8 pigs/little) were fed either a control or Ig supplemented diet, in which Ig was obtained from laying hens immunized with ETEC K88, K99, 987P, porcine rotavirus and PED virus, at 4.0% for 14 days before weaning and at 0.2% for 28 days after weaning. Diets supplemented with Ig significantly (P<.01)

increased ADG during both pre- (205 vs 226 g/d) and postweaning (375 vs 414 g/d) periods. Postweaning F/G was also improved by Ig (1.74 vs 1.64, $P < .05$). In Exp. II, 20 litters of preweaning piglets (14 days of age, 8 pigs/litter) were fed a diet with or without anti-ETEC K88 and K99 Ig antibodies at 0.5% for 14 days before weaning and at 0.035% for 28 days after weaning. Dietary Ig supplement improved ($P < .05$) ADG by 7.1% (269 vs 288 g/d) and 14.2% (393 vs 449 g/d) for pre- and postweaning period, respectively, as well as postweaning F/G (1.62 vs 1.47, $P < .01$). Subsequently, the growth performance (Exp. II) remained superior in Ig-fed group from 20 kg to market weight (ADG: 747 vs 801 g/d, $P < .01$; ADFI: 2242 vs 2323 g/d, $P > .05$; F/G: 3.00 vs 2.90, $P < .05$). Since less diarrhea and lower mortality were observed in Ig-fed young pigs, these results demonstrate that feeding anti-pathogenic antibodies to weaning pigs can protect pigs from infection and improve growth performance till growing-finishing phase.

Key Words: Pigs, Immunoglobulin, Performance

1572 Effects of dietary bacterial biodegradation velocity and electrolyte balance on nutrient digestibility, retention, and excretory patterns in finishing pigs. Z. Mroz^{*1}, A.J. Moeser², J.Th.M. van Diepen¹, and J. Kogut¹, ¹*Institute for Animal Science and Health, Lelystad, The Netherlands*, ²*North Carolina State University, Raleigh, NC, USA*.

Effects of dietary bacterial biodegradation velocity (BBV) and electrolyte balance (dEB=Na+K-Cl) were investigated with ten ileal cannulated pigs of 60 kg BW, according to a balanced row-column design. The BBV is a measure of dietary fermentative potential expressed in time (h) needed for a progressive anaerobic gas production (in vitro). Ten diets were formulated of barley, wheat, tapioca, soybean meal, corn products, soybean hulls, beet pulp, and K_2CO_3 to obtain two levels of dEB (180 and 360 mEq/kg), each with five BBV times (7.7, 9.2, 9.4, 10.6, and 12.1 h). Daily energy allowance ($2.4 \times ME_m$) was given in two wet meals (3 L of water per 9.2 MJ NE_g). No interactive effects of BBV and dEB were found, irrespective of the response parameter. Daily production of feces and urine was affected ($P < .05$) by BBV, and not by dEB. With a longer BBV time, more feces and less urine were excreted. Apparent digestibility (ileal/overall) of DM, OM, and CP diminished ($P < .05$) with increasing BBV time, whereas no effect of dEB (except for ash) was found. Body N retention was not affected by BBV, whereas it tended ($P = 0.068$) to be greater in pigs fed low dEB. Daily amounts of fecal N were greater ($P < .001$) with increasing BBV time, whereas urinary losses of N were similar. Reduced dEB tended to lower urinary N ($P = 0.082$), and to increase N retention ($P = 0.068$). Ratios of urinary to fecal N were affected by BBV ($P < .001$), and prolonging BBV time from 7.7 to 12.1 h resulted in "shifting" 28% of urinary N (easy degradable) into fecal bacterial N (less degradable). Thereby, a velocity of indoor ammonia volatilization could be slowed down.

Key Words: Pigs, Dietary fermentative velocity, Nutrient balance

1573 Effects of in-feed acidifiers for multiparous sows. Z. Mroz^{*1} and W. Krasucki², ¹*Institute for Animal Science and Health, Lelystad, The Netherlands*, ²*Agricultural University of Lublin, Lublin, Poland*.

Two in-feed acidifiers in graded doses were used for sows to study reproductive responses, nutrient digestion, and the inhibition of bacteriuria, lactation failure (PHS), and ammonia emission from manure. In Exp.1, 32 multiparous sows of 150 kg BW were fed a cereal-soybean meal-rapeseed meal-based diet with 0.0, 0.3, 0.6, and 0.9% of blended propionic and formic acids (1:3) over one reproductive cycle. In Exp. 2, 24 pregnant sows of 180 kg BW received a basal diet with Na-benzoate (0.0, 0.2, 0.4, and 0.8%) at free access to water. No PHS was noted in both experiments. In Exp. 1, sow's BW changes in pregnancy or litter size/weight at birth were similar ($P > .05$) among the groups. Lactating sows tended ($P < .01$) to increase milk production at greater ($P < .05$) contents of fat and PUFA (except for C18:3). Also, piglet's BW at weaning, and the ileal digestibilities of lysine, cystine, and histidine in lactation diets were improved ($P < .05$). In Exp. 2, voluntary feed intakes and growth rates were similar ($P > .05$) among the groups. Sodium-benzoate at the highest dose reduced ($P < .01$) urinary bacterial populations (from 10^6 at mating to less than 10^3 at farrowing), urine pH (by up to 2.2 units), and ammonia emission from manure (by up to

43.2%). These data imply that acidifiers for sows may inhibit periparturient hypogalactia syndrome, bacteriuria, and(or) ammonia emission from manure.

Key Words: Sows, Acidifiers, Bacteriuria

1574 The interaction between lactofeed level and soybean meal on growth performance of weanling pigs. J. V. O' Doherty^{*1}, C. S. Nolan¹, J. J. Callan¹, and P. McCarthy², ¹*University College Dublin, Ireland*, ²*Volac International, UK*.

A 3 x 2 factorial experiment was conducted to investigate the interaction between lactofeed 70 (LF70) (800 g/kg lactose, 200 g/kg soybean meal, Volac International, UK) levels and soybean meal inclusion (SBM) (9% and 22.5%) from d 0 to d 25 (starter period) after weaning on growth performance and diet digestibility. A common diet was fed from d 26 to d 38. Dietary treatments were established by substituting LF70 for extruded wheat and soybean meal for potato protein (PP) and soy protein concentrate (SPC). Digestible energy and amino acids were maintained by adjusting soy oil and synthetic amino acids. A total of 248 pigs (initially 7.3 kg and 25 +/- 4 d of age) were allotted randomly to 6 treatments containing (1) 0 LF70 with 4% PP and 4% SPC (2) 0 LF70 with 22.5% SBM (3) 17.5% LF70 with 4% PP and 4% SPC (4) 17.5% LF70 with 22.5% SBM (5) 35% LF70 with 4% PP and 4% SPC and (6) 35% LF70 with 22.5% SBM. There was an increase in average daily gain (ADG) (0.182 vs 0.292 vs 0.318 kg, sem 0.0089; $P < 0.001$), feed intake (0.413 vs 0.472 vs 0.489 kg, sem 0.0139; $P < 0.01$) and feed efficiency (FE) (2.12 vs 1.55 vs 1.49 kg, sem 0.057; $P < 0.001$) as the level of LF70 increased during the starter period. From d 26 to d 38, the pigs fed the starter diets containing 0% LF70 had an improved ADG ($P < 0.05$) and FE ($P < 0.001$) compared to the pigs fed 17.5 and 35% LF70. There was an increase in live weight (18.1 vs 20.2 vs 21.1 kg, sem 0.335; $P < 0.001$) at d 38 as the level of LF70 increased. There was an interaction between LF70 and SBM in the apparent digestibility of gross energy (GED) and nitrogen (ND). Pigs fed higher SBM diets had a higher GED ($P < 0.01$) at the 35% LF70 inclusion than pigs fed PP and SPC diets. However, there was no difference in GED at the 0 and 17.5% LF70 inclusion. Pigs fed higher SBM diets had a higher ND ($P < 0.05$) at the 35% LF70 inclusion than pigs fed PP and SPC diets. However, at 0 and 17.5% inclusion the pigs fed the higher SBM had a decreased ND ($P < 0.05$) compared to the pigs fed PP and SPC diets. In conclusion, the inclusion of LF70 increased ADG, feed intake and FE.

Key Words: Piglets, Lactofeed, Soybean

1575 Interaction between lactofeed level and antimicrobial growth promoters on growth performance of weanling pigs. J. V. O' Doherty^{*1}, C. S. Nolan¹, and P. McCarthy², ¹*University College Dublin*, ²*Volac International, UK*.

In experiment 1, 184 pigs (initially 8.85 kg and 28 +/- 2 d of age) were used in a 2 x 2 factorial arrangement of treatments to investigate the interaction between lactofeed (LF70) (800 g/kg lactose, 200 g/kg soybean meal, Volac International, UK) level (17.5% and 35%) and avilamycin (0 and 200 ppm of maxus, Elanco Animal Health) inclusion in piglet starter diets. Pigs were fed starter diets from d 0 to d 22 and a transition diet was fed from d 23 to d 39. The inclusion level of LF70 in the transition diet was 7.5% and 15%. Pigs fed 35% LF70 had a higher ADG ($P < 0.05$) during the starter period than the pigs fed 17.5% LF70. Pigs fed medicated diets had a higher ADG ($P < 0.01$) and an improved feed efficiency (FE) ($P < 0.05$) compared to the non medicated fed pigs. There was an increase in feed intake (AFI) ($P < 0.05$) during the transition period with increasing levels of LF70. There was an improvement in FE during the transition period with the inclusion of maxus ($P < 0.005$). There was a significant interaction ($P < 0.01$) between LF70 and maxus for ADG during the transition period. The inclusion of maxus at 17.5% LF70 inclusion had no effect ($P > 0.05$) on ADG. However at 35% LF70 inclusion the pigs offered medicated diets had a higher ADG ($P < 0.001$) compared to non medicated diets. In experiment 2, 184 pigs (initially 8.85 kg and 28 +/- 2 d of age) were used in a 2 x 2 factorial to investigate the interaction between LF70 level (17.5% and 35%) and zinc oxide (ZnO) (0 and 3.1 kg/metric tonne) inclusion in piglet starter diets. The inclusion level of LF70 in the transition diet was 7.5% and 15% and ZnO was 2 kg/metric tonne. There was a significant increase ($P < 0.05$) in ADG and an improvement in FE with increasing levels of LF70 during the starter period. The inclusion of ZnO during the starter period resulted in an increase ($P < 0.05$) in ADG and FE compared to

no ZnO inclusion. Neither the inclusion of zinc oxide or LF70 had an effect ($P>0.05$) on performance during the transition period. In conclusion the supplementation of starter diets with increasing levels of LF70, ZnO and avilamycin resulted in increased ADG and improved FE.

Key Words: Pigs, Lactofeed, Avilamycin

1576 Effect of dietary soy isoflavone concentrations on pig growth and meat quality. T.S. Stahly* and T.R. Lutz, Iowa State University.

The effects of four concentrations of dietary soy isoflavones on growth and meat quality of pigs fed from 27 to 119 kg BW were evaluated. Twelve sets of four littermate pigs (6 sets of barrows, 6 sets of gilts) were individually penned and randomly allotted within the litter to a basal (corn-soy concentrate, about 24 ppm isoflavone) diet supplemented with 0, 1x, 2x or 3x ppm of soy isoflavones during each of three stages of growth. The 1x increment represented addition of 180, 120 and 80 ppm isoflavones on an aglycone basis, in stage 1, 2 and 3, respectively. Isoflavones were provided as a soy extract (Novasoy, ADM) which consisted of 21% genistein, 15% daidzein, and 4% glycitein. These isoflavone concentrations are representative of those in diets containing traditional soybean meal with zero, low, medium or high concentration of isoflavones. At 119 kg BW, pigs were slaughtered and carcass and ham composition, longissimus meat quality, and selected muscle weights were determined. Dietary isoflavone concentrations did not alter daily BW gain or gain/feed ratios during any of the three stages of growth. Estimated carcass fat-free lean and dissected ham muscle and fat tissue content also were not altered by isoflavone regimen. Weight of four red-fibered muscles were unaffected by isoflavone addition, while weight of three white-fibered muscles were ($P=0.06$) reduced due mainly to the response of the biceps femoris muscle. Meat quality of the longissimus as reflected in ultimate pH, Hunter L, a, b values, and retail water loss percentage also was not affected by isoflavones. In these data, soy isoflavones at dietary concentrations below 240 ppm for finishing pigs did not alter carcass muscle content or meat quality.

Key Words: Pigs, Soy isoflavones, Growth

1577 Evaluation of chicory inulin extracts as feed additive for early-weaned pigs. G He*¹, S.K. Baidoo¹, Q. Yang¹, D. Golz², and B. Tungland³, ¹Southern Research and Outreach Center, University of Minnesota, MN 56093, ²Encore Technologies, MN 55305, ³Imperial Sensus, TX 77487.

This study was done to evaluate the effects of dietary inclusion of chicory inulin extract on the performance of early-weaned pigs. One hundred and eighty early-weaned (17-d old, 6.0 kg BW) crossbred pigs were allotted into five dietary treatments. The dietary treatments were (1) corn-soybean meal based diet - the basal diet, (2) basal diet + inulin in water, (3) basal diet + inulin in water and feed, (4) basal diet + inulin in feed and (5) basal diet + ASP 250 antibiotic in feed. Inulin supplemented diets fed to pigs in treatments 3 and 4 contained 0.5%, 0.2% and 0.1% inulin in phases 1 (wk 1), 2 (wk 2) and 3 (wk 3 and 4) respectively. Treatment 5 contained 0.25% ASP 250 in all three phases. Treatments 2 and 3 received inulin in water medicator (132 g/L) for 14 days and were maintained on their respective dietary treatments until d 28 of the study. The average daily gain (ADG) for the five dietary treatments was 192.7 g/d, 208.5 g/d, 203.9 g/d, 189.8 g/d, and 196.2 g/d, respectively. In phase 2, pigs fed inulin in feed or water tended to grow faster ($P<0.08$) than the control group (335.7 g/d, 355.1 g/d, 355.4 g/d, 374.1 g/d and 371.0 g/d for the respective five dietary treatments). Inulin in both water and feed did not ($P>0.05$) improve pig performance compared to pigs supplemented with inulin in water or feed only. In phase 3, pigs fed diets supplemented with antibiotics gained more ($P<0.05$) weight than other dietary treatment groups (476.5 g/d vs 399.9 g/d, 422.4 g/d, 402.7 g/d, and 425.5 g/d for treatments 1, 2, 3, and 4, respectively). In conclusion, supplementation of inulin in water or feed tended to improve average daily gain and feed conversion efficiency during the 28-d study.

Key Words: Inulin, Early-weaned pigs, Growth performance

1578 Milky flavor alone but not in combination with sweeteners improves preference at the dietary change from piglet prestarter to starter feeds. E. van Heugten*¹, E. Roura², and M. Gibson³, ¹North Carolina State University, Raleigh, NC, ²Lucta SA, Barcelona, Spain, ³Lucta USA Inc., Northbrook, IL.

Two flavors were assayed in a two double-choice (flavored vs. non-flavored) treatment design. The two flavors tested were both based on milky notes but flavor 1 had a sweetener added (289 ppm saccharine and 300 ppb neohesperidin dihydrochalcone in final feeds) and distinctive vanilla-coconut notes and flavor 2 had no sweetener added and distinctive vanilla-cheese notes. Pigs (5.92±0.01 kg BW) were weaned at 18 days of age, blocked by weight within gender and housed in 12 equally sized indoor nursery pens containing 3 barrows and 3 gilts. Pigs were simultaneously offered 2 identical feeders with the two diets (with and without flavor). Feeders within a pen were switched on a daily basis. Pigs had access to prestarter diets until the average feed consumption per pig for pens within a block had reached 2.27±0.11 kg of feed. At that point diets were changed to the starter feed until the average feed consumption per pig for all pens within a block had reached 9.07±0.45 kg of feed. During the prestarter phase, piglets showed initial neophobia to flavor 1 (30, 32, 31, 35, and 35 compared to the control set at an index of 100 ($P<0.05$) for 5, 4, 3, 2, and 1 d prior to the diet switch, respectively), while no preference or rejection ($P>0.10$) was shown for flavor 2 (66, 123, 89, 110, and 106 compared to the control). Up to 5 days following the diet change, piglets in treatment 1 showed equal preference for flavor 1 vs. the control (85, 61, 62, 72, and 82 compared to the control ($P>0.10$) for 1, 2, 3, 4, and 5 d following the diet change, respectively) while piglets in treatment 2 preferred flavor 2 over the control (190 ($P<0.10$), 156 (NS), 255 ($P<0.05$), 190 ($P<0.10$), and 223 ($P<0.05$)). It is concluded that in treatment comparison 1 control feed was preferred over a combination of flavor and sweeteners, except following the dietary change, while in treatment 2 flavor was preferred over the control particularly after the dietary change.

Key Words: Flavors, Sweeteners, Preference

1579 Interactive effects of diet complexity and a combination of flavor, acid and enzymes on growth of starter pigs. E. Roura*¹, M. Gibson², and J. Brennan³, ¹Lucta SA, Barcelona, Spain, ²Lucta USA, Northbrook IL, USA, ³Maple Leaf Foods Agresearch, Burford, ON Canada.

The effects of dietary supplement (Luctaplus[®] at 0 or 5 kg/tonne) and diet complexity were evaluated in a 2 x 2 factorial design with eight replicate blocks. The feed supplement consisted of a combination of a milky vanilla flavor, organic (citric and lactic among others) and inorganic acids (phosphoric), in addition to several enzyme activities, primarily protease and amylase. Complex and simple diets contained 5.0 or 2.5% plasma protein in phase 1 (week 1), 2.5 or 0% plasma protein in phase 2 (week 2) and 3.0 or 0% fish meal in phase 3 (week 3, 4). All diets contained 20% whey powder in phase 1 and 10% in phase 2. Simple and complex diets were isocaloric, were formulated to the same essential amino acid specifications (NRC, 1998) and contained 22 ppm lincomycin. A total of 192 pigs were weaned at approximately 21 days of age and randomly assigned to pens within block. There were four pens per block and six pigs per pen. Weekly bodyweight, feed intake and fecal consistency scores were recorded throughout a 28-day growth period. There were no significant main effects of treatment on bodyweight but there was a significant interaction effect on day 21 ($P<0.02$) and day 28 ($P<0.01$) bodyweight. Luctaplus[®] supplementation of simple diets significantly ($P<0.05$) increased final bodyweight from 14.5 to 15.3 kg which was not significantly different from that of pigs fed the complex unsupplemented diet (15.1 kg). There were no significant main effects of treatment on feed intake but there were significant interaction effects on feed intake for the day 7-14 ($P<0.02$), day 0-21 ($P<0.04$) and day 0-28 ($P<0.01$) periods. Luctaplus[®] increased ($P<0.05$; day 7-14) feed intake of pigs fed simple diets but reduced ($P<0.05$) overall intake of complex diets. There were no significant ($P>0.05$) main or interactive effects of treatment on feed efficiency and fecal scores. It is concluded that flavor, acid and enzyme supplementation of a simple diet resulted in growth performance and feed efficiency which were not significantly different from those of pigs fed a complex diet.

Key Words: Starter pig, Plasma protein, Flavor acid enzyme

1580 Effects of germanium biotite supplementation on the growth performance and serum characteristics in nursery pigs. O. S. Kwon^{*1}, I. H. Kim¹, J. W. Hong¹, S. H. Lee¹, and Y. K. Jung², ¹*Department of Animal Resource & Science, Dankook University, Cheonan,* ²*Seobong Biobestech. Co., Ltd, Korea.*

This study was conducted to determine the suitability of germanium biotite for a dietary supplement on growth performance, nitrogen digestibility and serum characteristics in nursery pigs. A total 60 crossed pigs (average 15.09±0.18kg BW, Landrace×Duroc×Yorkshire) were used in this experiment. Pigs were allocated into five treatments. Each treatment had three replicates with four pigs per replicate. This study was carried out for 28 days. The five treatments were control (Con: basal diet), GB0.1 (basal diet+germanium biotite 0.1%), GB0.3 (basal diet+germanium biotite 0.3%), GB0.6 (basal diet+germanium biotite 0.6%) and GB1.0 (basal diet+germanium biotite 1.0%). During 0 to 14 days, ADG, ADFI and Gain/feed were not significantly different among the treatments. During 14 to 28 days and overall experimental period, ADG and Gain/feed were not significantly different among the treatments. However, ADFI was significantly increased in GB0.6 treatment ($P < 0.05$). DM and N digestibility were not significantly affected by treatments. In total-cholesterol, difference between d 0 and d 14 was decreased in GB3.0 treatment. However, there was no significant difference among the treatments. HDL-cholesterol was significantly increased in GB3.0 treatment compared to Con ($P < 0.05$). LDL-cholesterol was significantly decreased in GB3.0 treatment with difference between d 0 and d 14 ($P < 0.05$). IgG significantly increased to 86.6% in GB0.1 treatment compared to Con ($P < 0.05$). In conclusion, the results obtained from this feeding trial suggest that below 0.6% supplementation for nursery pigs had improved immunostimulation and decreased cholesterol level in serum.

Key Words: Pigs, Biotite, Growth

1581 Dietary botanical product improves performance of nursery pigs. B. Z. de Rodas^{*}, B. L. Miller, R. Walker, D. A. Nelson, and J. Marin-Guzman, *Land O'Lakes, Webster City, Iowa/USA.*

Four experiments were conducted to determine the effect of a botanical product (BP) on the growth performance of nursery pigs fed diets with or without antibiotics (AB). The BP (Fresta, Delacon, Austria) was a mixture of essential oils, herbs, and spices. Treatments were replicated with six pens of three (Exp. 1 and 4) or five to six (Exp. 2 and 3) pigs each. All experiments were 35 days in length with experimental periods ranging from 7 to 11d, (Phase 1), 10 to 14 d (Phase 2), and 14 d (Phase 3). The diets for Phase 1, 2, and 3 contained 1.6, 1.3, and 1.2 % lysine, respectively. All Phase 1 diets contained Carbadox, while Phase 2 and 3 diets contained Chlortetracycline, Sulfathiazole and Penicillin. In Exp. 1 and 2, pigs (initial weight of 6.6 and 6.3 kg, respectively) were fed diets with 0 and 0.05% BP, with or without AB. In Exp. 1, BP improved overall ADG and F:G ($P < 0.05$). In Exp. 2, AB improved overall ADG ($P < 0.01$), ADFI ($P < 0.05$), and FG ($P < 0.01$). In Exp. 3, pigs with an average initial weight of 6.3 kg were fed a basal diet with 0.05% BP, the basal diet +AB, or the basal diet +BP and AB. For the overall 35 d experiment, the combination of both AB and BP improved ($P < 0.05$) ADG and F:G compared to the single additions of BP or AB. Pigs fed the basal diet +BP had improved ($P < 0.05$) F:G compared to pigs fed the basal diet +AB. In Exp. 4, pigs (initial weight of 6.6 kg) were fed a control diet containing AB with or without 0.05% BP for 35 d. The BP improved ($P < 0.1$) overall F:G. These data suggest that this BP improves the growth performance of nursery pigs. The observed improvement in growth performance of pigs fed BP appeared to be most evident during Phase 2 and 3.

Key Words: Nursery pigs, Botanicals, Antibiotics

1582 Effect of plant extracts and formic acid on the performance and gut microflora of early-weaned piglets. E. G. Manzanilla^{*1}, M. Martín¹, F. Baucells¹, J. F. Pérez¹, C. Kamel², and J. Gasa¹, ¹*Universitat Autònoma de Barcelona,* ²*AXISS France, S.A.S. Archamps, France.*

Two hundred and forty early (20 ± 2.0 d) weaned piglets (6.0 ± 0.46 kg BW) were randomly distributed in 24 replicates and fed a milk by-products diet without additives during a pre-experimental period of 12d. After this adaptation, a 3×2 experimental design resulting from the

combination of three levels of XTRACTTM (0, 150 and 300 ppm), a commercial product based on plant extracts, with or without the addition of 0.5% formic acid was carried out. A single experimental diet (ME: 3.3 Mcal/Kg, CP: 19.46%, Lys: 1.29%) was formulated with 60% of cereals (corn, barley and wheat) and 31% of soybean products (meal and full fat). Voluntary consumption and weight gain were measured on a 22-day period. Finally 8 piglets per treatment were slaughtered and samples from ileum digesta were taken for determination of total purine bases concentration (PB) (as an index of microbial mass) and counts of *enterobacteria* and *lactobacilli* (log₁₀CFU/g fresh weight content). Feed intake (647.6 ± 95.6, g/d), ADG (425.8 ± 57.0, g/d) and OMD (87.1% ± 3.6) were unaffected by treatment. However, piglets fed the 0.5% formic acid plus 300 ppm XTRACTTM diet compared to piglets fed the 0.5% formic acid diet tended ($P < 0.07$) to have higher ADG (g/d) after 14 days (432.6 vs 391.4) and 21 days (447.1 vs 417.0). A F4 (K88) ETEC (enterotoxigenic E. coli) episode occurred and five casualties were registered (4 animals from the replicates without XTRACTTM (two with and two without formic acid) and one from the 150 ppm of XTRACTTM with formic acid). The PB (mmols/g DM) in ileal contents showed a significant decrease as a result of the inclusion of 300 ppm of XTRACTTM (10.84 and 10.34 vs 6.84, $P < 0.01$) for 0, 150 and 300 ppm of XTRACTTM, respectively. The inclusion of 300 ppm of XTRACTTM also promoted a decrease of *enterobacteria* counts (5.85 and 6.06 vs 5.44, $P = 0.16$) coupled with a significant increase in *lactobacilli* counts (7.59 and 7.72 vs 8.31, $P < 0.05$).

Key Words: Plant extracts, Weaned piglets, Lactobacilli

1583 Supplementation of diets with herbal extracts enhances growth performance in newly-weaned piglets. M. Radford^{*1}, E. Jeaurond¹, B. Schumann², M. Clunies², and C.F.M. de Lange¹, ¹*University of Guelph,* ²*Grand Valley Fortifiers, Cambridge, Ontario.*

Concerns about food safety and public health force the pork industry to find alternatives to in-feed antibiotics. The effects of feeding a herbal extract product (HE; containing cinnamon, thyme and oregano) on growth, fecal consistency score (on a scale of 1 to 2) and blood parameters (counts for total and various types of white blood cells) were evaluated in purebred Yorkshire piglets weaned at 16-19 days (d) of age over a three-week period. Dietary treatments were: 0% (CON), 0.25%, 0.5%, 0.75% inclusion level of HE and a medicated control (MED; 55 mg carbadox in finished feed). A total of 27 pens, each with 6 pigs, were utilized (5 pens per diet, 7 for MED). In week 1, ADG was improved ($P < 0.05$) when feeding 0.5% and 0.75% HE, as compared to feeding CON (25 and 26 vs -5 g/d, respectively; SEM 9), while it was intermediate ($P > 0.10$) for the other diets (17 and 1 g/d for MED and 0.25% HE, respectively). In week 1, gain:feed (G:F) was higher ($P < 0.05$) for 0.5% and 0.75% HE than for 0.25% HE (0.30 and 0.32 vs -0.41, SEM 0.41), while it was intermediate ($P > 0.10$) for the other diets. During weeks 2 and 3, no diet effects on ADG and G:F were observed ($P > 0.10$). At 21 d post-weaning, 0.5% HE resulted in higher ($P < 0.05$) BW as compared to CON (8.84 kg vs 7.99 kg, SEM 0.23). Results were intermediate ($P > 0.10$) for the other diets: 8.6 kg, 8.19 kg and 8.32 kg for MED, 0.25% and 0.75% HE, respectively. ADG during the first week following weaning and BW at 21 d post-weaning for 0.5% and 0.75% HE were similar ($P > 0.10$) to MED. On d 14, piglets fed 0.75% HE had an improved ($P < 0.05$) fecal consistency score over CON (1.23 vs 1.55; SEM 0.10). There were no meaningful differences ($P > 0.10$) between diets for the blood parameters. Supplementation of diets with HE enhanced ADG in week 1, BW at d 21 and fecal scores at d 14 post-weaning, although it did not influence other selected indicators of piglet health.

Key Words: Piglets, Herbal extract, Performance

1584 Fermentation and microbial kinetics along the large bowel of growing pigs (20-60 kg) fed on 25% of cornstarch and raw potatoe starch. D. Martínez-Puig, E. G. Manzanilla^{*}, J. F. Pérez, M. Anguita, J. Morales, and J. Gasa, *Universitat Autònoma de Barcelona, Barcelona/Spain.*

Twelve growing pigs (Landrace, initial BW 26 ± 3.6) were randomly distributed in two dietary experimental treatments based on ground barley (29%), soybean meal (33%) and purified starch (25%), obtained either from corn (Diet CS) or raw potatoe (Diet RPS). Diets were characterized by their different content in resistant starch (52 g/kg CS; 143 g/kg RPS), and offered twice daily at 90% of the predicted voluntary intake.

From day 24, urine was collected for a 3 d period, and a sample frozen until analysis of N. On day 38 after dietary presentation, animals were slaughtered, the whole gut excised, ligated and digesta samples obtained from the caecum, proximal-, medium- and distal- colon, and rectum. Digesta samples were analyzed for their content of volatile fatty acid (VFA) and purine bases (PB). Urinary nitrogen excretion tended ($P < 0.11$) to be higher with CS (20.5 g/d) than RPS (15.98 g/d). Fermentation parameters in the large bowel showed differences between experimental diets. With both diets, VFA concentration increased from ileum to proximal colon and decreased thereafter. However, higher VFA concentrations were observed in the proximal colon with RPS than CS (222.09 vs 162.14 mmol/g; $P < 0.01$). PB concentration linearly decreased from the proximal colon to rectum with CS, while PB concentration remained remarkably high back to the medium colon with RPS, decreasing thereafter (Diet \times location; $P < 0.001$). Therefore, higher PB concentrations ($P < 0.02$) were observed with RPS compared to CS in the digesta obtained from the medium colon (48.26 vs 30.46) and distal colon (38.00 vs 26.47). The results suggest that resistant starch consumption promote a higher excretion of microbial N in the faeces and a lower excretion of urinary N.

Key Words: Resistant starch, Swine, Fermentation

1585 Effect of carvacrol on indigenous *Enterobacteriaceae* levels and fermentation products in an in vitro cecal fermentation system. A. Piva^{*1}, C. Cervellati¹, J. E. Call², and J. B. Luchansky², ¹University of Bologna-Italy, ²United States Department of Agriculture, Agricultural Research Service, Wyndmoor, PA.

The inclusion of herbal extracts in feed to enhance animal well being is gaining increasing interest despite the variable results being described. We investigated the effect of carvacrol (CVC), the major essential oil found in oregano, on cecal fermentation and indigenous *Enterobacteriaceae*. The cecal contents of several pigs were collected within 20 minutes after slaughter, pooled, and transferred to fermentation vessels used in a batch culture system held at 39°C. Four vessels were employed for each of the following two treatments: 1) control diet plus cecal contents (CTR), and 2) CTR added with CVC (2.66 mM). Gas production was recorded hourly and data were fitted by the Gompertz bacterial growth model ($r^2 > 0.98$). Ammonia levels were determined at 8 and 24h for each treatment. In addition, *Enterobacteriaceae* levels were determined at 8 and 24h by direct plating portions of each treatment onto Hektoen Enteric agar. During the initial 8h of fermentation, compared to the CTR, the CVC treatment displayed higher ammonia levels (+22%; $P < 0.05$), but there were no differences in ammonia levels between the two treatments at 24h. The maximum volume and rate of gas production were lower in CVC treatments compared to the control (-13 and -21%, respectively; $P < 0.05$). Indigenous *Enterobacteriaceae* levels were 8% (4.8 vs 5.2 log₁₀ CFU/ml; $P < 0.05$) and 24% (4.1 vs 5.4 log₁₀ CFU/ml; $P < 0.05$) lower in CVC treatment than in the control after 8 and 24h, respectively. These data establish the potential of CVC to reduce bacterial gas production and the levels of indigenous *Enterobacteriaceae* in a cecal fermentation.

Key Words: Carvacrol, *Enterobacteriaceae*, Swine

1586 High dose of carvacrol, and not oregano, controls swine cecal fermentation. A. Piva^{*}, C. Cervellati, G. Biagi, and G. Casadei, University of Bologna.

The increasing concern about antibiotic feed additives in farm animal nutrition has lead to explore natural strategies to increase food safety and maintain animal performances. In this in vitro study we investigated the ability of oregano and its major essential oil, carvacrol (CVC), to control swine cecal fermentation. Cecal inoculum was collected from pigs within 20 minutes from slaughter and the fermentation was carried out in a batch culture system and samples were collected for ammonia analysis after 0, 4, 8, and 24h. Gas production was recorded hourly and the data were fitted by the Gompertz bacterial growth model ($R^2 > 0.98$). Four vessels were employed for each of the following four treatments: 1) control diet (CTR), 2) CTR added with oregano (500 mg/kg), 3) CTR added with pure CVC at the concentration supplied by oregano (0.12mM), and 4) CTR added with CVC at the highest MIC recorded for *Escherichia coli* and *Salmonella* in our previous study (3.91mM). Only the latter concentration resulted in significant ($P < 0.05$) differences with a reduction of cecal ammonia over time (-34% at 4h, -28%, at 8h and -48% at 24h), and volume and velocity of gas production (-66% and

-73%, respectively; $P < 0.05$). Following this first trial, a second fermentation study was conducted to identify a dose-response and the minimal dose of CVC that could exert a statistical significant effect on cecal fermentation. Six two-fold dilutions of CVC from 3.91mM were investigated in quadruplicate. Only the 3.91mM dose reduced bacterial activity as shown by volume and rate of gas production (-54 and 57%, respectively; $P < 0.05$) and ammonia production (-11%; $P < 0.05$), whereas the 1.95 mM dose did not show any difference from CTR. These data substantiate the ability of a high dose of CVC to control cecal fermentation, whereas oregano at the tested dose was not effective.

Key Words: Oregano, Carvacrol, Swine

1587 In vitro fermentation characteristics of selected oligosaccharides using swine fecal inoculum. M. R. Smiricky^{*}, E. A. Flickinger, C. M. Grieshop, L. L. Bauer, and G. C. Fahey, Jr., University of Illinois at Urbana-Champaign.

Much of the negative perception concerning oligosaccharides (OS) in pig diets stems from potential depression in digestibility and the increase in gas production resulting from the fermentation of these substrates in the gut. The objective of this study was to compare the fermentation characteristics of selected OS sources: raffinose (R), stachyose (S), R+S combination (R/S), soy solubles (SS), glucooligosaccharides (Glu OS), short-chain fructooligosaccharides (scFOS), medium-chain FOS (mcFOS), long-chain FOS (lcFOS), granular and liquid transgalactooligosaccharides (g-TOS, l-TOS), mannanoligosaccharides (MOS), and xylooligosaccharides (XOS). Three healthy pigs (avg. initial BW = 25 kg) from an antibiotic-free herd served as sources of fecal inoculum. The donor pigs consumed a corn SBM-based diet during the study. Each substrate (115 mg) was fermented in vitro and samples were taken at 0, 2, 4, 8, 12, and 24 h, and pH change, and short chain fatty acid (SCFA) and gas productions determined. Bifidobacteria and lactobacillus populations were determined in the pig fecal inoculum and in the fermentation vessels after 4 and 12 h. Gas production at 12 h was similar for all FOS and TOS forms, SS, and XOS. Vessels containing R, S, and R+S resulted in the greatest ($P < 0.05$) gas production at 12 h for all substrates tested. The pH at 12 h for all FOS forms and XOS did not differ. The pH at 12 h in the vessels containing R, S, R+S was highest ($P < 0.05$) compared to all other substrates. However, the pH at 12 h for SS was much lower ($P < 0.05$) than for the pure soy OS and both TOS forms. Total SCFA production was similar for all FOS and TOS forms, GOS, and SS. However, total SCFA production was highest ($P < 0.05$) for XOS, S, and R+S and lowest ($P < 0.05$) for MOS and R. Vessels containing scFOS, mcFOS, S, and R+S had higher ($P < 0.05$) bifidobacteria concentrations than did those containing the other substrates, with the exception of g-TOS. All OS studied were readily fermentable, but varied in amount and type of SCFA produced. Furthermore, fermentation of pure soy OS resulted in more gas production and higher pH when compared to SS. The OS in the soy matrix appear to behave differently than their pure counterparts.

Key Words: Pigs, In vitro, Oligosaccharides

1588 Effects of elevated and reduced dietary N and S concentration upon growth and concentration of odor causing components in waste of finishing pigs. G. Apgar^{*}, K. Griswold, B. Jacobson, and J. Salazar, Southern Illinois University, Carbondale.

Crossbred finishing pigs (n = 95, initial wt 82 kg) were used to evaluate the effect of elevated or reduced dietary N and S concentrations on growth performance and odor components of waste. Feed and water were offered on an ad libitum basis. Pigs were weighed, feed intake recorded and efficiency calculated every 7 d. Diets contained altered N and S concentrations with chromic oxide as an indigestible marker. Lysine was equalized across dietary treatments and AA concentrations were balanced to support adequate growth. Random fecal samples were collected from each pen during each of the two dietary phases. Frozen fecal samples were subsampled, placed in diluent and analyzed on a mass spectrometer for known odorous compound concentrations. Growth performance did not differ among the treatments during either dietary treatment phase. During the first collection period, there was a significant N \times S interaction ($P < 0.039$), hexanoic acid decreased with lower S content in high N diets, but increased in diets containing reduced S content and lower N concentrations. 3-methylindole tended to respond in the same manner ($P < 0.075$). During the second collection period

there was a significant N x S interaction ($P < 0.036$) following the same pattern above for 4-methylphenol, and a tendency for this interaction to affect phenylacetic acid ($P < 0.092$). During the third collection period, phenol concentration was significantly altered by N ($P < 0.013$) and a N x S interaction ($P < 0.029$), with phenol increasing with reduced S content in the presence of elevated N, and decreasing with reduced S content in lower N diets. 3-methylindole tended to be affected by N ($P < 0.079$), while propanoic acid tended to be affected by S ($P < 0.092$). Reduction of N and S in swine finishing diets does not affect growth performance but can alter the concentration of components implicated in the odorous qualities of swine waste.

Key Words: Waste, Odor, Swine

1589 Effects of dietary supplementation of diatomaceous earth and zeolite on fecal excretion of major odor-causing compounds from growing-finishing pigs fed corn and soybean meal-based diets. Y. Gao, T. C. Rideout*, D. Lackeyram, M. Z. Fan, G. Duns, E. J. Squires, and T. K. Smith, *University of Guelph*.

A trial was conducted to examine the effects of dietary supplementation of natural binding compounds, i.e., diatomaceous earth and zeolite, on fecal excretion of major odor-causing compounds in growing-finishing pigs. Six Yorkshire barrows, with an initial BW of 19 kg, were fed six diets according to a 6 x 6 Latin square design. The diets were corn and soybean meal-based, contained the same amount of CP and AA and differed in the source and level of binding compounds. Diet 1 had no binding compounds and served as the control; diets 2, 3 and 4 contained 1.2, 2.4 and 3.6% of diatomaceous earth; diets 5 and 6 contained 0.6 and 1.2% of zeolite. Ammonia and volatile sulfide contents were analyzed by spectrophotometric analysis, and other odor-causing compounds were determined by using a gas chromatography-mass spectrometer. Supplementing diatomaceous earth and zeolite did not affect the fecal excretion of ammonia, short-chain fatty acids, *p*-cresol or indole. However, adding diatomaceous earth at the levels of 2.4 and 3.6% (diets 3 and 4) decreased ($P = 0.07$ and 0.05) the fecal excretion of total volatile sulfides (2.98 and 2.87 vs. 4.52 g H₂S ·kg DMI) in comparison with the control diet. In conclusion, adding suitable levels of diatomaceous earth

in swine diets may effectively decrease volatile sulfide-associated odor and pollution to the environment.

Key Words: Diatomaceous earth and zeolite, Odor-causing compounds, Pigs

1590 Efficacy of various microbial urease inhibitors in controlling ammonia and volatile sulfide emission from swine manure slurry. T. C. Rideout* and M. Z. Fan, *University of Guelph, Guelph, Ontario*.

Three experiments were conducted to evaluate the effectiveness of the microbial urease inhibitors phenylphosphorodiamidate, N-(n-butyl)thiophosphoric triamide, and acetohydroxamic acid in reducing ammonia (NH₃) and volatile sulfide (in hydrogen sulfide unit, H₂S) emission from stored swine manure slurry. Liquid manure slurry was collected from the University of Guelph Arkell Swine Research Station and treated with six graded dosages (0.00, 0.40, 0.80, 1.20, 1.60, and 2.00 g/kg DM manure slurry) of the aforementioned urease inhibitors according to a completely randomized block design. Cumulative NH₃ and H₂S emission was measured over a 7-d period in an *in vitro* measurement system. Ammonia-nitrogen, urea-nitrogen, and volatile sulfide contents of the manure slurry were analyzed at the start and the end of the 7-d emission measurement. There were no differences ($P > 0.05$) in NH₃-N, urea-N, and H₂S contents in the manure slurry at the end of the 7-d emission measurements among the six dosages of the urease inhibitors. As urea hydrolysis in the manure slurry was complete at the start of the emission measurement, there were no differences ($P > 0.05$) in NH₃ emission rates in response to the addition of the urease inhibitors. However, the control groups appeared to have a lower rate of H₂S emission in comparison with the urease inhibitor-treated groups. While the results of this study suggest that the effectiveness of microbial urease inhibitors in controlling NH₃ emission from animal waste is strongly dependent on the time of application, more work is needed to clarify the dose-response relationship between urease inhibitors and volatile sulfide emission from swine manure slurry.

Key Words: Microbial urease inhibitors, Swine manure slurry, Ammonia and sulfide emission

Ruminant Nutrition Ruminal Fermentation

1591 Effects of barley grain particle size on dairy cow performance. G. R. Ghorbani*¹ and A. Moradai¹, ¹*Isfahan University of Technology*.

Six Holstein cows were used in a 3 x 3 replicated Latin square design to investigate the effect of different particle sizes of ground barley grain on lactation performance. Geometric mean diameters of the barley particles were 0.94, 1.93 and 2.9 mm for treatment 1, 2 and 3 respectively. Diets were only different in barley particle size and all cows received diets containing 40 percent corn silage and 60 percent concentrate (DM basis). About 50 percent of the concentrate was ground barley with different particle sizes. The differences among dry matter intake (DMI), milk fat percentage, milk total solid percentage, daily fat yield, dry matter digestibility, urine, and ruminal pH, daily body weight change, and fecal particle size distribution were not significant. Treatment 3 caused a decrease ($P < 0.05$) in milk protein percentage, daily milk yield, and fecal pH compared to treatment 1 and 2, but the differences between treatment 1 and 2 were not significant. With increasing barley particle size, fecal dry matter was increased and daily milk protein yield was decreased significantly ($P < 0.05$). Differences between treatments 1 and 2 or 2 and 3 for 4 percent FCM, 4 percent FCM/DMI daily, milk lactose yield, daily total solids yield and organic matter digestibility were not significant, but differences between treatments 1 and 3 for 4 percent FCM and 4 percent FCM/DMI were observed. The soluble fraction, the potential degradable fraction, the ruminal degradation rate and the effective degradability of dry matter increased linearly for treatments 1, 2 and 3, respectively. It is concluded that fine grinding of barley which is commonly used on dairy farms improved OM digestibility, milk yield, protein percentage and production and would be recommended for nutrition conditions similar to the present experiment.

Key Words: Barley, particle size, Dairy cow

1592 Determination of energy values and degradability characteristics of triticale varieties. Ulku Gursay*¹ and Aydan Yilmaz, ¹*Ankara University Agriculture Faculty, Ankara, Turkey*.

The objective of this research was to investigate the rumen degradability characteristics and energy values of triticale varieties used in ruminant nutrition in Turkey. Three Anatolia Merinos rams (3 yr old and 70 kg live weight) fitted with ruminal cannulas were used. Animals were fed the same ration during the trial. To determine rumen degradability characteristics, triticale varieties were incubated in nylon bags for 2, 4, 8, 16, 24, and 48 h in the rumen. Degradability characteristics of DM (dry matter) and OM (organic matter) of feed samples were determined using the equations $P = a + b(1 - e^{-t})$ and $Pe = a + bc/(c + k)e^{-t}$ (McDonald 1981). Effective ruminal degradabilities (at an assumed passage rate of 0.05/h) of triticale varieties for DM and OM were: (Presto, Karma 2000, Tatlycak 97, and Tacettinbey) 76.37, 77.77; 67.97, 70.90; 76.87, 79.57; and 74.94, 77.47. Degradability (%) in 48 h were: 91.35, 91.35; 82.66, 84.19; 88.40, 89.82; and 87.36, 88.62 respectively. The enzyme technique (in vitro) was used to estimate energy values. The ME values (kcal/kg DM) of triticale varieties were 3079, 3012, 3065, and 3046, respectively. Differences for DM and OM (based on DM) effective degradabilities for Presto, Tatlycak, and Tacettinbey varieties were not significant ($P > 0.05$), but the Karma 2000 variety was lower ($P < 0.05$). When the same varieties were compared for ME values, the Presto and Tatlycak varieties did not differ ($P > 0.05$), but differences between the other varieties were significant ($P < 0.05$). *This research was summarized from the M.S. thesis of Ulku Gursay, Ankara University Agriculture Faculty, Department of Feeds and Animal Nutrition.

Key Words: Varieties of Triticale, Nylon Bag Technique, Method of Cellulase, Degradability

1593 Metabolism of 1,2-propanediol in lactating cows under washed reticulo-rumen conditions. N.B. Kristensen*, A. Danfaer, B.A. Rojen, B.-M.L. Raun, M.R. Weisbjerg, and T. Hvelplund, *Danish Institute of Agricultural Sciences, Tjele, Denmark.*

The present study aimed to investigate the metabolism of 1,2-propanediol (PPD; propylene glycol) by studying glucose kinetics and plasma metabolite concentrations in lactating cows without interference from the ruminal microbiota. Three rumen-cannulated cows (14, 20, and 25 kg milk/d) were subjected to three washed reticulo-rumen infusion treatments in a Latin square design. The treatments were control (acetate + butyrate), propionate (control + propionate), and PPD (control + PPD). The absorption rate of each of the metabolites was maintained for 420 min by continuous intra-ruminal infusion of the nutrients into 30 L of bicarbonate buffer placed in the reticulo-rumen. The irreversible loss rate of glucose as well as the relative enrichment of lactate and alanine were measured by GLC-IRMS following intravenous infusion of [U-¹³C]glucose. The ruminal disappearance of acetate ($1,219 \pm 25$ mmol/h) and butyrate (210 ± 4 mmol/h) was not affected ($P > 0.10$) by treatment. With the propionate treatment 730 ± 23 mmol/h of propionate were absorbed and with the PPD treatment 721 ± 17 mmol/h of PPD were absorbed. The irreversible loss rate of glucose decreased during the study ($P < 0.001$; the mean decrease was 68 ± 12 mmol/h). However, the mean irreversible loss rate of glucose (441 ± 35 mmol/h) was not different ($P > 0.10$) between treatments. The plasma concentration of PPD reached 4.9 ± 0.6 mmol/L at the end of the intra ruminal infusion indicating that it was not efficiently metabolized under washed reticulo-rumen conditions. Nevertheless, the relative C-13 enrichment of plasma lactate decreased ($P < 0.05$) with the PPD treatment compared with control. It was concluded that PPD had a low metabolizability under washed reticulo-rumen conditions though some PPD apparently was metabolized into lactate. The study also suggested that it is difficult to induce short-term treatment differences in the irreversible loss rate of glucose even in ruminants deprived of the ruminal propionate absorption.

Key Words: Ruminant, Propylene glycol, Metabolism

1594 A comparison between rumen evacuation and gas production techniques in screening forages. H. Z. Taweel, B. Tas, B. A. Williams, J. Dijkstra, and S. Tamminga, *Animal Nutrition Group, Wageningen, The Netherlands.*

This study compares rumen evacuation and gas production as means to screen forages. Eight cultivars of perennial ryegrass (*Lolium perenne*) were cut daily at the same age (4 weeks re-growth) and stall-fed to six rumen-cannulated, high-producing, Holstein-Friesian dairy cows in 7 periods of 2 weeks each. Cultivars 7 and 8 were each fed to 3 cows in periods 1, 3, 5, and 7, whereas cultivars 1 to 6 were each fed to one cow in periods 2, 4, and 6 in a 2 (3×3) Latin square design. At the end of the second week, cows were rumen-evacuated twice, and the fractional NDF degradation rate (kd) was estimated using ADL as an internal marker for solid particles passage. Grass samples were also taken, freeze-dried, ground, and fermented for 72 hours using the automated gas production technique. The resulting gas production curves were fitted using dual-pool Logistic and Gompertz models. In these models the second pool is assumed to represent the non-soluble (fiber) fraction, and allows the estimation of the specific fermentation rate of the fiber. The kd based on evacuation was lower than that based on gas production (2.57 VS 5.40 %/h). Moreover, ranking of cultivars was different between techniques. Rumen evacuation showed that cultivars 7 and 8 had faster kd than the other cultivars, whereas, data from gas production showed the opposite as cultivars 7 and 8 had the slowest kd. Rumen evacuation refers to the declining total NDF pool in the rumen and it estimates kd of the total NDF fraction. Whereas, gas production refers to the growing gas pool and it estimates kd of the potentially degradable NDF fraction with the assumption that the rate of gas production is directly proportional to substrate degradation. Moreover, with gas production the second pool is often assumed to represent the fiber fraction, though it actually represents the slowly fermentable fraction, which may or may not be fiber. Therefore, it can be concluded that these techniques are not comparable for these forages.

Key Words: Rumen-evacuation, Gas-production, Degradation rate

1595 Effect of stage of growth on the protein and carbohydrate subfractions of alfalfa and Timothy hay. P. Yu*,¹ D.A. Christensen¹, and J.J. McKinnon¹, ¹*Department of Animal and Poultry Science, University of Saskatchewan.*

The two varieties of alfalfa (*Medicago sativa* L. cv. Pioneer, Beaver) and timothy (*Phleum pratense* L. cv. Climax, Joliette) hay grown at three different locations (N=3) were cut at three stages of growth: 1=early bud for alfalfa and joint for timothy; 2=late bud for alfalfa and pre-bloom head for timothy; 3=early bloom for alfalfa and full head for timothy. The objective was to investigate the effect of variety and maturity stage on the degradable crude protein (CP) (PA, PB1, PB2, PB3, PC) and carbohydrate (CHO) (CA, CB1, CB2, CC) subfractions as partitioned by the Cornell Net Carbohydrate Protein System. The results showed that comparing alfalfa and timothy means, alfalfa contained higher ($P < 0.05$) levels of PA (41.5 vs. 16.5 % CP), PB3 (27.2 vs. 21.3 % CP), PC (8.6 vs. 5.2 % CP; $P = 0.08$), CA (36.0 vs. 14.7 % CHO) and CC (35.1 vs. 16.4 % CHO), but lower ($P < 0.05$) levels of PB1 (8.4 vs. 23.6 % CP), PB2 (10.7 vs. 33.5 % CP) and CB2 (27.4 vs. 67.6 %CHO). Forage variety had little effect, however, stage of growth influenced both the CP and CHO subfractions. As plant maturity advanced from stage 1 to 3, the rapidly degradable CP fraction (PA) was reduced ($P < 0.05$) in alfalfa (51.2 to 34.8% CP), but increased ($P < 0.05$) in timothy (9.2 to 27.5% CP); the rapidly degradable CP fraction (PB1) increased ($P < 0.05$) in alfalfa (0.0 to 25.2% CP) but decreased ($P < 0.05$) in timothy (31.6 to 16.7% CP); the intermediately degradable CP fraction (PB2) was reduced ($P < 0.05$) in both forages (alfalfa: 14.1 to 5.2% CP; timothy: 37.8 to 29.4% CP); the slowly degradable CP fraction (PB3) was reduced ($P < 0.05$) in alfalfa (33.1 to 17.7% CP) but not in timothy (averaging 21.3% CP); the unavailable CP fraction (PC) was increased ($P < 0.05$) in alfalfa (3.5 to 17.1% CP) but not in timothy (averaging 5.2% CP). As plant maturity advanced, CHO subfractions in both forages were impacted to a lesser degree than the CP subfractions. The results indicate that within each forage species, stage of growth has a greater impact than variety on the partitioning of CP and CHO, into fractions that vary in availability to fermentation by rumen microbes.

Key Words: Protein and Carbohydrate Subfractions, Forage Quality, Maturity and Variety

1596 Site of digestion when soyhulls replace corn in diets of dairy cows. I. R. Ipharraguerre*, Z. Shabi, J. H. Clark, and D. E. Freeman, *University of Illinois.*

Soyhulls (SH), a by-product of soybean processing, can be used as a replacement for corn grain in dairy cattle diets because of their high content of fermentable fiber. Five multiparous Holstein cows cannulated in the rumen and duodenum that averaged 63 DIM were used in a 5x5 Latin square design to evaluate the substitution of SH for corn in the diet. Diets contained 23% alfalfa silage, 23% corn silage, and 54% concentrate on DM basis. Pelleted SH replaced corn to supply 0, 10, 20, 30, or 40% of the dietary DM. Intakes of DM and OM and OM truly digested in the rumen were unaffected by treatments ($P > 0.05$; mean = 21.6, 20.0, 8.1 kg/d, respectively). The intake of NDF (5.9, 6.3, 7.7, 8.9, and 9.4 kg/d) increased linearly ($P < 0.01$), but the intake of NSC (8.5, 6.7, 6.0, 5.0, and 3.7 kg/d) decreased linearly ($P < 0.01$) as SH increased from 0 to 40% of the dietary DM. As SH replaced corn in the diet, the amount of NDF digested was increased whereas the amount of NSC digested was decreased in the rumen (NDF = 2.6, 2.6, 3.6, 3.6, and 4.2 kg/d, $P < 0.01$; NSC = 1.8, 2.1, 1.0, 0.6, and 0.3 kg/d, $P < 0.01$), in the lower digestive tract (NDF = 0.6, 0.9, 0.9, 1.6, and 1.4 kg/d, $P < 0.04$; NSC = 6.0, 4.2, 4.6, 4.1, and 3.0 kg/d, $P < 0.01$) and in the total tract (NDF = 3.2, 3.5, 4.5, 5.2, and 5.5 kg/d, $P < 0.01$; NSC = 7.8, 6.3, 5.6, 4.6, and 3.3 kg/d, $P < 0.01$). Passage to the duodenum of nonammonia N, microbial N, nonammonia nonmicrobial N, total essential AA, total nonessential AA, and total AA were not affected by treatments ($P > 0.05$; mean = 574, 304, 270, 1389, 1665, and 3053 g/d, respectively). Differences in the source of energy (fiber vs. NSC), in the amounts of fiber and NSC digested, and in the site of digestion in the gastrointestinal tract may cause a shortage of energy that decreases milk production when more than 30% of the dietary DM that is supplied as corn is replaced with SH.

Key Words: Soyhulls, Ruminal fermentation, Nutrient digestion

1597 Effects of combinations of crotonate and three methane inhibitors on rumen fermentation in vitro. E.M. Ungerfeld*, S.R. Rust, and R. Burnett, *Michigan State University, East Lansing, MI.*

We hypothesized that the use of crotonate as an electron sink could relieve the constraints on fermentation caused by the CH₄ inhibitors lumazine, propynoate, and ethyl 2-butyrate. In three experiments with 24-h mixed rumen batch cultures, lumazine (0, 0.3 and 0.6 mM, Exp. 1), propynoate (0, 2 and 4 mM, Exp. 2), and ethyl 2-butyrate (0, 4 and 8 mM, Exp. 3), were each incubated in 160 mL Wheaton bottles (n = 4) with crotonate (0 and 8 mM with lumazine, 0 and 4 mM with propynoate acid, and 0 and 4 mM with ethyl 2-butyrate). Ground alfalfa hay was the substrate. Lumazine, propynoate, and ethyl 2-butyrate decreased (P < 0.01) CH₄ production by 9, 70, and 94 %, respectively. Crotonate decreased (P < 0.01) CH₄ production by 10 % in Exp. 1, and tended (P = 0.08) to decrease it by 9 % in Exp. 2, but did not affect it in Exp. 3. There were no interactions between crotonate and any of the inhibitors. Lumazine, propynoate, and ethyl 2-butyrate decreased (P < 0.01) fermented OM (as estimated through a mass balance) by 7, 21, and 35 percentage units, respectively. Crotonate did not affect fermented OM in Exp. 1 and 3. In Exp. 2, crotonate stimulated OM fermentation by 5 percentage units at 4 mM propynoate, but dropped it by 6 and 3 percentage units at 0 and 2 mM propynoate, respectively (interaction P = 0.04). Crotonate increased (P < 0.01) the acetate:propionate ratio (A/P) in Exp. 1. In Exp. 2, crotonate increased A/P at 0 and 4 mM propynoate, but not at 2 mM (quadratic interaction P < 0.01). Crotonate tended (P = 0.11) to increase A/P in Exp. 3. Lumazine increased (P = 0.02) A/P, while both propynoate and ethyl 2-butyrate decreased (P < 0.01) it. The inhibition of methanogenesis by propynoate and ethyl 2-butyrate caused (P < 0.01) the accumulation of H₂, formate, and ethanol. In all the experiments, crotonate increased (P < 0.01) butyrate molar percentage. Crotonate did not overcome the decrease in fermentation caused by the CH₄ inhibitors.

Key Words: Rumen, Methane, Inhibition

1598 Effects of natural plant extracts on nitrogen metabolism and fermentation profile in continuous culture. M. Busquet¹, S. Calsamiglia^{*1}, A. Ferret¹, and C. Kamel², ¹*Universitat Autònoma de Barcelona, Spain*, ²*Aixis France*.

Eight 1.3-L dual flow continuous culture fermenters were used in two periods (10 d) to study the effects of natural plant extracts on N metabolism and fermentation profile. Fermenters were fed 95 g/d of a 60 to 40 forage to concentrate diet. Treatments were: no extract or negative control (C), Monensin (1.75 mg/d per fermenter, M), or 7.5 mg/d per fermenter of Fenugreek (F), Cade (CA), Tea Tree (T), Dillweed (D), Ginger (G) or Clove Bud (CL). Fermenters were maintained at constant temperature (39 °C), pH (6.4) and solid (5% / h) and liquid (10% / h) dilution rates. Each day, a sample was taken 2 h after the morning feeding for the determination of ammonia (NH₃) N and volatile fatty acids (VFA). During the last 2 days, samples were taken at 0, 2, 4, 6, and 8 h after the morning feeding, and analyzed for peptide (Pep), amino acid (AA) and NH₃ N concentrations. Data were analyzed using the PROC MIXED (SAS, 1996) and significance declared at P < 0.05. Total VFA was similar across treatments (111.1 mM). Acetate concentration (mol/100mol) was lower for CL (57.5) compared to C (61.9) and M (61.1). Propionate concentration (mol/100mol) was higher in CL (28.0) versus C (23.2) and M (24.2). The Pep-N concentration across all hours (mg/100ml) was higher for CL (6.93) compared to C (3.84) and M (4.18). The AA-N concentration across all hours (mg/100ml) was numerically lower in CL (2.85) and higher in C (5.27) and M (5.17). The NH₃-N concentration across all hours (mg/100ml) was numerically higher in M (9.55) and lower in CL (6.43). The accumulation of Pep-N, and the decrease in AA-N in CL suggested that peptidolysis was inhibited.

Key Words: Microbial fermentation, Plant extract

1599 Influence of grain density on rumen and digestive characteristics. A. Offner^{*1}, A. Bach², and D. Sauvant¹, ¹*INA P-G INRA, Paris, France*, ²*Agribrands, Barcelona, Spain*.

The effect of technological treatment of cereals on ruminant digestion has been poorly quantified. The objective of this study was to evaluate the interest of using grain density (D) as a predictor of treatment effects.

A database on ruminal digestibility in cattle pooled 21 references and 69 treatments studying the influence of grain density. Corn and sorghum were used in 80 % of the references. Treatments were mostly steam flaking and dry rolling and the corresponding grain density ranged from 170 to 684 g/L (D = 389 ± 100 g/L). Statistical analyses of the data used GLM models and integrated the experimental effect as a qualitative variable. The results showed the large effect of density on several key parameters. Decreasing density significantly increased ruminal starch digestibility (Starch dR = 73.7 ± 15.8 %): Starch dR, % = 99.88 - 0.063D (n = 58, n_{exp} = 20, R² = 93.2 %, rsd = 5.1 %). Consequently, ruminally fermented organic matter (RFOM = 61.6 ± 12.0 %DM) increased by 21 %DM when density dropped by 100 g/L. Organic matter digestibility in the total tract (dOM = 73.9 ± 8.0 %) increased similarly: dOM, % = 84.04 - 0.025D (n = 46, n_{exp} = 16, R² = 93.7 %, rsd = 2.5 %). The treatments had an effect on microbial protein formation (MCP = 73.7 ± 16.5 %DM), which increased when density decreased: MCP, %DM = 83.82 - 0.021D (n = 33, n_{exp} = 12, R² = 95.3 %, rsd = 4.5 %DM). Nevertheless, the influence of grain density on rumen pH (pH = 6.0 ± 0.3) was also noticeable: pH = 5.54 + 0.001D (n = 38, n_{exp} = 13, R² = 94.4 %, rsd = 0.1). Adjusted pH was under 6 for density below 460 g/L. Grain density is a simple quantitative parameter, which can be used to predict some ruminal parameters. It is concluded that the digestive effects of technological treatments such as steam flaking can largely be captured considering density effects.

Key Words: Rumen, Grain density, Steam flaking

1600 The binding and degradation of nisin by mixed ruminal bacteria. S.S. Lee^{*1}, H.C. Mantovani¹, and J.B. Russell², ¹*Cornell University*, ²*ARS/USDA*.

Monensin and the bacteriocin, nisin, have similar effects on ruminal fermentation, and bacteriocins have been suggested as another means of altering ruminal fermentation. Because monensin and nisin both catalyze potassium efflux from sensitive bacteria, potassium depletion can be used as an index of sensitivity. Nisin catalyzed potassium efflux from glycolyzing *S. bovis* cell suspensions, and the steady state concentration of residual potassium was dependent on the amount of nisin added. The relationship between nisin concentration and potassium depletion was a saturation function that had considerable cooperativity. By pre-incubating mixed ruminal bacteria with nisin and removing them prior to *S. bovis* JB1 addition, it was possible to estimate the ability of mixed ruminal bacteria to bind or degrade nisin. Low concentrations of mixed ruminal bacteria did not bind or degrade all of the nisin in 6 h, but little nisin remained if the mixed ruminal bacteria were present at more than 50 g protein per ml. Because cell-free ruminal fluid (10% v/v) inactivated the nisin in less than 2 h, and this inactivation could be counteracted by autoclaving, ultra-filtration and proteinase inhibitors it appeared that there was an enzymatic degradation of nisin. Mixed ruminal bacteria degraded nisin rapidly, but this degradation did not prevent potassium depletion from mixed ruminal bacteria. These latter results indicated that nisin binding was faster than nisin degradation. The idea that nisin binding could protect nisin from degradation was supported by the observation that intact nisin could be extracted from mixed ruminal bacteria. These observations support the hypothesis that bacteriocins can be used to modify ruminal fermentation, but further work will be needed to see if these peptides can be produced economically.

Key Words: Rumen, Bacteriocin, Fermentation

1601 A decision support system to evaluate methane and nitrogen emissions from dairy cows. E. Kebreab^{*}, J.A.N. Mills, L.A. Crompton, and J. France, *The University of Reading, Reading, United Kingdom*.

Methane and nitrogen (N) emissions from dairy cattle are major contributors to environmental pollution arising from agriculture. The agricultural industry needs to reduce its emissions considerably, and research has demonstrated that one way to achieve this goal is through dietary manipulation. To this end, a few technical models have been developed to evaluate environmental pollution. However, few if any, combine the effects of more than one pollutant and most are too technical and detailed to be used efficiently by farmers or farm advisors. The objective of this study was, therefore, to integrate published, dynamic models describing methane and N metabolism in the lactating dairy cow, and

present the results with the aid of graphical user interface (GUI). Although the technical models were originally developed using ACSL, the advanced continuous simulation language, they were re-coded in Visual Fortran to harmonize the models. The GUI was written in Visual Basic 6. Comparison of the decision support system (DSS) output with those of the individual models showed that the DSS was able to predict methane and N output with the same degree of reliability as the individual models. The GUI allows the user to enter commonly available information on the diet and obtain results in a spreadsheet format on emission levels for methane and predicted N outputs in urine, feces and milk, and assigns a pollution index. Within a short period of time, the user can optimize a dietary regime which balances the economic cost of the diet and pollution index. Preliminary results have shown that feeding diets based on low degradable energy sources such as corn, significantly reduce methane emissions and shifts the route of N excretion from urine to feces, which is a lesser pollutant. The DSS can also be used to estimate emissions at the farm or national level.

Key Words: Dairy cows, Models, Pollution

1602 The effect of condensed tannins from *Lotus corniculatus* on growth and proteolytic activity of rumen bacteria. B.R. Min^{*1}, G.T. Attwood², T.N. Barry³, and W.C. McNabb², ¹E (Kika) dela Garza Institute for Goat Research, Langston University, OK 73050, USA, ²AgResearch, Grasslands Research Center, Palm/North, ³Massey University, Palm/North, NZ.

Eleven strains of ruminal bacteria (*Streptococcus bovis* NCFB 2476 and B315, *Butyrivibrio fibrisolvens* strains WV1 and C211a, *Prevotella ruminicola* 23, *Prevotella*-like strain C21a, *Ruminococcus albus* 8, *Fibrobacter succinogenes* S85, *Eubacterium* sp. C12b and C124b, and *Clostridium proteoclasticum* B316T) were used to determine the effect of condensed tannins (CT) from *Lotus corniculatus* (LC) on the proteolysis of the large (LSU) and small (SSU) subunit of ribulose-1,5-bisphosphate carboxylase (Rubisco) protein extracted from white clover, and on bacterial growth in vitro. The effects of CT were determined with and without polyethylene glycol (PEG; 1.7 mg PEG/mgCT), which binds and inactivates CT. Proteolysis of LSU and SSU of Rubisco (with 1.5 mgCT/ml) was determined in vitro and measured using a SDS-PAGE procedure. Bacterial growth in a plant protein medium containing 0, 50, 100, 200, 400, and 600 µgCT/ml was also measured after 0, 2, 4, 8, 12 and 24h of incubation. Proteolytic bacterial cultures without CT or with CT+PEG degraded LSU and SSU rapidly (6-38%/h), but proteolysis varied markedly between species. Cultures of *P. ruminicola* C21a degraded both the LSU (11.3%/h) and SSU (9.8%/h) when grown in the presence of 1.5 mgCT/ml. Bacterial strains *S. bovis* B315 (11.5%/h) and strain NCFB 2476 (10.6%/h), *Eubacterium* sp. C12b (5.1%/h) and C124b (5.5%/h) appeared to degrade SSU more effectively than the LSU (2.6, 2.3, 3.8, and 2.6%/h, respectively) in the presence of 1.5 mg CT/ml. *F. succinogenes* S85, *R. albus* 8, *P. ruminicola* 23, *C. proteoclasticum* B316T, *B. fibrisolvens* WV1 and C211a had low (0.3) to moderate (3-4%/h) rates of proteolysis when CT was included in the medium. In the absence of CT, all bacterial strains showed typical growth. Addition of 200, 400 and 600 µgCT/ml significantly ($P < 0.05$) reduced the growth rate and maximum optical density of most bacterial strains tested compared to the minus CT controls. Some strains (*C. proteoclasticum* B316T; $P < 0.05$ and *R. albus* 8; $P = 0.09$), however, showed transient increases in their growth rate at low (50-100 µgCT/ml), but not at higher concentrations. It was concluded that CT from LC reduced the rate of proteolysis and inhibited the growth of proteolytic rumen micro-organisms.

Key Words: Condensed tannins, rumen bacteria, proteolysis

1603 Dose-response effects of intra-ruminal infusion of propionate on feeding behavior of lactating dairy cows in early or mid-stage of lactation. M. Oba^{*} and M. S. Allen, Michigan State University, East Lansing, MI.

The objective of this experiment was to evaluate how dose-response effects of intra-ruminal infusion of propionate on feeding behavior and DMI differ by stage of lactation. Six cows in early stage of lactation (EL) and six cows in mid stage of lactation (ML) were used in a duplicated 6 x 6 Latin square design (9 6 and 192 17 days in milk, respectively for EL and ML; mean SD). All cows were ruminally cannulated prior to the experiment. The experimental diet was formulated to contain 30% NDF, and dry cracked corn (mean particle size = 3.6 mm)

was the primary source of starch. Infusion treatments were mixtures of sodium propionate and sodium acetate, at ratios of 0:5, 1:4, 2:3, 3:2, 4:1 and 5:0, infused into the rumen continuously for 18 h starting 6 h before feeding at a rate of 21.7 mmol of sodium VFA/min. We hypothesized that propionate infusion decreases DMI by stimulating oxidative metabolism in the liver. We expected greater hypophagic effects of propionate for EL compared to ML because of greater oxidative metabolism of non-esterified fatty acids in the liver for EL compared to ML (plasma concentration: 275 and 76 meq/L, EL and ML, respectively; $P < 0.001$). Propionate infusion decreased DMI for EL and ML, but a quadratic effect of propionate infusion was observed for ML only (interaction $P < 0.10$), indicating greater marginal reduction in DMI at higher doses of propionate for ML compared to EL. Contrary to our hypothesis, propionate infusion linearly increased intermeal interval for ML but not EL, but decreased meal size similarly for both stages of lactation. Greater milk yield for EL compared to ML (42.0 vs. 30.8 kg/d $P < 0.001$) probably increased glucose demand of peripheral tissues and decreased the relative proportion of infused propionate oxidized in the liver, delaying the sense of hunger. Glucose demand of peripheral tissues might alter hypophagic effects of propionate by affecting the extent of oxidative metabolism in the liver.

Key Words: Propionate, Oxidative metabolism, Glucose demand

1604 Monensin by fat interactions on *trans* fatty acid concentrations in cultures of mixed ruminal microbes grown in continuous fermenters fed corn or barley. T. C. Jenkins^{*1} and V. Fellner², ¹Clemson University, Clemson, SC, ²North Carolina State University, Raleigh, NC.

In previous studies, monensin (M) and unsaturated plant oils independently increased *trans* fatty acid concentrations in cultures of mixed ruminal microbes. This study was conducted to determine if combining M with plant oil yielded interactions on *trans* fatty acid concentrations in cultures of mixed ruminal microbes or their effects were additive. Four continuous fermenters were fed 14 g of dry feed per day (divided equally between two feedings) consisting of alfalfa hay pellets (30% of DM) and either a high corn (HC) or a high barley (HB) concentrate (70% of DM) in each of two fermenters. Within each grain type, one fermenter was supplemented with M (25 ppm) and the other fermenter was supplemented with 5% soybean oil (SBO) during d 5 to 8. Monensin and SBO were added together in all fermenters during d 9 to 12. Samples were taken at 2 h after the morning feeding on the last day of each period and analyzed for fatty acids by gas chromatography. A second run of the fermenters followed the same treatment sequence to give additional replication. Average pH across all treatments was 6.15, which was reduced ($P < 0.01$) by M but not affected by SBO. Monensin reduced ($P < 0.05$) the ratio of acetate to propionate, which averaged 2.03 across all treatments; fat decreased the acetate to propionate ratio in cultures not receiving M but increased it in the presence of M. Monensin and SBO altered the concentration of several *trans* fatty acids, but the only interaction was a grain x M x SBO interaction for *trans*-10 C18:1. The increase in *trans*-10 C18:1 by the M and SBO combination exceeded the sum of increases in *trans*-10 C18:1 for each individual feed additive, but only for HB. For the HC diet, M increased ($P < 0.05$) *trans*-10 C18:1 more than fat alone and more than the M and SBO combination. The results of this study show that M and SBO effects are additive for all *trans* fatty acids except for *trans*-10 C18:1. In the case of *trans*-10 C18:1, M and SBO interacted to give higher *trans*-10 C18:1 concentrations in ruminal contents than would be expected simply by adding their individual effects, but only for HB. Because some *trans* fatty acid isomers have been associated with milk fat depression in dairy cows, these results suggest more severe depressions in milk fat content when cows are fed M along with unsaturated plant oils.

Key Words: Monensin, *Trans* Fatty Acids, Continuous Cultures

1605 Utilization of fermentable carbohydrate and protein by ruminal microbes in continuous cultures. K.S. Mohney^{*1}, V. Fellner¹, A.L. Mueller², R.L. Belyea², and M.L. Gumpertz¹, ¹North Carolina State University, Raleigh, NC, ²University of Missouri, Columbia, MO.

A major factor in maximizing microbial protein synthesis is the availability of energy and protein in the diet. Our objective was to determine the effect of fermentable carbohydrate and protein on microbial fermentation. Diets were formulated using three ingredients, soybean meal

(SBM), ground corn (GC) and soybean hulls (SBH). Corn and SBH were used in ratios of 60:20, 40:40 or 20:60, respectively to prepare high (HC), medium (MC) or low (LC) corn diets. Soybean meal was included either unextruded (control) or extruded at L (L), medium (M) or high (H) temperature. Degradability of the N fractions in the control, L, M and H soybean meal were, 97, 80, 80 and 60%, respectively. Diets were arranged as a 3 x 4 factorial (3 levels of corn/soybean hulls and 4 levels of protein) and analyzed according to a split plot design. Total volatile fatty acids were not affected ($P > 0.10$) by dietary treatments and averaged 70.9 mM across all diets. Diets had no effect on molar ratios of acetate, propionate and butyrate which averaged 60.2, 25.0 and 11.9. Compared to the unextruded SBM, extrusion increased ($P < 0.10$) molar proportion of isovalerate but only in the HC diets. Varying the level of fermentable carbohydrate had no effect on ruminal pH. Extrusion altered pH in the HC and MC diets. In the HC diets both the L and M extrusion temperatures lowered ($P < 0.05$) pH (5.5 and 5.5, respectively) compared to H or the control (5.9 and 5.8, respectively). In the MC diets, the L extrusion temperature resulted in the lowest ($P < 0.05$) pH. Extrusion temperature altered ammonia concentrations. In the LC diets, both L and H increased ($P < 0.10$) ammonia concentration (32.1 and 32.2 mg/dl, respectively) when compared with M and the control (25.6 and 21.0 mg/dl, respectively). Methane concentration averaged 581 nmoles/ml and was not affected by dietary treatment. The HC and MC diets increased ($P < 0.05$) bacterial nitrogen percentage (9.4 and 9.5%, respectively) compared to the LC diet (8.3%). Data suggest that the fermentability of the structural carbohydrates in SBH was similar to the high starch corn diets. Furthermore, large differences in protein degradability did not seem to have a major impact on microbial fermentation.

Key Words: Fermentable carbohydrate, Extrusion, Fermenters

1606 Ruminant N intestinal digestibility estimated by mobile bag or “in vitro” technique. M. de J. Marichal*, M. Carriquiry, and A.I. Trujillo, *Facultad de Agronomía, Universidad de la República, Montevideo, Uruguay.*

Same batch wet and dried brewers grain (WBG, DBG), sorghum distillers grains (SDG) and alfalfa hay (AAH) nitrogen intestinal digestibilities estimated by mobile bag technique (MB) or pepsin+pancreatin digestion (P+P) were compared. Fourteen polyester bags (6 x 7 cm) containing samples of each feed were incubated (16 h) in rumen of three dry Holstein cows, two with duodenum cannulas, individually confined and fed (8am and 5 pm) 10 kg DM alfalfa hay. After incubation, bags were placed (2.5 h) in acid pepsin-HCl solution (pH 2; 3g pepsin /L 0.1N HCl) in shaking water bath (38.5°C). Bags were then randomly assigned to intestine digestion or “in vitro” pancreatin incubation, 10 and 4 bags/feedstuff, respectively. Ten bags / cow (2 feedstuffs/day) were introduced (evening meal) into small intestine and recovered from from 8am to 5pm following day feces. For pancreatin digestion, bags were incubated (24h; 0.5M KH2PO4 pH 7.8 solution, containing 50 ppm thymol and 3g/L pancreatin) in shaking water bath (38.5°C). Feces recovered or pancreatin digested bags were machine washed (60 bags/washing batch, 45 min). Rumen undegraded N was estimated from six bags/feedstuff incubated for 16h. Intestinal N digestibility was residual N in bags after intestinal or pancreatin incubation / undegraded N . Differences in N digestibilities resulted from: a) amounts DM after total digestion and proportion final DM / initial DM, which were higher in P+P than MB, and b) N concentration in final DM, although not pattern was observed. Results suggest pancreatin digestion cannot replace small intestine incubation.

	WBG	WBG	DBG	DBG	SDG	SDG	AAH	AAH
	MB	P+P	MB	P+P	MB	P+P	MB	P+P
Initial DM, g	0.59	0.93	1.50	1.42	1.36	1.36	1.38	1.32
Initial N, %	4.52	4.52	5.78	5.78	5.14	5.14	3.30	3.30
Undegraded N, %	20	20	48	48	51	51	40	40
Final DM, g	0.23	0.65	0.50	0.83	0.24	0.53	0.52	0.65
Final N, %	0.69	0.76	0.91	1.68	4.71	2.55	1.07	0.93
N “intestinal” digestibility, %								
Mean	70 a	41 b	89 a	65 b	68 a	63 a	69 a	65 a
SD	3.7	2.6	1.2	3.6	7.1	0.7	8.1	3.8

a,b : values with equal subscript did not differ ($P \geq 0.0001$)

Key Words: Dairy cows, Intestinal digestibility, Mobile bag technique

1607 Development of a real-time quantitative PCR assay to control the yield of DNA extracted from rumen content samples spiked with an exogenous bacteria. G. Talbot*¹ and J. Chiquette¹, ¹*Dairy and Swine Research and Development Centre, Agriculture and Agri-Food Canada, Lennoxville, QC.*

Recent quantitative PCR-based technologies are now currently used to study rumen microbial ecosystems. They permit to quantify specific rumen bacterial species. We have developed a real-time quantitative PCR assay (TaqMan technology from Applied Biosystems) to normalize for differences in efficiency of DNA extraction and purification from rumen content samples. For this purpose, known amounts of a bacterium not found in the rumen, *Thermus aquaticus*, were added into rumen content samples before DNA extraction. A primer pair and an internal probe were designed based on small subunit ribosomal DNA sequences that were specific to the *Thermus* strain used. No signal was obtained when using unspiked rumen content samples, suggesting that the designed set of oligonucleotides could not anneal to any other DNA found in the rumen. Results revealed a typical logarithmic amplification of DNA (correlation factor (R^2) of 0.994) from TaqMan PCR assays when using rumen content samples that were spiked with 2×10^6 to 2×10^8 *Thermus aquaticus* cells as DNA templates. A number as low as 14 cells of *Thermus aquaticus* could be detected using these assays. In addition to the normalization of the efficiency of DNA extraction and purification, the development of this assay will serve as a tool to correct for the presence of any possible substances interfering with the PCR process such as humic acids. A more precise picture of the rumen ecosystem and dynamics could be obtained when the exogenous bacteria, *Thermus aquaticus*, is used to spike rumen content samples.

Key Words: Rumen, PCR technology, Bacteria

1608 Digestion kinetics of pasture and forage mixed rations prepared by mincing fresh material. A.V. Chaves*^{1,2}, G.C. Waghorn¹, S.L. Woodward³, and I.M. Brookes², ¹*AgResearch, Massey University*, ³*Dexcel Ltd, New Zealand.*

New Zealand dairy cows are grazed on ryegrass (*Lolium perenne*) dominant pasture (P) as a sole diet but production is constrained by intake and nutrient balance (high bulk and fibre content) and by P availability in summer. The study used *in sacco* incubations to define digestion kinetics of P and mixtures of P with either maize silage (M) and sulla silage (S) or mixtures of all three. Sulla is a low fibre biannual legume containing condensed tannins able to reduce protein degradation. Dry matter (DM) digestion kinetics are presented here. Ten ruminally fistulated cows were fed 5 diets (two cows/treatment) to measure *in sacco* digestion of either P or the particular forage mixed ration (FMR) on which the cows were fed. The rations were (%DM basis): 100P (P); 60P, 40M (PM); 60P, 40S (PS); 60P, 25M, 15S (PMS); 60P, 25S, 15M (PSM). Feeds used for incubation were prepared by mincing fresh (frozen) forages to achieve a particle size distribution similar to chewed material. Duplicate dacron bags containing 5 g DM of P and FMR were removed at 0, 2, 6, 9, 12, 24, 48 and 72 h, washed and dried at 60 °C for 48 h. Reference internal standards were used to adjust for variability between cows. The effects of animal, *in sacco* contents and host animal diet on rumen degradation were examined using a non-linear model with a ruminal rate of passage of 0.06 h⁻¹. A GLM model of variance-covariance was used for statistical analysis. Data show highest degradation rates (k, h⁻¹) when cows were fed PS ($P < 0.001$); diets with a high proportion of maize silage were degraded more slowly. Supplementation with sulla may increase digestion rate and rumen clearance and reduce the effect of fibre in ryegrass diets. These data will be used in a dairy nutrition model (CNCPs) to develop strategies to increase milk production from pasture based grazing systems and predictions will be evaluated against animal feeding trials.

Cow diet	Pasture		Diet	
	k	SE	k	SE
P	0.068	0.003	0.068	0.003
PM	0.058	0.004	0.053	0.002
PS	0.071	0.002	0.085	0.002
PMS	0.066	0.003	0.052	0.004
PSM	0.059	0.004	0.072	0.004
p	<0.0001		0.0069	

Key Words: *In sacco*, forage

1609 Evaluation of dry matter disappearance of roughage sources alone or in combination with ground corn for ruminants. G.V. Pollard^{*1}, K.F. Wilson², C.R. Richardson³, and T.C. Bramble³, ¹*Southwest Texas State Univ., San Marcos*, ²*Loveland Industries, Greeley, CO*, ³*Texas Tech Univ., Lubbock*.

The objective of this research was to determine the dry matter digestibility (DMD) of roughage sources commonly used in ruminant feeding operations by five different methods: in vitro DMD (IVDMD), Ankom Daisy IVDMD (ADDMD), in situ DMD (ISDMD) in both nylon bags (NB) and Ankom F57 bags (AB), and gas production (GP). Dietary treatments were rice hulls (RH), peanut hulls (PH), cottonseed hulls (CH), soybean hulls (SH), corn (C), or a 40% corn and 60% RH, PH, CH, or SH mixture. All dietary treatments were ground through a 1 mm screen and .5 g samples were used for each incubation method. The ISDMD was determined with AB or NB incubated in the rumen of a cannulated steer fed a roughage diet. All evaluations were conducted at 24 and 48 h. Incubation at 48 h improved ($P < 0.01$) DMD compared to 24 h for all dietary treatments. Within dietary treatment IVDMD produced the highest ($P < 0.01$) DMD, while ISDMD using AB produced the lowest DMD, with ISDMD using NB and ADDMD being intermediate for all dietary treatments. Regardless of the method used RH had lower ($P < 0.01$) overall DMD than other roughage sources, and RHC had lower ($P < 0.05$) DMD than other combination treatments. Addition of C to the roughage sources improved ($P < 0.01$) DMD of all sources. Soybean hulls had the greatest ($P < 0.01$) DMD for all methods compared to other dietary treatments, except SHC or C. Cottonseed hulls had greater ($P < 0.05$) DMD than PH as estimated by IVDMD, however, PH had greater ($P < 0.05$) DMD than CH when estimated by ADDMD, ISDMD with NB, or ISDMD with AB. Gas production proved to be ineffective in estimating DMD for RH, PH, or CH. These results indicate that the addition of C to low quality roughage sources improves digestibility, however, SH alone had greater DMD than combinations of C and RH, PH, or CH. Replacement values of rice hulls, cottonseed hulls, peanut hulls, and soybean hulls are not equal when considering rumen digestibility.

Key Words: Roughage, Hulls, Dry matter disappearance

1610 Influence of rinsing technique and sample size on in situ protein degradation of protein sources. K.M. Whittet^{*}, K.W. Creighton, K.J. Vander Pol, G.E. Erickson, and T.J. Klopfenstein, *University of Nebraska, Lincoln, NE*.

Four experiments evaluated the effect of in situ bag rinsing technique and sample size on undegraded intake protein (UIP) and dry matter disappearance (DMD) of soybean meal (SBM) and Soypass, heat-treated soybean meal. The objective was to determine a rinsing technique and sample size that reduced variation in UIP. Experiments 1 and 2 evaluated the effect of 5 rinsing techniques (2 hand rinsing techniques and 3 machine rinsing techniques with 3, 5, and 8 rinses) after 16 h incubation, with 5 g per bag. Experiments 3 and 4 evaluated the effect of 5 sample sizes (5, 10, 20, 30, and 50 g of sample per bag). Experiments 1 and 3 utilized a feedlot diet with 7.5% roughage, while Exp. 2 and 4 utilized a mixed diet (70% forage:30% concentrate). Samples were unground and weighed into 10 x 20 cm dacron bags with a 50- μ m pore size. Run was used as a repeated rinse within day or steer. Effects of steer, day, and run were also examined: Exp. 1 day and run; Exp. 2 steer and run; Exp. 3 steer and day; and Exp. 4 day and run. Three replicate bags within steer within day within run were used. There was a sample effect across all experiments ($P < 0.01$). SBM had higher DMD and lower UIP values than Soypass and higher variance for UIP. A steer effect was noted for experiments with steer as a replication ($P < 0.01$). Steer had a larger effect than day with an F-statistic of 243.5 and 8.6, respectively. In Exp. 3, the F-statistic for steer was 146.2 and day in Exp. 4 was 4.4. Rinse and size were not significant ($P = 0.85$) in concentrate fed steers (Exp. 1 and 3) but were ($P < 0.01$) in mixed diet steers. There was a rinsing effect ($P < 0.01$) in Exp. 2, with 8 machine rinses having higher DMD and lower UIP values. Size effect ($P < 0.01$) was noted for Exp. 4, with 50 g having the lowest DMD and highest UIP values. Steer contributed a larger effect than day. There is no difference between hand and machine rinsing, but with increased rinsing, washout can occur. Based on the effects, a mixed diet is a better model for in situ incubation.

Key Words: In Situ, Protein, Undegraded Protein

1611 Influence of buffer pH and biotin addition on forage fiber digestibility in vitro. O Rosendo^{*1}, D Bates¹, C. R. Staples¹, R. J. McMahon¹, and L. R. McDowell¹, ¹*University of Florida*.

The objective of these studies was to determine if supplemental biotin would overcome the negative effect of low pH on NDF digestibility. In the first study, the effect of media pH on fermentation pH across a 24 h period and at 39 C was tested. Standard artificial saliva (pH = 6.9) was made more acidic (pH = 6.7 and 5.5) by modifying the $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$, Na_2HPO_4 , and NaHCO_3 concentrations. Each artificial saliva was added to rumen fluid at a ratio of 4:1 and then to a substrate of corn silage (0.25 g as-fed). The pH of fermentors decreased by 0.34, 0.17, and 0.13 pH units for the 5.5, 6.7 and 6.9 initial buffer pH, respectively. In the second study, only artificial saliva with initial pH of 5.3 or 6.7 were used to carry out in vitro incubations of alfalfa hay, bermudagrass hay and corn silage (0.25 g as-fed per substrate) with the same conditions as before. Either one ml of distilled water or d-biotin (Sigma, St. Louis, MO) in aqueous solution was added to each tube to supply 0, 10, or 20 μ g biotin/26 ml of total incubation fluid. Three tubes for each biotin concentration by forage source were incubated. Blanks for each substrate were included to correct for NDF provided by the inoculum. Three experiments (runs) were conducted in different weeks. Ash-free NDF was determined at 24 h of fermentation. The extent of NDF digestibility (ENDFD) was analyzed using the general linear models procedure of SAS. The model included factors for run, forage, biotin concentration, pH, and interactions. An interaction of biotin by pH by forage on ENDFD ($P = 0.071$) was observed. For corn silage, the addition of 20 μ g of biotin stimulated ENDFD at pH 6.7 (36.4, 35.4, and 38.1% for 0, 10, and 20 μ g of biotin, respectively) but depressed ENDFD when the pH was 5.3 (11.3, 11.7, and 6.9% for 0, 10, and 20 μ g of biotin, respectively). The ENDFD of the alfalfa and bermudagrass hay were markedly reduced by the lower buffer pH but did not change with biotin addition. Results did not support the hypothesis that supplemental biotin would reduce the depression of fiber digestibility caused by low ruminal pH.

Key Words: Biotin, Fiber digestibility, pH

1612 Comparison of in vitro and in situ methods for measuring dry matter disappearance of ruminant fiber sources. G.V. Pollard¹, K.F. Wilson², T.C. Bramble^{*3}, and C.R. Richardson, ¹*Southwest Texas State Univ., San Marcos*, ²*Loveland Industries, Greeley, CO*, ³*Texas Tech Univ., Lubbock*.

The objective of this research was to evaluate in vitro (IV) methods, DAISY¹¹ (AD), Tilley and Terry method (TT) and in situ (IS) methods using nylon bags (NB) or Ankom F57 bags (AB) to determine the DM disappearance (DMD), and gas production (GP) of roughage sources commonly used in ruminant diets. Feed sources were ground to pass a 1-mm screen and consisted of rice hulls (RH), peanut hulls (PH), cottonseed hulls (CH), soybean hulls (SH), corn (C), or a 40% corn and 60% RH, PH, CH, or SH. Standard procedures, chemicals, and ruminal inoculum amounts were utilized for each IV method. Gas production was determined by incubating 0.5 g of each feed source in 50 mL of TT ruminal fluid and buffer mixture, and recording mL of gas produced per g DM. In situ DMD was conducted utilizing standard procedures except, in addition to NB, AB were also evaluated to determine whether they could replace NB in IS evaluations. Of all methods tested, GP was the least effective for estimating DMD of lowly digestible fiber sources (RH, PH, CH). Milliliters of gas produced was similar among all three fiber sources; however, DMD as estimated by IV or IS methods differed ($P < 0.05$) by greater than 121%. In situ DMD estimated using AB consistently produced the lowest ($P < 0.01$) DMD. Among all methods compared, TT produced the greatest ($P < 0.05$) DMD, with AD being greater ($P < 0.05$) than IS with NB, while IS with AB had the lowest DMD. This pattern was also the same when compared among individual fiber sources, except for PH, which had similar ($P > 0.05$) DMD for TT, AD, and ISNB. Results of this study indicate that gas production and in situ DM disappearance using Ankom F57 bags are poor indicators of DM disappearance as indicated by traditional in vitro or in situ procedures. The Tilley and Terry method likely produced the greatest disappearance due to a higher concentration of ruminal fluid used in the inoculum as compared to DAISY¹¹.

Key Words: Dry matter disappearance, In vitro, In situ

1613 Evaluation and refinement of ruminal volatile fatty acid absorption equations in a dynamic, metabolic model of the lactating dairy cow. M. D. Hanigan*, D. C. Weakley, F. Standaert, and L. R. Reuzel, *Purina Mills, LLC, St. Louis, MO.*

Kohn et al. (1994) previously observed that ruminal volatile fatty acid (VFA) concentrations were not well predicted by the model of Baldwin et al. (1995). The objective of this work was to further evaluate the model and to undertake corrective changes if warranted. Model evaluations were conducted using treatment means for a data set comprised of 17 experiments and 69 dietary treatments. Diets were primarily dairy-type diets with varying nutrient profiles, however, one experiment consisted of low-forage feedlot rations. The model of Baldwin (1995) predicted total VFA, acetate, propionate, and butyrate concentrations with root mean square prediction errors (RMSPE) of 37.8, 46.7, 19.0, and 29.1% of the mean observed values, respectively. Fitting rate constants for fiber hydrolysis and VFA absorption to the data set reduced RMSPE to 11.8, 11.3, 17.0, and 21.8%, respectively. However, RMSPE for duodenal flows of cellulose and hemicellulose increased from 17.4 and 30.2% to 22 and 33.9%, respectively. Additionally, residual errors for acetate and butyrate concentrations contained significant slope bias that appeared to be associated with ruminal pH suggesting that the lack of consideration of pH effects by the absorption submodel was inappropriate. The VFA absorption model of Dijkstra et al. (1993) utilizes VFA concentration and pH as determinants of absorption rates. Adoption of that submodel resulted in RMSPE of 7.9, 10.1, 26.9, and 13.2%, respectively. Analyses of propionate residuals indicated that pH prediction errors were at fault. Adoption of a revised pH prediction equation resulted in RMSPE of 11.9, 12.8, 11.9, and 12.8 for total VFA, acetate, propionate, and butyrate predictions, respectively, and RMSPE for predictions of duodenal cellulose and hemicellulose flows of 20.4 and 28.0%, respectively. Changes undertaken appear to have improved predictions of ruminal propionate and butyrate without negatively affecting predictions of fiber digestion.

Key Words: model, rumen, volatile fatty acids

1614 Nucleic acid content and profile of protozoal and bacterial fractions isolated from ruminal contents of lactating dairy cows. L. T. Mydland* and H. Volden, *Agricultural University of Norway.*

The main objective of this study was to compare the nucleic acid base composition of liquid-associated protozoa (LAP), liquid-associated bacteria (LAB) and solid-adherent bacteria (SAB). Three cannulated multiparous dairy cows were used in a 3 × 3 Latin square experiment to study the proportion of red clover in grass silage. Dietary treatments were (1) solely timothy, (2) 23 % red clover, and (3) 46 % red clover. Protein content (g/kg DM) in silage was (1) 149, (2) 166 and (3) 182 and NDF content (g/kg DM) was (1) 567, (2) 485 and (3) 402. Cows were fed a 70:30 ration based on silage and a barley/oats based concentrate mixture four times daily. The microbial fractions were isolated from the rumen at 0530, 0800 and 1000. Nucleic acid bases (NAB) in microbes were determined by HPLC after hydrolysis with perchloric acid. Microbial nitrogen content (g/kg DM) was affected by diet ($P < 0.1$) and averaged 72.5, 74.1, and 74.5 for diet 1, 2 and 3, respectively. However, the NAB:N ratio was not affected by diet composition. The microbial fractions harvested at 0800 (two hours post-feeding) showed a higher ($P < 0.05$) content of total-NAB, Adenine, Cytosine, Guanine and Uracil than when isolated before feeding and 4 h post-feeding. The present results demonstrated that sampling time has an effect on the NAB content of the rumen microbes. The composition of NAB was different among microbes, and it is concluded from this study that microbial reference sample will have an effect on estimated microbial protein synthesis.

	LAP	SAB	LAB	SEM
Nitrogen, g/kg DM	72.4 ^a	74.1 ^b	74.5 ^b	0.7
Total NAB:N ¹	13.0 ^a	13.6 ^a	16.6 ^b	0.3
Adenine ¹	5.7 ^a	5.0 ^b	6.1 ^c	0.1
Cytosine ¹	1.2 ^a	1.8 ^b	2.4 ^c	0.05
Guanine ¹	4.3 ^a	4.8 ^b	6.0 ^c	0.1
Thymine ¹	0.5 ^a	0.5 ^a	0.6 ^b	0.02
Uracil ¹	1.4 ^a	1.4 ^a	1.6 ^b	0.04

¹ gram NAB-nitrogen 100 g⁻¹ nitrogen. ^{a,b,c} Means in rows with different superscripts differ ($P < 0.05$).

Key Words: Rumen microbes, Nucleic acid bases, Grass silage

1615 Effects of rumen degradable protein and fiber quality on microbial growth, digestion, and fermentation in continuous culture. K. E. Griswold*, D. L. Hastings, B. N. Jacobson, J. Salazar, and G. A. Apgar, *Southern Illinois University, Carbondale, IL.*

The effects of rumen degradable protein (RDP) and fiber quality on microbial growth, digestion, and fermentation were examined using a 4 × 4 Latin square with a 2 × 2 factorial arrangement of treatments in dual-flow continuous culture. Factors were level of RDP and quality of fiber, and the treatments were: 1) high RDP (12.4% of dietary DM), high quality alfalfa (156 RFV) (HPHF); 2) high RDP (12.4% of dietary DM), low quality alfalfa (105 RFV) (HPLF); 3) low RDP (10.4% of dietary DM), high quality alfalfa (156 RFV) (LPHF); and 4) low RDP (10.4% of dietary DM), low quality alfalfa (105 RFV) (LPLF). Periods were 10 d with 7 d for equilibration and 3 d for sampling. Data were analyzed using SAS GLM procedures with the model including period, fermentor, RDP, fiber quality, and the RDP × fiber quality interaction. Increasing dietary RDP significantly increased microbial N flow (g/24 h), and tended to increase N degradation %, NH₃-N (mg/dL), nonammonia, nonmicrobial N (NANMN), and microbial efficiency (g N/kg OM digested). Microbial N (% of microbial DM) was 7.86, 6.27, 6.51 and 5.75 for HPHF, HPLF, LPHF, LPLF, respectively, and tended to increase with increased fiber quality ($P < 0.10$). The RDP × fiber quality interaction significantly increased DM and OM digestibility of HPHF compared to the other treatments ($P < 0.05$). Increasing dietary RDP significantly increased NDF, hemicellulose, and ADF digestibility ($P < 0.02$). Increasing fiber quality from 105 to 156 RFV tended to increase ADF digestibility ($P = 0.078$), but did not alter NDF or hemicellulose digestibility. Propionate molar percentage significantly decreased ($P = 0.007$) and total VFA (mM) tended to decrease ($P = 0.081$) as fiber quality increased while acetate and isovalerate molar percentage tended to decrease ($P < 0.10$). These results suggest that peptides and AA released from increased dietary RDP increased hemicellulose and NDF digestibility regardless of fiber quality of the diet.

Key Words: RDP, Fiber quality, Continuous culture

1616 Comparative kinetic of dry matter ruminal degradation of alfalfa hay and clitoria hay (Clitoria ternatea) in sheep. R. Barajas*, M. Placencia¹, A. Estrada¹, and J.F. Obregon¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

With the objective of compare the kinetic of dry matter ruminal degradation of alfalfa hay and clitoria hay (Clitoria ternatea) in sheep, an experiment was conducted. Four Pelibuey sheep (Females; BW = 32 kg), fitted with ruminal cannula (ID = 5 cm) were used in a complete randomized design experiment. Animals were placed individually in metabolic crates (0.6 × 1.2 m), fed (3% of BW) a 14% CP ration, containing 25% alfalfa hay (AH), 25% clitoria hay (CH) and 50% concentrate. Fifty six Dacron bags (10 × 18 cm) were filled with 5.5 g of alfalfa hay, another fifty six bags were filled with clitoria hay (5.5 g), randomized were grouped in 28 set of four bags (AH 2 bags and CH 2 bags); set of bags were assigned to one of six incubation times (3, 6, 12, 24, 48, and 72 hours) in rumen of sheep. Solubility was measured placing bags in warm distilled water (39 C) five minutes. After incubation bags were washed, oven dried (110 C; 24 hours) and weighed, and dry matter disappearance was calculated and kinetics parameters and effective degradation were performed. DM solubility was similar ($P > 0.10$) for AH (27.65%) and CH (26.66%), respectively. Dry matter disappearance from bags were not affected ($P > 0.05$) by treatments in all rumen incubation times, except for 48 h incubation time, where AH was higher

($P = 0.03$) than CH (62.02 vs. 58.07%). Kinetics of rumen degradation of DM was described by the equation $P = 26.03 + 31.76 (1 - e^{-0.14t})$. Effective ruminal degradation were similar ($P > 0.10$) with values of 51.6% and 49.4% for HA and CH, respectively. This data suggest that degradation that suffers dry matter of clitoria hay in the rumen, is similar to exhibits by alfalfa hay, and consequently clitoria can be used as alfalfa substitute in tropical regions where is an available feed resource.

Key Words: Alfalfa, Clitoria ternatea, Rumen degradation, Dry matter, Sheep

1617 Effect of extracting soluble proteins on estimates of in situ and in vitro degradability. Y.-G. Goh*¹ and G. A. Broderick², ¹Kangwon National University, Chunchon, South Korea, ²U.S. Dairy Forage Research Center, Madison, WI.

In situ procedures may overestimate microbial degradation because soluble protein, that still can escape the rumen, is assumed to be degraded when it is solubilized. Effect of extracting soluble proteins on the ruminal degradabilities was assessed in four protein sources: solvent soybean meal (SSBM), expeller soybean meal (ESBM), blood meal (BM) and corn gluten meal (CGM). Ground (Wiley mill, 2 mm screen) samples of each were either unprocessed or extracted for 16 h in McDougall's buffer (70 g protein source/L buffer) at 39 C. Extracts were filtered (Whatman no. 1 paper) and residues dried (48 h; 60 C) and ground (2 mm). Ground, extracted samples were sieved and particles > 0.5 mm retained for in situ and in vitro studies. Extracted proteins were added to dacron bags; bags were soaked in buffer then inserted into the rumens of two cannulated cows. Duplicate bags for each protein were removed after 0 (washed only), 4, 8, 12, 16, 24, 48, 72, and 96 h of incubation, then washed, dried (24 h, 60 C) and residues ground (2 mm). Mixed microbes were isolated from ruminal contents from the cows; in situ residues and mixed microbes were analyzed for total N and purines. The inhibitor in vitro (IIV) procedure also was used to determine rate and extent of ruminal degradation of both unprocessed and extracted proteins. As expected, there were wide differences ($P < 0.01$) among proteins in degradation rate (ranging from 0.02/h (CGM) to 0.08/h (SSBM) by in situ, and from 0.01/h (BM) to 0.11/h (SSBM) by IIV) and estimated ruminal escape (ranging from 42% (SSBM) to 75% (BM) by in situ, and from 36% (SSBM) to 90% (BM) by IIV). There were trends ($P = 0.08$) for more rapid in situ rates with unprocessed than extracted proteins and with the use of the microbial correction. However, estimated escapes were not affected by protein extraction ($P = 0.17$) or by microbial correction ($P = 0.38$). Buffer extraction did not alter rates ($P = 0.37$) or escapes ($P = 0.42$) estimated by the IIV method. Moreover, degradation rates ($P = 0.12$) or ruminal escapes ($P = 0.52$) did not differ between the in situ or IIV method. These results suggest that rapid loss of soluble proteins during in situ incubations does not excessively inflate estimates of ruminal protein degradation.

Key Words: In situ incubation, IIV method, Ruminal degradability

1618 Nutritive value of ground and expanded yellow corn determined in digestibility trials with sheep. N.M. Rodriguez¹, E.N. Rodrigues¹, G.L. Teixeira¹, I. Borges¹, E.O.S. Saliba¹, and L. Goncalves¹, ¹Federal University of Minas Gerais, Belo Horizonte - MG/ Brazil.

The nutritive value of ground and expanded yellow corn in diets with tifton hay (*Cynodon spp.*) was determined using a randomized 4x2x5 factorial design (four levels x two processings x five replicates) in an apparent digestibility trial with sheep. Four levels of ground and expanded corn (Sprout Matador expander) were used, 0% (A); 19% (B); 37% (C) and 62% (D) (dry basis), and the intake was limited to a maximum of 1.5 maintenance. Expansion slightly decreased NDF of corn (4%) and non fibrous carbohydrates (NFCOH) (6%) with a proportional increase of crude protein. Crude protein and FDN of tifton hay were 10.4 and 76.9%, respectively. Expansion increased 35% crude protein digestibility of the diet in treatment D ($p < 0.05$, SNK test), however, decreased digestibility of fibrous components (FDN, cellulose, hemicellulose) from about 70% in treatment A to 48% in treatment D. Digestibility of fibrous components of the diets with ground corn were not affected (around 70%). Digestibility of gross energy followed a quadratic model, where $y = 64.8927 + 0.7939X - 0.01109X^2$ for expanded corn ($r = 0.80$), and $y = 66.4852 + 0.4294X - 0.0050X^2$ for ground corn ($r = 0.78$). The inflection points of the curves were at 36% and 43% of inclusion in the

diets of expanded and ground corn respectively. Up to those levels of inclusion in the diets, the digestible energy of ground corn was calculated to be 3.89 Mcal/kg DM, and for expanded corn 5.31 Mcal/kg DM, which means an increase of about 37%. The digestible energy of the hay was 2.8 Mcal/kg DM. Nitrogen balance was positive in all treatments and increased as corn increased in the diet but it was higher in treatments with expanded corn ($p < 0.05$).

Key Words: Expanded Corn, Ground Corn, Nutritive Value

1619 Comparative ruminal degradation of dry matter of alfalfa hay, peanuts hay, and common beans hay from cultivars for green beans, using nylon bag technique in sheep. R. Barajas*¹, A. Estrada¹, and J.F. Obregon¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

With the objective of comparative ruminal degradation of dry matter of alfalfa hay, peanuts hay (*Arachis hipogaea* L.), and common beans hay (*Phaseolus vulgaris* L.) from cultivars for green beans, using nylon bag technique in sheep, one experiment was conducted. Three Pelibuey sheep (Males; BW = 33.5 kg), fitted with ruminal cannula (ID = 5 cm) were used in a complete randomized design experiment. Animals were placed individually in pens (1.5 x 2.5 m), fed chopped alfalfa hay having free access to drinking water and a mineral salt. Dacron bags (10 x 18 cm) were filled with 5.5 g of alfalfa hay (AH), peanuts hay (PH) or beans hay (BH), randomized were grouped in 18 set of six bags (AH 2 bags, PH 2 bags, and BH 2 bags); set of bags were assigned to one of five incubation times in rumen of sheep (4, 8, 12, 24, and 48 hours). Solubility was measured placing bags in warm distilled water (39 C) five minutes. After incubation bags were washed, oven dried (110 C; 24 hours) and weighed, and dry matter disappearance and kinetics parameters were performed. Peanut hay was less soluble ($P < 0.01$) than AH (26.3 vs. 16.4%), and ruminal degradation of PH was lower ($P < 0.01$) than AH in all incubation times, with values of 71.4 and 52.9% at 48 h for AH and PH respectively. Common beans hay DM was more soluble ($P < 0.01$) than AH DM (26.3 vs. 37.4%). Beans hay was consistently more degradable in rumen ($P < 0.01$) than AH in all incubation times tested, with mean value of 71.4% and 81.8% at 48 hours in rumen for AH and BH, respectively. Equation that describes rumen kinetics were: Alfalfa hay = $25.583 + 46.123 (1 - e^{-0.159t})$, $R^2 = -0.94$; peanut hay = $15.196 + 39.533 (1 - e^{-0.10t})$, $R^2 = -0.94$; and beans hay = $37.496 + 43.9 (1 - e^{-0.174t})$, $R^2 = -0.96$. This results suggest, that peanut hay is 37% less degradable in rumen than alfalfa, and the fact that common beans hay is 9% faster degradable in rumen than alfalfa may keep some relation with presence of bloat.

Key Words: Peanut hay, Beans hay, Alfalfa hay, Rumen, Sheep

1620 Effects of nitrogen type and level on in vitro digestion, VFA production and gas yield. K.J. Harvatin* and P.H. Doane, *ADM Alliance Animal Nutrition.*

Nitrogen form and level may affect fiber digestion and yield of gas and VFA. *In vitro* fermentations were conducted in 300 mL serum bottles with 300 mg of isolated corn silage NDF (CS) or alfalfa, with and without addition of 150 mg of starch. Cumulative gas volume was recorded every half-hour and gas curves fit to a two pool logistical model for rate calculation. Digestibility and fermentation products were measured at 24 h. Fermentations were replicated six times, three replicates tested a high quality alfalfa (21.6% NDF, ALF1) and three tested a moderate quality alfalfa (47.4% NDF, ALF2). Nitrogen concentration and sources for treatments where: no nitrogen added (1), 8 mM from urea (2), 16 mM from urea and ammonia (3), 16 mM from urea and tryptone (4), 38 mM from urea, ammonia and tryptone (5), and 38 mM from urea, ammonia, tryptone and branched chain AA (6). Addition of starch significantly decreased NDF digestion in CS and Alf1 (5.1 and 6.3%), but not with Alf2. Starch addition increased the rate and volume of gas produced, and total VFA concentration ($P < 0.05$). Source of nitrogen (3 vs 4) had no effect on NDF digestion, 24 h gas volume, VFA production or VFA profile. Treatment 5 increased NDF digestibility (4.79 and 3.14%, $P < 0.003$) and VFA production (12.4 and 8.0 mM, $P < 0.004$) compared to treatments 3 and 4. Nitrogen treatment interacted with starch addition. Digestion of NDF and 24 h gas production without starch were not different among treatments 3, 4 and 5 although total VFA concentration tended to increase in treatments 4 and 5. With addition of starch, treatment 5 increased NDF digestibility (50.2 vs 44.2

and 46.0%) and VFA concentration (116.9 vs 104.7 and 103.4 mM) relative to treatments 3 and 4, with no increase in gas volume (77.8 vs 77.9 and 75.5 ml). Starch addition reduced fiber digestion. There were no apparent differences between use of ammonia or tryptone in the 16 mM N treatments. Increasing true protein, as shown in treatment 5, altered digestion particularly when starch was added to the fermentation.

Key Words: Gas production, Fiber digestion, Degradable nitrogen

1621 Evaluation of quillaja extract, quebracho tannin and safflower oil as selective defaunating agents in cattle. J. Baah^{*1}, A.N. Hristov², T.A. McAllister¹, M. Ivan¹, K.M. Koenig¹, and L.M. Rode³, ¹Agriculture and Agri-Food Canada, Lethbridge, AB, ²University of Idaho, Moscow, ³Rosebud Technology Development, Lethbridge, AB.

Rumen protozoal populations and fermentation characteristics were assessed in four cannulated Jersey heifers fed quillaja extract (QE, 60 g/d), quebracho tannin (QT, 6 g/kg diet), high linoleic acid safflower oil (SO, 200 g/d) or no dietary supplements (control, CON) in a 4 × 4 Latin square. The basal diet comprised (DM basis) 80% barley grain, 18% barley silage, 1% canola meal and 1% mineral, and was consumed ad libitum. All antiprotozoal agents (APA) tended ($P = 0.1$) to reduce total protozoal numbers, relative to CON, and all reduced ($P < 0.05$) *Entodinium* populations (\log_{10} /mL ruminal fluid), as compared with CON; in CON, QE and SO, these were 6.2, 5.7, 5.9 and 5.8, respectively. Populations of *Epidinium*, *Isotricha*, *Dasytricha*, *Diplo-dinium* and *Ophryoscolex* spp. were lower ($P < 0.001$) with SO than with the other APA. With CON, QE, QT and SO diets, respectively, 2.0, 11.4, 5.7 and 0.2% of protozoa were cellulolytic. Treatment did not affect ($P > 0.05$) mean ruminal pH or concentrations of reducing sugars, ammonia, total free amino acids, soluble protein, peptides, total VFA or individual VFA except isobutyrate, for which CON and SO > QE > QT ($P < 0.05$). Isobutyrate was present at 1.28, 1.26, 1.19 and 1.08 mM with CON, SO, QE and QT, respectively. Feeding QE or SO reduced ($P < 0.05$) ruminal carboxymethylcellulase activity, compared to CON. Treatment did not affect ($P > 0.05$) nutrient intake or digestibility, duodenal nitrogen (N) flow or urea and glucose in blood. Urinary N excretion (as % of N intake) was lower ($P < 0.05$) with QT (57.7%) than with CON (66.3%), QE (65%) or SO (66.7%). All three compounds studied reduced *Entodinium* populations, which as a group have the largest negative impact on bacterial turnover in the rumen, with no adverse effects on fermentation or nutrient digestion. Thus, each may have potential for use as a selective agent for reducing the impact of *Entodinium* on bacterial N recycling in cattle.

Key Words: Rumen Protozoa, N Recycling, Cattle

1622 Characterization of microbial adaptation in dairy cows with changes in diet and lactational state. A.F. Park^{*}, J.E. Shirley, E.C. Titgemeyer, R.C. Cochran, J.M. DeFrain, E.E. Ferdinand, N. Wallace, and T.G. Nagaraja, ¹Kansas State University, Manhattan Kansas.

Four-ru-minally fistulated, multiparous, pregnant Holstein cows were utilized in a randomized design to delineate microbial adaptations as the cow transitioned from a non-lactational to lactational state. Microbial measurements were obtained 51 (far-off dry), 23, and 9 d (close-up dry) prepartum and 6, 20, 34, 48, 62, 76, and 90 d postpartum. Calculated NEL (Mcal/kg), measured crude protein (%) and digestibilities (based on steers fed the same diets at 2% of BW) of the diets were 1.46, 11.5, 66.2; 1.56, 15.6, 71.0; 1.70, 18.4, 70.7 for far-off dry, close-up dry, and early lactation. Counts of protozoa and viable counts of bacteria and fungi were assessed using the most probable number technique. Total and cellulolytic fungi decreased (3.2×10^6 versus 10 counts) when cows were switched from the far-off to the close up diet then increased (10 versus 3.2×10^4 counts) prior to calving. Total fungi increased and remained relatively constant (3.2×10^6) after parturition but total cellulolytic fungi approached zero on d 6 postpartum, then increased to 3.2×10^4 on d 20, remaining fairly constant thereafter. The population of cellulolytic bacteria was relatively constant across diets (1.5×10^9) but total bacteria decreased during the dry period (1.0×10^{13} versus 1.0×10^{10}) then remained relatively stable (3.2×10^{11}) during the first 90 d of lactation. Total protozoa (1.6×10^{10}) were unaffected by diet and lactational state. These data illustrate rumen microbial adaptations to changes in diet and lactational state.

Key Words: Periparturient, Dairy cow, Microbial

1623 The effect of buffers on rumen fermentation patterns. A Jackson¹, J Spain², J Sampson^{*2}, D Chatman², and M Ellerseick², ¹University of Arkansas-Pine Bluff, ²University of Missouri-Columbia.

This study was conducted to measure the effects of presence and source of supplemental buffer on rumen pH and fermentation. A single effluent continuous culture system was used to model rumen fermentation. Rumen fluid for the fermenters was obtained from two, ruminally fistulated lactating Holsteins and commingled. Rumen fluid was collected by squeezing fluid from whole rumen contents through commercially available cheesecloth. Fermenters were fed a diet typically fed to cows during the final phase before calving. Fermenters received this moderate NFC diet for 4 days. On days 5-7, the fermenters were fed a high energy, low fiber diet typically fed to lactating cows. The control diet (A) contained no buffer. Diet B contained a standard feed grade buffer included in the diet at 0.75% of the lactation diet DM. Diet C contained a 1:1 ratio of feed grade buffer to encapsulated sodium bicarbonate buffer at 0.75% of the lactation diet DM. Diet D contained encapsulated buffer at 0.75% of the lactation diet DM. The fermenters were fed at 700, 1500 and 2300 h. The pH of each fermenter was measured four times daily at 0, 2, 4 and 6 hours following the 7 a.m. feeding. Samples were taken daily from each fermenter to measure ammonia levels. Fermenter pH levels increased when buffers were added to the diet. Diet D maintained fermenter pH that was significantly higher than the other diets. Diet D also maintained higher pH in the fermenters across all three days fermenters were fed the high-energy diet. Diet D also maintained the highest pH for hours 0, 2, 4 and 6. Ammonia levels were not different due to dietary treatment. Ammonia levels increased significantly ($P=0.019$) from days 5-7 as the microbes adapted to the diet containing the higher concentration of dietary crude protein. These data provide evidence that encapsulated buffers provided a sustained release of sodium bicarbonate that minimized the acidic conditions in the rumen associated with feeding low-fiber diets.

Key Words: Rumen pH, Rumen Fermentation, Rumen Buffers

1624 Effects of level of pelleted beet pulp substituted for high-moisture corn on rumen digestion kinetics and microbial protein efficiency in lactating dairy cows. J. A. Voelker^{*} and M. S. Allen, Michigan State University.

Effects of increasing levels of pelleted beet pulp substituted for high-moisture corn were evaluated with 8 ruminally and duodenally cannulated multiparous Holstein cows in a duplicated 4x4 Latin square design with 21-d periods. Cows were 79 ± 17 (mean \pm SD) DIM at the beginning of the experiment. Experimental diets with 40% forage (corn silage and alfalfa silage) and 60% concentrate contained 0%, 6.1%, 12.1%, or 24.3% beet pulp (0BP, 6BP, 12BP, and 24BP, respectively) substituted for high-moisture corn on a DM basis. Diet contents of NDF and starch were 24.3% and 35.4% (0BP), 26.2% and 31.2% (6BP), 28.0% and 27.0% (12BP), and 31.6% and 18.6% (24BP), respectively. True rumen digestibility of starch decreased with increasing BP substitution ($P < 0.01$). This was caused by a linear increase in starch passage rate ($P < 0.05$), and a linear decrease in digestion rate ($P < 0.01$) of starch in the rumen, possibly the result of reduced amylolytic enzyme activity of rumen fluid. Although substituting BP for corn decreased rumen starch digestibility, true rumen OM digestibility and microbial N flow to the duodenum were not affected by treatment ($P > 0.20$), nor was microbial nitrogen efficiency (MNE), expressed as microbial N flow to the duodenum as a percent of OM truly digested in the rumen ($P > 0.20$). MNE was not correlated to mean rumen pH ($P > 0.40$) or daily minimum pH ($P > 0.60$). MNE was positively correlated with passage rates of starch ($r = 0.66$, $P < 0.001$) and indigestible NDF ($r = 0.64$, $P < 0.001$), which were increased by substituting BP for corn ($P < 0.05$). Increasing passage rate probably increases MNE by increasing the rate at which microbes escaped lysis and predation in the rumen. Although substituting BP for high-moisture corn might have increased rate of microbial passage from the rumen relative to lysis, rumen microbial pool might have been reduced by lower starch fermentation, resulting in no overall effect on MNE.

Key Words: Beet pulp, High-moisture corn, Rumen microbial N efficiency

1625 Effects of NPN in alfalfa and red clover silages on production of lactating cows. JJ Olmos Colmenero^{*1}, AF Brito¹, GA Broderick, and SM Reynal, ¹University of Wisconsin-Madison, ²US Dairy Forage Research Center.

Sixteen multiparous and 8 primiparous Holstein cows (8 ruminally fistulated) were randomly assigned to six 4 x 4 Latin squares to assess the effect of NPN level in alfalfa and red clover silages on milk production, ruminal metabolites, microbial protein synthesis, and ruminal escape of amino acids and peptides. The experimental diets contained (DM basis): 50% control alfalfa silage (AS), 50% formic acid-treated alfalfa silage (AAS), 50% red clover silage (RCS1, lower NDF and CP than AS), or 50% red clover silage (RCS2, similar to AS in NDF and CP). Diets were formulated to contain about 17% CP and NDF content was 28, 29, 27 and 29%, respectively, for diets AS, AAS, RCS1 and RCS2. DMI and milk yield were higher for AS and AAS compared to RCS2, whereas RCS1 was intermediate. Fat and protein yield, MUN and rumen ammonia were higher for the alfalfa silages relative to both red clover silages. Apparent digestibilities of DM and NDF were highest on RCS2, intermediate on RCS1 and lowest on the alfalfa silages. Rumen pH, acetate, propionate and acetate:propionate ratio did not differ. RCS1 had higher N efficiency than the alfalfa silages while RCS2 was intermediate. Overall, feeding alfalfa silages resulted in greater DMI and milk yield

than feeding red clover silages; however, N utilization, BW gain, and nutrient digestibilities were greater in cows fed red clover silages.

Item	AS	AAS	RCS1	RCS2	SELSMD ¹
DMI, kg/d	23.3 ^{ab}	23.7 ^a	22.2 ^{bc}	21.5 ^c	0.7
BW gain, kg/d	0.19 ^{bc}	0.09 ^c	0.66 ^a	0.62 ^{ab}	0.25
Milk yield, kg/d	30.5 ^a	30.8 ^a	29.5 ^{ab}	28.6 ^b	0.8
Milk fat, kg/d	1.23 ^a	1.25 ^a	1.14 ^b	1.10 ^b	0.04
Milk protein, kg/d	0.99 ^a	1.02 ^a	0.94 ^b	0.90 ^b	0.03
MUN, mg/dl	19.1 ^a	18.1 ^a	15.3 ^b	14.9 ^b	0.8
Milk-N/N-intake, %	22.3 ^b	22.4 ^b	24.6 ^a	23.2 ^{ab}	1.0
DM digestibility, %	58.7 ^c	57.4 ^c	60.7 ^b	63.9 ^a	1.1
NDF digestibility, %	37.2 ^a	36.9 ^c	48.2 ^b	55.0 ^a	1.2
Rumen pH	6.38	6.41	6.45	6.45	0.05
Rumen ammonia, mM	10.0 ^a	9.1 ^a	4.7 ^b	5.7 ^b	0.7
Rumen TAA, mM	4.0 ^a	3.4 ^{ab}	2.3 ^c	2.9 ^{bc}	0.4
Rumen Acetate, mM	74.4	73.8	75.8	73.5	2.3
Rumen Propionate, mM	21.2	21.1	21.9	21.15	0.9
Rumen Ace:Prop	3.56	3.57	3.55	3.54	0.09

¹Standard error of least square mean difference; ^{a,b,c}Means in rows without common superscripts are different (P<0.05)

Key Words: NPN, Red clover silage, Alfalfa silage

Sheep Species

1626 Assessment of gestational age in Chall ewes by ultrasonography. Sarang Soroori¹, Parviz Tajik², and Abbas Veshkini, ¹Ferdowsi University of Mashhad, Faculty of Veterinary Medicine, Mashhad, Tehran, ²University of Tehran, Faculty of Veterinary Medicine, Tehran, Iran.

To assess gestational age by ultrasonography, 16 synchronized estrous Iranian Chall ewes were placed with fertile rams from the same breed. After mating these ewes were separated from the rams and ultrasonography program was performed. In order to assess the earliest time of pregnancy, ultrasonography was performed daily from the day 10 to 26 of mating, and two times a week from day 26 to 68, and once a week from day 68 until parturition for all ewes. Ultrasonography diagnosis was performed using intrarectal technique as well as transcutaneous. The earliest assessment of pregnancy was day 18 in which pregnancy could be diagnosed in two ewes. The best criterion pregnancy diagnosis in primary days of pregnancy was observation of embryonic vesicle by intrarectal ultrasonography. By increasing of gestational age some criteria such as Thoracic Depth (Dorsoventral diameter of thoracic cavity), Abdominal Depth (Dorsoventral diameter of abdominal cavity) and Intercoastal Space were measured. Regarding to the results of the present study some morphometric values were gained by which the gestational age could be assessed in this breed.

Key Words: Ultrasonography, Pregnancy, Ewe

1627 The effects of offering grass or maize silages with mineral lick supplementation to pregnant ewes on ewe performance and IgG absorption in the lamb. T.F. Crosby^{*1}, J.V. O'Doherty¹, P. Nowakowski², P.J. Quinn¹, J.J. Callan¹, B. Flynn¹, D. Cunningham¹, P. Reilly¹, and D. Joyce¹, ¹University College Dublin, Faculty of Agriculture, Belfield, Dublin 4, IRELAND, ²Agricultural University Wroclaw, Department of Sheep Breeding, Wroclaw, POLAND.

Individually fed twin bearing ewes (n=64) were offered either grass or maize silage ad-libitum which was supplemented with 400g concentrates per day in addition to they having limited access (3-5h/d) to a molasses based mineral lick (ML) from day 92 of pregnancy until lambing, in order to evaluate the effects of the mineral lick supplementation on ewe performance and immunoglobulin (IgG) absorption in the lamb. Average daily ML intake was 84.3g and 93.7g for the grass and maize silages respectively. Forage DM intake was higher for the maize than for grass silage (1.11 vs 0.95 kg/ewe; SEM 0.037; P<0.05) and also when ewes had access to ML (1.10 vs 0.96 kg/ewe; SEM 0.037; P<0.01). A similar trend applied to protein intake. There was a big increase in daily water intake when ewes had access to ML (3.7 vs 2.69 l/day; SEM 0.101; P<0.01). The ML treatment had no effect on ewe live weight change, body condition score change, gestation length, litter weight or the incidence of mal-presentations at lambing (P>0.05). When ewes had access

to ML, colostrum yield tended to be higher at the 1h milking (598 vs 436 g/ewe; SEM 60.6; P=0.06) but there was no effect on the concentration of solids, crude protein or colostral IgG concentration (P>0.05). In contrast, lambs fed colostrum obtained from ewes on the ML treatment had significantly lower serum IgG concentration (6.8 vs 18.8 g/litre; SEM 1.48; P<0.05) and the percentage of IgG absorbed from the colostrum was also lower (9.71 vs 24.74; SEM 2.140; P<0.01). These data clearly show that when pregnant ewes have access to molasses based mineral licks in late pregnancy that water intake is considerably increased and the lamb has a dangerously lowered level of protective antibodies in the serum, so necessary to protect it from disease. Further research is needed to determine if the lowered IgG absorption is due to programming of the foetus in utero or is due to changed characteristics of the colostrum.

Key Words: Sheep, Colostrum, Immunoglobulin

1628 Performance of St. Croix White and Dorper x St. Croix White lambs from birth to weaning in the tropics. R.W. Godfrey^{*}, A.J. Weis, and R.E. Dodson, Agricultural Experiment Station, University of the Virgin Islands.

To evaluate the neonatal and pre-weaning performance of crossbred lambs under tropical conditions a Dorper (DRP) and a St. Croix White (STX) ram were bred to STX ewes (n = 12 and 14 ewes/sire, respectively). Ewes were maintained on guinea grass pastures (4 ha) in a rotational grazing system from the start of breeding (June) through weaning (August/September). The 24-hr milk production of all ewes was measured on days 7, 21, 35, 49 and 63 (lambing = d 0). Ewes were given 1 IU of oxytocin (i.v.) and milked by hand and separated from their lambs. Four hours later ewes were hand milked, using oxytocin, and the milk was weighed to determine 24-h milk production. Total milk production was determined as the sum of 24-h milk production for each day of milking. Ewes were weighed weekly. Lambs were weighed at birth and at weaning at 63 d of age. Data were analyzed using GLM procedures of SAS. Dorper-sired lambs were heavier at birth (P<0.008) than STX-sired lambs (3.4 ± 0.1 vs 2.9 ± 0.1 kg, respectively). Lamb survival rate at birth, 1 wk of age or weaning was not different (P>0.10) between DRP and STX sire groups (100, 95.2 and 85.7 vs 100, 88.5 and 84.6 %, respectively). Ewe body weight at lambing was not different (P>0.10) between DRP and STX sire groups (41.1 ± 1.5 vs 41.1 ± 1.3 kg, respectively). Weaning weight of DRP lambs was greater (P<0.008) than STX lambs (14.7 ± 0.4 vs 13.2 ± 0.4 kg, respectively). Ewe weight at weaning was not different (P>0.10) between DRP and STX sire groups (42.8 ± 1.6 vs 44.3 ± 1.6 kg, respectively). Milk production of ewes during the 63-d lactation was not different (P>0.10) between sire groups. There was no difference (P>0.10) in total milk production between DRP and STX bred ewes (4577 ± 324 vs 4507 ±

298 g, respectively). The results of this study show that STX ewes can raise DRP sired lambs under the tropical conditions found on St. Croix.

Because the crossbred lambs were heavier than the purebred lambs the potential exists for an increase in meat production.

Key Words: Sheep, Crossbreeding, Growth

Women and Minority Issues in Animal Agriculture

1629 Status and role of women in rural livestock production in central Punjab, Pakistan. A.U. Hyder, M. Abdullah*, and N. Khatoun, *University of Agriculture, Faisalabad, Pakistan*.

A survey of 105 farm families, selected randomly from village Youngpur, Okara, was conducted for ascertaining the contribution of women in livestock production. More than 65 % of the respondent families were having < 6 acres of land, however, some of them acquired some additional land on rent or as a tenants. The second major source of income was livestock after agriculture and 94 % families were engaged in raising livestock. Annual income per family ranged from Rs. 10,000

to 100,000. About 30, 31 and 41 % women were involved in fodder harvesting, hauling and chaffing respectively, while 29, 20 and 33 % were partially involved in these activities and remaining did not perform this work. Participation in livestock management was 82, 89, 91, 94 and 86 % for feeding and watering, milking, milk processing, manure disposal and marketing of products, respectively. Extent of women participation in livestock management was not affected by the level of education, age, size of land holding extent of their involvement in family affairs, their perception as house wives and annual income.

Key Words: Livestock production, Women in agriculture, Socioeconomic status

ADSA Student Affiliate Division Original Research/Independent Study

1630 Effect of breed, parity, and stage of lactation on milk fat content of CLA in the dairy cow. J.A. Kelsey¹, B.A. Corl^{*1}, R.C. Collier², and D.E. Bauman¹, ¹*Cornell University, Ithaca, NY*, ²*University of Arizona, Tucson, AZ*.

Conjugated linoleic acid (CLA) has been shown to possess a variety of health benefits in biomedical studies with animal models. Foods of ruminant origin are the major dietary source of CLA. Some milk fat CLA originates from CLA that escapes complete rumen biohydrogenation, but the major source is endogenous synthesis via Δ^9 -desaturase from *trans*-11 C_{18:1}. The four primary substrates for Δ^9 -desaturase are C_{14:0}, C_{16:0}, C_{18:0}, and *trans*-11 C_{18:1}. The ratio of these and their products (desaturase index) serves as a proxy for Δ^9 -desaturase activity. Diet has a major influence on milk fat CLA, however the effect of animal-related aspects is largely unknown. Our objectives were: 1) to determine the influence of breed, parity and stage of lactation on milk fat content of CLA and 2) to examine variation among individuals in milk fat content of CLA and desaturase index. Holstein (n = 116) and Brown Swiss (n = 106) cows (University of Arizona herd) were fed the same traditional TMR diet and milk was sampled on the same day to eliminate diet and seasonal effects. Cows ranged from 7 to 522 DIM and varied in parity (primiparous = 97 and multiparous = 125). Fatty acid analysis demonstrated that stage of lactation and parity had minimal effect on CLA. Breed differences were significant (p<0.05), but of small magnitude; CLA averaged 4.4 ± 0.1 vs 4.1 ± 0.1 mg/g fatty acid for Holsteins and Brown Swiss, respectively. Similarly, *trans*-11 C_{18:1} concentration was higher in Holsteins than Brown Swiss (11.4 ± 0.2 vs 9.5 ± 0.2 mg/g fatty acid). Overall, the proportion of fatty acids that were γ C16, C16, and δ C16 were 20.7 ± 0.2 , 30.7 ± 0.1 , and 48.7 ± 0.3 for Holstein, and 22.5 ± 0.2 , 30.7 ± 0.1 , and 46.8 ± 0.3 for Brown Swiss. There was a three-fold variation among individuals in milk fat content of CLA and in the desaturase index for all desaturase pairs. Overall, results indicate that breed, parity and stage of lactation had only minor effects on CLA concentration, but substantial individual variation existed in CLA content and desaturase index of milk fat.

Key Words: CLA

1631 Nanofiltration of tryptic peptide mixtures in the presence of β -lactoglobulin. J. Lemay*, S. F. Gauthier, and Y. Pouliot, *Centre de recherche STELA, Université Laval, Sainte-Foy, Quebec, Canada*.

The separation of peptide mixtures by nanofiltration (NF) membranes is strongly affected by electrostatic interactions between peptides and with the negatively charged membrane material. Our work is based on the hypothesis that adding β -lactoglobulin (β -LG) to a peptide mixture can modify its NF-fractionation profile by promoting Donnan exclusion phenomena and by specific interactions between β -LG and peptides. The goal of our study was to evaluate the effect of adding β -LG on the permeation flux and peptide transmission during NF. Solutions 1% w/v of β -LG tryptic peptides were prepared at different levels of added β -LG (

0, 0.01, 0.05, 0.07, 0.1, 0.3 and 0.5 %), and the solutions were adjusted at 3 different pH values (5.0, 7.0 et 9.0). Solutions were concentrated using a polymeric NF-membrane mounted on a dead-end cell, to a volumic concentration factor of 3X. A significant effect of the pH (p < 0.001) on permeation flux and protein concentration of the permeate was found. The lowest values of permeation flux was observed at pH 7.0, and the highest nitrogen transmission was obtained at pH 9.0. Levels of added β -LG had a significant effect (p < 0.001) only on the permeation flux. Our results suggest that presence of β -LG in the polarization layer affects the NF-separation characteristics of peptide mixtures. Preliminary data revealed changes in peptides transmission through NF-membranes as a result of the presence of β -LG. Similar experimental conditions are currently used to study the effect of added β -LG on peptides transmission by NF-membranes in tangential filtration mode.

Key Words: β -lactoglobulin, peptides mixtures, nanofiltration

1632 The effect of dietary zeolites on fecal ammonium concentrations. E. L. Williams*, F. Lundy², and G. A. Varga¹, ¹*Pennsylvania State University*, ²*Clemson University*.

The objectives of this study were to determine the effects of type of zeolite on the release rate of ammonium nitrogen from manure and effects on dry matter intake, nutrient digestibility, and milk production. Phillipsite and Clinoptilolite, both naturally occurring hydrophilic zeolites, were selected for their ability to adsorb ammonium. The synthetic hydrophobic zeolite, CBV, was selected for its ability to remove odor causing organic molecules. The experiment was conducted using multiparous Holstein cows (197 \pm 25.41 DIM), in a 4 x 4 replicated Latin Square design. Cows were fed one of three zeolites, Clinoptilolite, Phillipsite, or CBV, topdressed at 2% DMI and a control ration without zeolite. Diets were formulated to contain on a DM basis 49% forage and 51% concentrate with a nutrient composition of 17.5% CP, 1.73 Mcal/kg NEL, and 34% NDF. Experimental periods were 21 days in duration and feces and urine were collected on d 17, 18, 19 pooled and then subsampled. Fecal ammonium concentrations were evaluated using a system for indirect measurement of ammonium nitrogen. The Quantofix-N-Volumeter, a commercially available product, utilizes a system of reactions that allows ammonium nitrogen content to be determined through water displacement. Compared to the control, addition of the zeolite to the diets did not have an effect on dry matter intake (20.8 kg/day \pm 0.64), fiber digestibility (41.8% \pm 1.1), or milk production (24.3 kg/day \pm 1.1). An average increase of 30% fecal ammonium nitrogen concentration was observed for all zeolites compared to the control (P < 0.11; 1.90 kgs/m³ vs 2.46 kgs/m³). Results of this study demonstrate that the addition of zeolites to the diets of Holstein cows increases ammonium nitrogen binding in the manure, thereby decreasing the release rate of ammonium nitrogen into the environment.

Key Words: Zeolite, Ammonium, Manure

1633 The effects of Echinacea on immune function of transitional calves. N. R. Gill^{*1}, C. Powell², S. T. Franklin¹, and K. I. Meek¹, ¹University of Kentucky, ²Western Kentucky University.

In making the transition from a relatively isolated environment in the calf hutch, to a community within the heifer barn, calf immune efficiency may be challenged. The objective of this study was to determine the effects of Echinacea, a suspected herbal immuno-stimulant, on immune function in transitional calves. Ten weaned calves were assigned to treatments of 0 or 2.5 g of Echinacea and supplemented daily for seventeen days in the normal calf ration. Blood samples and body weights were obtained periodically. Immune function was evaluated using flow cytometric analysis of mononuclear leukocytes, white blood cell counts, neutrophil assays, packed cell volumes, serum protein concentrations. Monocyte percentages in treated calves decreased ($P=0.0343$) over time and varied between breeds. B cell percentages also decreased ($P=0.0403$) with treatment as well as with treatment over time. CD4+ T cell levels significantly increased ($P=0.0253$) with Echinacea supplementation and CD2+ T cell and white blood cell percentages tended to be higher in treated calves. Neutrophil assays indicated no effect of treatment on neutrophil function. Packed cell volumes, serum protein concentrations and body weight values also demonstrated no effect by treatment. Calf handlers observed that calves fed the supplement had firmer feces than the untreated calves, but these observations were so few that they were not included in the statistical analysis. The results of this experiment indicate a potential for Echinacea to modulate immune function in calves.

Key Words: Echinacea, Immune Function, Calves

1634 Comparison of Holstein and Holstein-Jersey crossbred heifer calves for body weight, hip height, and average daily gain from birth to 56 days of age. R.M. Templeton^{*1}, J.G. Linn¹, A.J. Seykora¹, and B.J. Heins¹, ¹University of Minnesota.

A crossbreeding project involving the Holstein and Jersey breeds was initiated at the University of Minnesota, St. Paul Dairy Teaching and Research Facility. Twenty-four Holstein heifer calves and twenty-seven Holstein-Jersey crossbred heifer calves were born from September 2001 to February 2002. Duration of this study was from birth to 56 days of age. Calves were fed colostrum for the first 3 days and then milk replacer at 10% of birth weight until weaning at 42 days of age. Calves were also fed a dry calf starter ad libitum from 3 days of age. No hay was fed during this period. They were housed in individual calf hutches. Survivability of calves to 56 days was 100% immediately following birth and at 28 and 56 days of age. Least squares means were determined using the PROC GLM of SAS. Holstein calves were significantly larger than crossbred calves at birth. At birth, Holstein calves weighed 42.1 kg and the crossbred calves weighed 35.2 kg. Hip heights averaged 62.9 cm and 60.5 cm for the two genetic groups. From birth to 28 days of age, Holstein calves averaged .41 kg gain per day, while the crossbred calves averaged .37 kg ($P<.10$). The Holstein calves did gain significantly faster ($P<.01$) from 28 to 56 days of age; averaging .96 kg per day versus .82 kg per day for the crossbreds. The average daily gains for the first 56 days of life averaged .68 kg per day for the Holsteins and .60 kg per day for the crossbreds ($P<.01$). The 56 day average weights for the Holsteins and crossbreds were 80.1 kg and 68.2 kg, respectively ($P<.01$). Holsteins averaged 74.2 cm tall at 56 days and the crossbreds averaged 70.3 cm tall ($P<.01$).

Key Words: Holstein-Jersey Crossbreeding, calf size

1635 Am vs. Pm harvest of alfalfa forage for hay and haylage. I. A. Norris^{*1}, K. Ballard², C. Cotanch², M. Carter², and E. Thomas², ¹Louisiana State University, Baton Rouge, LA, ²W. H. Miner Agricultural Research Institute, Chazy, NY.

In the last few years a significant amount of research has focused on the question, "Is it better to mow forages in the morning or the afternoon?" To address this question, the objective of this research was to determine if there were differences in forage quality in Am and Pm cut alfalfa. Two alfalfa seedings were selected based on approximate stage of growth and density in the field. Each field was divided into plot A or B, and each plot was sub-divided into Am and Pm sections. Fresh forage samples were collected after mowing, and additional samples collected after being wilted for 6 hours and 24 hours. When the alfalfa had been

wind-rowed for chopping, samples were taken one-hour before being harvested and after chopping. Daily air temperature, humidity, wind speed, and solar radiation were measured to account for differences in drying time and possibly forage quality at harvest. All samples were analyzed for dry matter, crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), non-structural carbohydrates (NSC), sugar, and starch levels. Additionally, approximately 4000 grams of undried chopped samples for both Am and Pm sections of fields 1 and 2 were packed into mini silos. After 90 days silage samples were analyzed to determine changes in forage quality. Alfalfa cut in the Am was higher ($P=.02$) in ADF. For both fresh and chopped samples CP and NDF did not differ ($P<.05$) between Am and Pm cuttings. The percent NSC of fresh Pm samples was greater ($P=.0129$). There also was a trend for chopped samples to be slightly higher ($P=.05$) in NSC in Pm cut sections. Sugar levels were greater in the afternoon for both fresh ($P=.005$) and chopped samples ($P=.02$). Starch levels were numerically higher in the fresh and chopped Pm samples. These data indicate that the time of cutting may affect alfalfa forage quality. Although this factor should be taken into consideration in forage management, it may not be feasible for all producers to alter their current cutting and harvesting practices.

Key Words: alfalfa, cutting time, quality

1636 Stability of oil in water emulsions formed in presence of skim milk powder: effect of calcium salts and heat treatments. Deepa Mathew^{*} and Phillip, S Tong, *California Polytechnic State University, San Luis Obispo, CA.*

Stability of oil in water emulsions made with soy oil, water and skim milk powder fortified with calcium salts was studied. Four salts - calcium carbonate, calcium phosphate, calcium citrate and calcium lactate were studied separately. The amounts of skim milk powder and calcium salts were adjusted so that the protein content in the final emulsion was either 3.5% or 1.75% (w/w) and calcium content was either 0.24% (w/w) (2 times the amount naturally present in milk) or 0.36% (w/w) (3 times the amount naturally present in milk). Skim milk powder and calcium salt were blended together. The dry mixture was reconstituted in the required quantity of water and was kept at 5°C for 18 hrs for proper hydration of the powder. The temperature was then brought up to 25°C; soy oil was added (10% (w/v) and homogenized with a two stage homogenizer (first stage pressure of 13.8 MPa and second stage pressure of 3.45 MPa). The emulsions were subjected to either pasteurization (63°C for 30 minutes) or retorting (121°C for 16 minutes) and then were cooled to 25°C. Stability of emulsions was studied by measuring particle size distributions and fat analysis of the cream layer after centrifugation. Calcium phosphate caused immediate instability at both levels of calcium and protein. As a result, further studies were not pursued with calcium phosphate. It was observed that with the other three salts, instability of emulsions decreased as the protein content increased, for the same level of calcium. In all cases, retorted samples were more unstable compared to pasteurized samples. Emulsions containing calcium lactate and calcium citrate were more sensitive to heat treatments than emulsions containing calcium carbonate. The most stable emulsions were obtained when calcium carbonate was added (even more stable than control sample with no added calcium at 1.75% protein).

Key Words: Emulsion, Stability, Calcium

ADSA Student Affiliate Division Dairy Foods

1637 Methods of inhibiting bacteriophage infections in lactococcal bacteria. M. L. Bush*¹, ¹*University of Kentucky.*

Lactococcal microorganisms are used in the fermentation and production of dairy foods such as cheese and yogurt. These fermentations are inhibited when bacteriophages, or phages, infect the culture bacteria, and cause lysis of the cells. Bacteriophages search for specific host receptor sites for attachment. Research has shown that phages attach to bacterial cell walls in locations where nutrient transport occurs, perhaps because the cell wall is thinner and more permeable. Typically, these locations are rich in carbohydrates, and multiple phages are found stuck to these sites. After the phages are initially attached to the bacteria, subsequent phage movement works the spikes deep into the cell wall so that the phage tail is irreversibly attached. Enzymes that degrade the cells' membranes have been observed at work, which may be important in triggering the release of ATP that allows the injection of phage DNA into Lactococcal cells. The phage genetic material then takes over control of the cells' actions so that more viruses can be replicated. Techniques including culture rotation, growth of phage-resistant mutants, and use of phosphate media have been used to limit phage infections. Some defined cultures have been partially protected through genetic techniques. Another technique involves introduction of peptides to growth media that compete with viable phages for cell receptor sites. Successful cheese and yogurt fermentations in the future will probably result from a combination of multiple techniques to prevent phage attachment, DNA injection, replication, and lysis of the host cell.

Key Words: Bacteriophage, Bacteria, Lactococci

1638 The organic cheese industry and where it is headed. Mandy McIsaac*, *California Polytechnic State University, San Luis Obispo, CA.*

The interest in and consumption of organic dairy products, as well as other foods continue to increase each year. In order to be considered certified organic cheese, cows must not receive any hormones or antibiotics and have to be fed organic feed. Certification also requires that the land be certified organic and the cheese plant must be environmentally safe. Organic cheese makers have been working to maintain the integrity and safety of the products while using limited resources because of organic specifications. Although the procedures for organic cheese making do not vary greatly from the production of non-organic cheese, the quality of the ingredients is perceived by consumers to be more wholesome, as many of the standards are very high for organic production. However, there has been no evidence showing that non-organic cheese is of lesser quality than organic. Many organic producers are instilling artisan cheese making practices to ensure a pure and wholesome finished product. The steps in the organic cheese making process are similar to that of non-organic cheese. However, the production of organic cheese allows these processors to establish a niche market that fulfills the needs and perceptions of the consumers. The small volume produced by most organic processors creates a unique product that tends to be appealing to its customers. Generally, these small production organic cheeses can be found in natural food stores, upscale groceries, and specialty markets.

Key Words: organic, cheese, niche market

1639 What's in a name? A closer look at the Physicians Committee for Responsible Medicine. L.L. Connelly*¹, ¹*Pennsylvania State University.*

The Physicians Committee for Responsible Medicine (PCRM) is an active group of individuals dedicated to persuading the American public into choosing a strictly vegan diet. This group has established a facade amongst the public. They are often perceived as a reputable group of physicians concerned for the preventative health of Americans. However, there is much evidence demonstrating that their campaigns are indeed illegitimate. Several animal rights and animal liberation organizations have ties to PCRM. The PCRM has implemented several tactics to convey their messages. Such tactics include exaggerations, insinuations, creating a false trust, and instilling fear into their audience. These tactics have primarily been used to steer consumers away from milk and dairy products.

The American Medical Association (AMA) agrees that the PCRM is an illegitimate group of activists that irresponsibly misinforms the public. Many of the PCRM's claims about dairy products have been disproved by scientific studies, and their techniques for unsound science have been refuted by leading experts.

Key Words: PCRM, Dairy foods

1640 All milk, all the time: Milk vending machines. R. A. Cornman*¹, ¹*Virginia Polytechnic Institute and State University.*

The dairy industry has made tremendous strides in recent years in the marketing of milk and dairy products. Milk vending machines are an important innovation to increase demand. This technology presents both challenges and opportunities to the dairy industry, to manufacturers of vending equipment, and to schools, companies, and institutions interested in using these machines. Dairy processors, schools, vending companies and others have launched pilot studies to evaluate the use of milk vending machines in school and work settings. To increase fluid milk consumption and encourage youth to choose a healthier alternative to soft drinks, schools have been the primary settings for the pilot studies. Dairy Management, Inc. conducted one such milk vending test in 2001 placing machines in middle and high schools in five regions of the country: Boston, MA; Miami, FL; Omaha, NE; Austin, TX; and Southern CA. Average weekly sales per machine were 280 units; students preferred flavored milk to white milk by a ratio of nine to one. This pilot test indicates that milk vending machines may lead to increased milk consumption. However, there are challenges involved in their operation. Important considerations include management of the machine, financing, and proper machine design and placement. Milk vending machines have tremendous potential to promote milk products and to provide consumers with cold refreshing milk at any time of the day.

Key Words: Milk vending machines

1641 Organic: Is this the future? R. Blades*¹, ¹*Louisiana State University, Baton Rouge, LA.*

As we have learned over the last few years, organic food products have really made their way into the market. These products have the ability to make an impact on everyone's life, but may be more influential to those who are health conscious. Organic is a philosophy and system of production that mirrors the natural laws of living organisms with the emphasis on the interdependence of all life. Specific to the dairy industry is organic milk, which is produced without using any antibiotics, herbicides, pesticides, insecticides, fertilizers, or hormones. For those health conscious individuals, the possible benefit of organic milk and dairy products is the reduced exposure to these substances they believe to be harmful. These organic products are expensive, so the consumer must decide if the potential advantages are worth the extra cost. In order to tell if a product is "certified organic," it must have "certified organic" stamped on the package. For a product to be considered organic, the materials and methods used throughout the entire manufacturing process must be certified through the use of a paid third party agent. Organic products have found their way into our market, and are probably here to stay.

Key Words: organic, dairy products

ADSA Student Affiliate Division Dairy Production

1642 Nutritional approaches to reduce phosphorus losses from dairy farms. Katie Peacock*¹, ¹*Virginia Polytechnic Institute and State University, Blacksburg, VA.*

Dietary nutrient management is a powerful and cost-effective approach to reduce the environmental impact of dairy farms. Producers overfeed phosphorus (P) to lactating dairy cows without beneficial effects on cow performance. This overfeeding is an environmental concern, because it increases excretion of P, increasing the risk of over-application of manure P to cropland. Over-application of manure P increases P runoff, leading to surface water contamination. This issue is becoming more important to producers trying to meet increasingly stringent nutrient management regulations. One way to minimize P excretion is to reduce P intake. Feeding diets that meet the P requirements of cows decreases the amount of P that is excreted compared to current feeding practices. In one study, the P content of diets was reduced from 0.49% to 0.40%, and P excretion through manure was reduced by 23%. There were no effects of dietary P on cow health or production in this study. Other research indicates that P deficiency symptoms are not observed until dietary P is reduced to .31% P or less. Despite the lack of benefit to increased dietary P, a survey of 33 Virginia dairy herds indicated that the average farm overfed P by 45%, increasing purchased feed costs by \$1,059/100 cows/year. This degree of overfeeding would increase acreage required to land apply manure by 69% for farms under P-based manure application limits. Ongoing research focuses on the identification of field level indicators of P status to encourage farmers to reduce overfeeding. Producers can reduce feed costs, minimize P content of land-applied manure, and reduce environmental contamination by formulating diets to more precisely meet the P requirements of lactating cows.

Key Words: Phosphorus, Water Quality, Dairy Cattle

1643 Production of volatile fatty acids and rumen pH in dairy cattle. A.M. Reynolds*, *California Polytechnic State University, San Luis Obispo.*

Feeding cows requires the support of an environment of rumen microorganisms that share a symbiotic relationship with the cow that are affected by fluctuations in rumen pH. These changes in rumen pH will inevitably affect the production of volatile fatty acids correlating to the cow's overall milk production and milk fat synthesis. These ratios of volatile fatty acids specifically acetate to propionate, can differ as the pH in the rumen changes. Changes in rumen pH are affected by the feeding of the cow but can be controlled by certain feeding strategies. The feeding of a total mixed ration helps to alleviate rumen depressions by providing a mix of both concentrates and roughages. Multiple feedings per day versus once or twice a day has metabolic consequences by causing alterations in rumen pH, thus affecting the ratio of acetate to propionate. By providing the recommended physical effective neutral detergent fiber (peNDF) and/or a buffer can minimize the depressions in rumen pH. Optimizing the acetate to propionate ratio should be the goal when maximizing milk fat capability and milk production.

Key Words: Volatile Fatty Acids, Rumen pH, Dairy Cattle

1644 Storks and scientists. J.R. Swallow*¹, ¹*Pennsylvania State University.*

With today's cutting edge biotechnology, the age-old question, "Is it a heifer or a bull?" may be erased from our minds. New technology allows scientists to separate X and Y-chromosome bearing sperm from one another with up to 95% accuracy. These laboratory procedures utilize high-speed flow cytometry coupled with DNA staining to identify and separate X and Y-chromosome carrying sperm. The theory behind the machine lies in the inherent difference in DNA content between the X and Y-chromosomes. Sperm are sorted by measuring the fluorescent intensity of each individual sperm cell. Field trials using sexed semen from this procedure have shown much success in producing viable offspring in all of the major livestock species and humans. Combined with other assisted reproductive techniques (ARTs), sexed sperm should give breeders the opportunity to produce what the industry needs at a particular point in time. Many economic considerations and efficiency obstacles still stand in the way of the commercialization of sexed semen, but this new technology has

the potential of turning into a readily accepted breeding standard much as AI has today.

Key Words: Sexed semen, Artificial insemination

1645 Feeding anionic rations to pre-fresh dairy cows. R Leuer*, ¹*University of Minnesota.*

Optimal management and feeding of transition cows can result in gains of 1500 to 3000 pounds of milk per lactation. Every cow experiences varying degrees of hypocalcaemia at parturition, and it is in the herds person's best interest to minimize this problem by effective feeding practices. Varying degrees of feeding calcium to pre-fresh cows has been used as a management tool to prevent severe hypocalcaemia, or milk fever as it is commonly called. Restricting calcium to reduce the incidences of milk fever can be difficult to achieve, as investigations have shown that intake of calcium needs to be limited to less than 15g calcium/cow/day. An alternative strategy is to add ions to induce mild acidosis. Anionic rations seek to affect the cow's acid-base balance instead of just focusing on the level of calcium fed to the animal. Balancing anionic rations takes into account the level of calcium, potassium, chlorine and sulfur that is in the diet. The desired ionic balance may be accomplished by limiting potassium and adding sources of chlorine and sulfur that carry negative charges. Monitoring of successful anionic diets can be accomplished through urine pH analysis. Acid-base balance within the animal causes the pH of the urine to change. If a pre-parturition diet is properly balanced, the dietary cation-anion balance will produce a urine pH of ≤ 6.5 . A properly balanced anionic diet will result in an elevated blood calcium level at parturition, increased muscle tone, and reduction in the incidences of milk fever, displaced abomasums, udder edema, and retained placenta. Studies have shown that feeding phosphorus at a rate of over 80g phosphorus/cow/day may increase milk fever. Other research has indicated that cows can be successfully fed 150g calcium/cow/day combined with anionic salts to prevent hypocalcaemia. Anionic pre-parturition diets are a viable alternative to reduced calcium intake diets for the reason that they maintain blood calcium levels and at the same time decrease incidences of milk fever.

Key Words: Pre-fresh, Anionic, Milk fever

1646 Mastitis: Prevention is the best cure. I. F. Jackson III*¹, ¹*University of Georgia.*

Controlling mastitis has been a major challenge to the dairy industry. With the advances in animal technology, there have been many things done to lessen the effect mastitis has had on an individual and an entire herd. The most important improvements being made today are the changes in milking procedure. More care is being taken to prevent mastitis from occurring in dairy cattle. This has proven to be a cost effective way of controlling mastitis in today's larger dairies. No matter how good and fine tuned a procedure is, there will always be that one cow that comes down with mastitis and treatment is needed. There are also improvements in the way dairy cattle are treated for mastitis, therefore lessening the chance of recurrence and the possibility of spreading mastitis to other cattle in the herd. Dry cow antibiotic preparations have also been proven to be a vital asset to the dairy farmer. Other advances have allowed treatments to be manufactured that have a shorter withdrawal time, therefore reducing the number of milkings that have to be dumped from a treated individual. It all boils down to proper milking procedures and correct handling of dairy cattle to reduce and control mastitis in a herd.

Key Words: Mastitis, Controlling Mastitis, Preventing Mastitis

1647 The effect of dietary tribasic copper chloride, Availa®Cu copper amino acid complex, zinc oxide, and combinations on nursery pig growth performance. Terry L. Ward*¹, Timothy M. Fakler¹, Murray J. Pettitt², and Eduardo Beltranena², ¹*Zinpro Corporation*, ²*Prairie Swine Centre Inc.*

Five hundred-twelve pigs weaned at 19.70 d were used to compare the effects of the dietary inclusion of Cu from Cu₂(OH)₃Cl (TBCC) or Availa-Cu (CuAA), Zn from ZnO, and combinations to Phase 1 (0-14 d) and Phase 2 (15-35 d) nursery diets on ADG, ADFI, and feed:gain (F:G).

Eight pigs per pen (4 males and 4 females) were randomly assigned to 8 treatments within 4 location blocks within 2 rooms. Treatment diets for Phase 1 included 1) a control diet (C), 2) C + 200 ppm Cu as TBCC, 3) C + 100 ppm Cu as CuAA, 4) C + 100 ppm Cu as CuAA, 5) C + 3000 ppm Zn as ZnO, 6) C + 200 ppm Cu as TBCC + 3000 ppm Zn as ZnO, 7) C + 100 ppm Cu as CuAA + 3000 ppm Zn as ZnO, 8) Control + 3000 ppm Zn as ZnO. In Phase 2, treatments were the same, with the exception of 4) C + 50 ppm Cu as CuAA and 8) C + 100 ppm Cu as CuAA. In Phase 1, pigs fed CuAA, TBCC, or ZnO had increased ADG ($P \leq 0.02$) and ADFI ($P \leq 0.10$). Pigs fed CuAA had decreased ($P \leq 0.04$) F:G. Pigs fed TBCC or ZnO tended to have increased F:G, but pigs fed the combination of TBCC and ZnO had decreased F:G (TBCC \times ZnO, $P \leq 0.08$). In Phase 2, pigs fed TBCC had decreased ($P \leq 0.01$) ADG and ADFI. Pigs fed ZnO had increased ($P \leq 0.07$) ADG and ADFI. The inclusion of ZnO partially ameliorated the negative effect of TBCC on ADG (TBCC \times ZnO, $P \leq 0.06$). Pigs fed CuAA had higher ($P \leq 0.01$) ADG and ADFI, and lower ($P \leq 0.10$) F:G compared to pigs fed TBCC. During d 0-35, pigs fed CuAA had increased ADG and decreased F:G ($P \leq 0.02$). Pigs fed ZnO had increased ($P \leq 0.02$) ADG and ADFI. Pigs fed TBCC had decreased ADG ($P \leq 0.10$) and ADFI ($P \leq 0.06$). The inclusion of TBCC decreased ADG and increased F:G but not in the presence of ZnO (TBCC \times ZnO, $P \leq 0.02$). Pigs fed CuAA had greater ADG and ADFI, but lower F:G than pigs fed TBCC ($P \leq 0.04$). Overall, these results indicate that inclusion of Availa-Cu or ZnO in nursery pig diets improved growth performance, but TBCC decreased growth performance.

Key Words: Copper Amino Acid Complex, Growth Performance, Nursery Pig

1648 Cow response to summer environmental conditions within tunnel-ventilated and naturally ventilated dairy freestall facilities. R.R. Stowell¹, C.A. Gooch¹, S.F. Inglis¹, N.R. St. Pierre¹, and E.J. Beiler¹, ¹*Biological Systems Engineering, University of Nebraska-Lincoln, Lincoln*, ²*Cornell University, Ithaca, NY*, ⁴*The Ohio State University, Columbus*, and ⁵*Mercer County, Celina, OH*.

Cows in three pairs of naturally ventilated and tunnel-ventilated dairy barns were monitored during the summer of 2000 to compare cow activity, respiration rates, and milk production of the animals housed within barns with the differing systems. Supplemental cooling fans were used within each of the naturally ventilated barns to direct airflow onto the cows. Ambient air temperatures during midsummer were cooler than normal in New York and Ohio, but both states had near-normal cooling seasons. No consistent differences existed between activity levels of cows within naturally ventilated and tunnel-ventilated barns. Average levels of productive activity (eating or resting) within the study barns ranged from 60-77%. Statistically significant differences in activity levels existed between regionally paired barns in Ohio, but the differences conflicted. As interior THI rose, the trends were for the shares of cows at the bunk to increase very slightly, cows lying in stalls to decrease fairly steadily, and, subsequently, cows resting or eating to decrease.

Similar trends existed for the variables regressed against interior air-speed. Measured respiration rates of resting cows within 2 of the 3 tunnel-ventilated barns were higher than within the corresponding naturally ventilated barns. The respiration rates measured in this study may show some negative effects of reduced air velocity within stall areas of tunnel-ventilated barns. The data do not represent the status of all cows in the barns very well, however, since the status of cows standing within the barns was not ascertained. Respiration rate was moderately correlated to THI within the representative quadrant. Respiration rate did not appear to be as associated with airspeed and airflow through the barns as was cow activity. Associations between milk yield per cow and air temperature and wind speed were evident for both ventilation systems. No difference in the net impact of ventilation system selection on milk yield could be determined in this study. Risk management approaches should be used to evaluate these systems.

Key Words: Cow Behavior, Heat Stress, Milk Yield

1649 Effect of high fat diet on reproduction in replacement beef heifers. D. L. Cuddy*, J. B. Hall, W. E. Beal, and W. S. Swecker, *Virginia Tech, Blacksburg, VA*.

High fat diets may affect reproduction in cows. The objectives were to examine the effects of feeding a high fat diet to periparturient beef heifers on puberty, estrus response to synchronization, pregnancy rates, and ovarian structures. During a two yr study, crossbred heifers ($n = 44/\text{yr}$), blocked by BW, received a high fat which contained whole cottonseed, (HF; 5.0% fat) or a normal (NORM; <2.0% fat) diet. Silage based diets, formulated to be isonitrogenous, isocaloric and meet NRC requirements for replacement heifers, were fed for 100 d. Heifers were weighed every 14 d. Starting on d 42 of the trial, heifers were estrous synchronized using the MGA-PGF system (0.5mg MGA/hd/d for 14 d with an injection of 25mg PGF2 α 19 d after cessation of MGA feeding). Estrus was monitored by the Heat Watch[®] estrus detection system. From d 75 to d 100, heifers were artificially inseminated (AI) 12 h after estrus. Ten d after the end of the AI period, heifers were exposed to a fertile bull for 30 d. During year one, ultrasonography of ovarian structures was performed on d 59, 75 and 78 of the experiment, and data from 5 heifers from each treatment analyzed. Weights of HF and NORM heifers were similar ($P = 0.8$) after receiving their respective diets for 100d. HF and NORM heifers were similar for diameter of the dominant follicle after MGA ($n=41$; $P = 0.7$), size of the CL at injection of PGF2 α ($n = 31$; $P = 0.3$), and diameter of the ovulatory follicle 3 d after PGF2 α injection ($n = 10$; $P = 0.6$). Similar numbers of HF and NORM heifers exhibited estrus following PGF2 α ($P = .3$). No treatment differences were detected for synchronized AI (S-AI; $P = .28$) and total AI (T-AI; $P = .18$) pregnancy rate. Pregnancy rates to S-AI were 52.3% (23/44) and 38.6% (17/44), whereas T-AI pregnancy rates were 70.5% and 56.8% for HF and NORM heifers, respectively. However, fewer HF than NORM heifers ($P=.1$) were pregnant to natural service. Feeding a high fat diet to replacement beef heifers did not improve reproduction, but effects on pregnancy rate may warrant further study.

Key Words: Heifers, Dietary fat, Reproduction